The Hague Centre
for Strategic Studies

Navigating the great game of chokepoints

Assessing geopolitical risks and advancing Dutch and European strategic indispensability in digital value chains

Joris Teer, Abe de Ruijter and Michel Rademaker

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Executive summary

1. Introduction

Context: interdependence at a time of great power competition

"For want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the battle was lost. For the failure of the battle the kingdom was lost – All for the want of a horse-shoe nail."

Variations of this rhyme, attributed to a variety of people, have appeared over the last 1000 years.

Norms, rules and institutions governing international trade have rapidly eroded, mainly due to rapidly intensifying competition between great powers.

In the Post-Cold War era the global economy grew more intertwined than ever before. The last thirty years of hyper globalisation bound the world's great economic powers, China, the U.S. and the EU, in a web of value chains stretching the globe.[1] In the last seven years, however, the norms, rules and institutions governing international trade have rapidly eroded, mainly due to rapidly intensifying competition between great powers . After all, their actions to a large extent determine the rules of the game.

Within value chains, states increasingly leverage strategic dependencies to exert power: they manipulate "money, goods and information" flows by making use of chokepoints in the global economy to achieve their preferred policy outcomes.[2]The Trump Administration used extra-territorial sanctions to block the completion of the Nord Stream 2 pipeline, fearing European overdependence on Russian natural gas. Putin halted exports of natural gas, in order to punish European states for export of weapons to Ukraine and sanctions against Russia. The Trump and Biden Administrations, together with allies in Europe and Asia, instituted increasingly expansive export boycotts to prevent China from developing an advanced, domestic semi-conductor industry. The G7, Taiwan and South Korea imposed a near-comprehensive ban on chip exports to Russia following its invasion of Ukraine. Beijing leveraged its export of critical economic inputs, namely its dominant position in the production of critical raw materials.[3]

1 Arvind Subramanian and Martin Kessler, 'The Hyperglobalization of Trade and Its Future - Working Paper', July 2013, https://www.piie.com/sites/default/files/publications/wp/wp13-6.pdf. The report refers to only China, the U.S. and the EU when it speaks of "economic great powers."

2 Henry Farrell and Abraham L. Newman, 'Weaponized Interdependence: How Global Economic Networks Shape State Coercion', *International Security* 44, no. 1 (1 July 2019): 45, 46, https://doi.org/10.1162/isec_a_00351.

3 Since 1 August 2023 the export of gallium and germanium, two critical raw materials that are used to produce semiconductors and defence technologies, requires a license by China's Ministry of Commerce. In addition, China introduced export limitations on graphite, a crucial material for the energy transition and obliged exporters to report the quantities and destinations of shipments of Rare Earth Elements (REE). In 2010, China imposed temporary restrictions on the export to Japan of rare earths, a key raw material for the production of semiconductors, smartphones, computers, MRI scanners and pacemakers, after the Japanese coastguard seized a Chinese fishing trawler around disputed islands in the East-China Sea.

In response, first China, then the U.S. and finally the EU expanded innovation and industrial policies to make their economies more geopolitically shock-resistant. Through these initiatives, the economic great powers aim to enhance security of supply of critical economic inputs. Critical economic inputs can be end-products or applications (e.g., cloud services), components (e.g., semiconductors) and materials (e.g., rare earths). The Made in China-2025 initiative, the U.S. CHIPS and Science Act, the Inflation Reduction Act (IRA), the European Chips Act and the EU's Critical Raw Materials Act (CRMA) are all examples of initiatives that seek to achieve greater security of supply. These initiatives confirm that the world economy is moving away from a neoliberal model, based on global, just-in-time supply chains with cost-efficiency as its central organizing principle, to a new competitive model in which economic resilience and security of supply became increasingly important.[4]

During the same period, digitalisation and the fourth industrial revolution have gone hand in hand with the rise of new winner-take-all industries. Microsoft 365 takes up almost 90 percent of the global market for productivity suites.[5] Google Cloud, Microsoft Azure and Amazon Web Services (AWS) dominate the cloud services market, having a conjoint market share of around 70 percent in the Netherlands and the EU.[6] Only three companies dominate the 5G network market in Europe, with China's Huawei initially offering substantially lower prices than Nokia and Ericsson.[7] Whereas in the year 2000 more than 20 companies made the world's most advanced chips, there were only two left by 2022, namely South Korea's Samsung and Taiwan's Taiwan Semiconductor Manufacturing Company (TSMC).[8] The enormous research & development (R&D) investments required and the advantages of economies of scale have gone hand-in-hand with task specialisation across borders and continents in these highly specialised digital markets. But also the upstream parts of digital value chains have witnessed task specialization and consolidation. The production of rare earths, around 60 percent of mining and 90 percent of refining globally, is done by a smaller and smaller number of Chinese State-Owned Enterprises (SOEs).[9] In short, globalisation and the fourth industrial revolution have led to new and deeper strategic dependencies between the great powers, despite state-led initiatives to diversify supplies over the past five-to-ten years.[10]

4 For an early appreciation of the "securitisation of economic policy and economisation of strategic policy" please see Anthea Roberts, Henrique Choer Moraes, and Victor Ferguson, 'Toward a Geoeconomic Order in International Trade and Investment', *Journal of International Economic Law* 22, no. 4 (20 December 2019): 655–76, https://doi.org/10.1093/jiel/jgz036.

5 Craig Roth, 'Should Microsoft Office 365 Be Afraid of Google Workspace? Gartner 2020 Market Share Report Says …', *Craig Roth* (blog), 30 July 2021, https://blogs.gartner.com/craig-roth/2021/07/30/should-microsoft-office-365-be-afraid-of-google-workspace-gartner-2020-market-share-report-says/; Craig Roth, 'Should Microsoft Office 365 Be Afraid of Google Workspace?', IDM, 6 August 2021, https://idm.net.au/article/0013549-should-microsoft-office-365-be-afraid-google-workspace.

6 Synergy Research Group, 'Q1 Cloud Spending Grows by Over $10 Billion from 2022; the Big Three Account for 65% of the Total', 27 April 2023, https://www.srgresearch.com/articles/q1-cloud-spending-grows-by-over-10-billion-from-2022-the-big-three-account-for-65-of-the-total; 'EU Strategic Dependencies and Capacities: Second Stage of In-Depth Reviews' (European Commission, 22 February 2022), 63. ; 'Market Study into Cloud Services' (Netherlands Authority for Consumers and Markets, 5 September 2022), 34, https://www.acm.nl/system/files/documents/market-study-def-public.pdf.

7 Karim Taga, Christoph Uferer, and Cameron McInroy, '5G Supply Market Trends: Baseline Scenario Report', 19 March 2021, 27, https://doi.org/10.5281/zenodo.4621102; Minoru Satake, 'Nokia Hopes for Slice of 5G Pie on Huawei's Home Turf', 4 June 2020, https://asia.nikkei.com/Spotlight/Huawei-crackdown/Nokia-hopes-for-slice-of-5G-pie-on-Huawei-s-home-turf.

8 Jean-Christophe Eloy et al., 'Chip Shortages: A 5 Nm European Fab Is Not the Answer', Yole Group, 9 March 2021, https://www.yolegroup.com/strategy-insights/chip-shortages-a-5-nm-european-fab-is-not-the-answer/.; "Most advanced chip" is defined as those chips with the smallest transistors, as these co-determine the computing power of a semiconductor. The report acknowledes that other definitions of "advanced" are also used in the semiconductor industry.

9 Michelle Michet Foss and Jacob Kolsch, 'Of Chinese Behemoths: What China's Rare Earths Dominance Means for the US' (Baker Institute for Public Policy, 19 December 2022), https://www.bakerinstitute.org/research/chinese-behemoths-what-chinas-rare-earths-dominance-means-us.

10 Hugo van Manen et al., 'Taming Techno-Nationalism: A Policy Agenda' (The Hague Centre for Strategic Studies (HCSS), September 2021), II, https://hcss.nl/report/taming-techno-nationalism/.

CRM and 5G networks from China, cloud services and productivity software from the U.S., and advanced semiconductors from South Korea and Taiwan currently all underpin Dutch and European vital processes. They form layers in a stack that underpin our current security and prosperity.[11] Critical raw materials should be regarded as the skeleton of the modern, digital economy. Semiconductors can be best described as its central nervous systems . Without CRM such as silicon, gallium and rare earths, no semiconductors or other electronic components can be produced. Without either CRM or semiconductors, 5G-infrastructure, open source and proprietary software (for instance for cloud services) and productivity software like Office Suites cannot be created. Network technologies, both goods and services, have a similar centrality in enabling vital processes. Losing access to a strategic good or service in a previous layer in the digital stack is therefore as detrimental as the loss of access to a (seemingly frivolous) nail in the poem *For want of a Nail*. It goes: "for want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the battle was lost. For the failure of the battle the kingdom was lost."[12]

Critical raw materials should be regarded as the skeleton of the modern, digital economy. Semiconductors can be best described as its central nervous systems.

The Netherlands and the EU in the great game of chokepoints

In this great game of chokepoints, strengthening the Digital Open Strategic Autonomy (DOSA) of the Netherlands and the European Union (EU) has become important and increasingly urgent. Strategic dependencies in the digital domain may threaten the digital open strategic autonomy of the Netherlands and the EU. These dependencies can limit "the ability [of the EU] as a global player, in collaboration with international partners, to safeguard its public interests on the basis of its own insights and choices and to be resilient in an interconnected world."[13] This report seeks to help policymakers and industry leaders in the Netherlands and the EU to navigate the great game of chokepoints in two ways:

- It presents a strategic dependence risk framework tool to identify high-risk strategic dependencies both within and outside of the digital domain. By doing so, it seeks to provide policymakers, experts and industry leaders with tools to complete thorough strategic dependence risk assessments, including both technical and supply chain-focused impact-assessments and actor-based geopolitical risk assessments. By making the risk levels of a wide variety of strategic dependencies comparable, this assessment tool facilitates policymakers, experts and industry leaders with prioritising strategic dependencies for risk mitigation measures. The framework also provides insight into what mitigation measures would be most and least effective. With the strategic dependence risk framework the authors seek to help policymakers beyond the Netherlands. In June 2023, the European Commission announced the need to develop a framework for "assessing risks affecting the EU's economic security".[14] With the risk assessment framework presented in this report, the authors seek to help fulfil that need too.
- It presents policy opportunities and recommendations aiming to enhance the strategic indispensability of the Netherlands and EU in digital value chains. A party is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply

11 The 'stack model' is inspired by the work of the American philosopher of technology Benjamin Bratton. 'Toekomstverkening Digitalisering 2030' (Freedom Lab, 26 April 2021), 22, https://uploads-ssl.webflow.com/60c-8c09220a68c595992bca4/615c427d33f9c3976619e61f_Toekomstverkenning%20Digitalisering%202030.pdf.

12 Variations of this rhyme, attributed to a variety of people, have appeared over the last 1000 years.

13 Wopke Hoekstra, M.A.M. Adriaansens, and Liesje Schreinemacher, 'Kamerbrief Open Strategische Autonomie', 8 November 2022, 3, https://open.overheid.nl/documenten/ronl-5b134a1ba15379fdfc6ecb0b6dcc431843087193/pdf.

14 'An EU Approach to Enhance Economic Security', Press release (European Commission, 20 June 2023), 14, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3358.

chains and to the global economy as a whole."[15] In today's era of great power competition, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy. Effectively, a state makes a payment upfront to achieve greater centrality in international value chains. This centrality may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms.

Full report

A full, but restricted version of this report demonstrates how the strategic dependence risk framework ought to be used, by applying it to five strategic dependencies in the digital domain. That version provides a preliminary assessment of the risk levels of five of the EU's key dependencies in the digital domain. In other words, the report gives a quantified judgment of the risks of dependence on China for 5G networks and CRM, on the US for cloud services and productivity software and on South Korea and Taiwan for advanced semiconductors. The report highlights the dependencies that should be prioritised for mitigation. In addition, the full report lays out what the most promising strategies for mitigation are for each case.

2. Strategic dependence in the digital domain

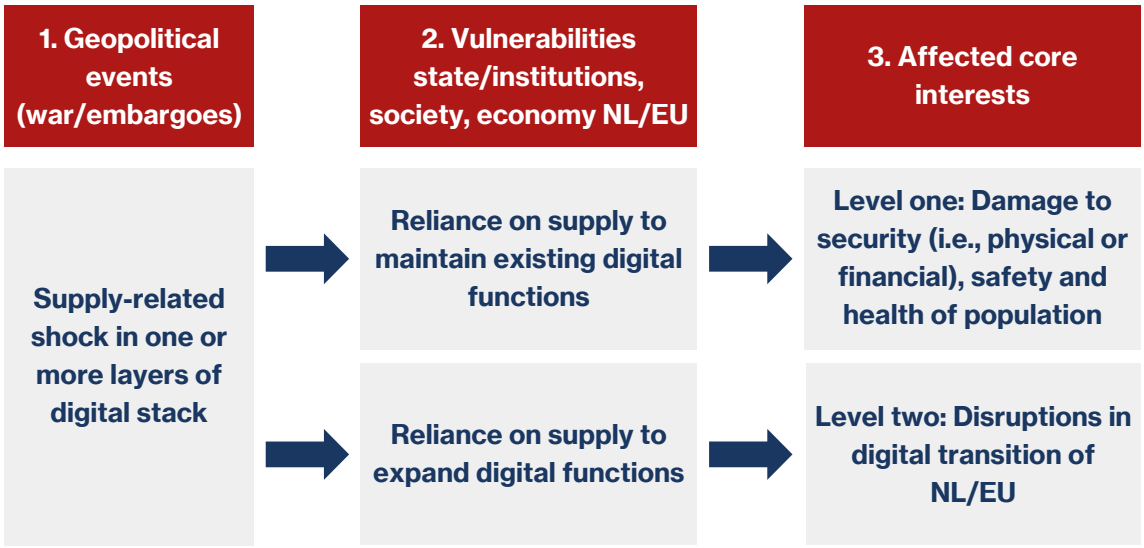
Strategic dependencies in the digital domain may threaten the digital open strategic autonomy of the Netherlands and the EU. Strategic dependencies can be leveraged to deter, compel or simply to corrode (i.e., to destroy or degrade capabilities). The supplier does not have to actually withhold or threaten to withhold the strategic good or service in order to exert influence. This report judges strategic dependencies that threaten "the security and safety, the health of Europeans" to be more severe, than those that 'merely' threaten the supply of "goods services and technologies [...] for the green and digital transition". The report therefore adopts the following definition of strategic dependence:

> One can speak of a level-one strategic dependence in the digital domain, if at the moment a supply-related shock occurs (meaning one or more strategic goods or services are no longer supplied) then the function(s) of the digital society and/or economy that enable the Netherlands and the EU to secure its first line of core interests, meaning the security (i.e., physical or financial), safety, and health of Dutch and Europeans, are disrupted. When a supply-related shock only disrupts the continuation of the digital transition of the Netherlands and the EU, one can speak of a level-two strategic dependence in the digital domain (see figure 2 for a visualisation of this definition).[16]

15 Julian Ringhof and Tobias Gherke, 'Indispensable Leverage: How the EU Can Build Its Technological Edge', 12 September 2023, https://ecfr.eu/article/indispensable-leverage-how-the-eu-can-build-its-technological-edge/. The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on both enhancing Japan's self-reliance as well as making its technologies more "indispensable." 'National Security Strategy of Japan (Provisional Translation)' (Tokyo: Ministry of Foreign Affairs of Japan, December 2022), 30, https://www.cas.go.jp/jp/siryou/221216anzenhoshou/nss-e.pdf.

16 Hence, the definition makes use of the EU's definition of a supply-related shock, meaning "a given supplier within a value chain no longer producing or delivering certain goods and services, or in reduced quantities; or the country where the supplier is based imposing certain export restrictions." 'Commission Staff Working Document Strategic Dependencies and Capacities' (European Commission, 5 May 2021), 8, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021SC0352.

Figure I. Geopolitical events can disrupt state, society and economic digital functions, threatening core interests



3. Strategic dependence risk framework: design

Policymakers can use the strategic dependence risk framework to weigh carefully the dependencies they want to prioritise for mitigation.

Risk assessment tools can support policymakers, experts and industry leaders in identifying high risk strategic dependencies. By making the risk levels of a wide variety of strategic dependencies comparable, this strategic dependence risk framework aims to facilitate them with prioritising strategic dependencies for risk mitigation measures. The framework also provides insight into what mitigation measures would be most and least effective. These mitigation measures, such as undoing a strategic dependence by moving to internal production, are often costly. At a time of geopolitical fragmentation and less efficient global trade, efforts to hedge against geopolitical crises rely on increasingly strained government budgets. Policymakers, can use the framework to weigh carefully the dependencies they want to prioritise for mitigation.

The risk level of a strategic dependence is both determined by the *impact* if supply of the good or service is disrupted and the *probability* that a supplier or supplier country-of-origin becomes unwilling or unable to continue supply. In the risk framework, risk levels of strategic dependencies are concluded on the basis of seven impact indicators and five probability indicators. Some indicators carry more weight than others. Please find the table below for an overview of the main guiding question per indicator (and see annex 1a and 1b for a full presentation of the guiding questions). Please find figures II. and III. below for a full overview of the impact-assessment and probability-assessment matrices that together determine risk scores.

Impact of a supply-related shock is defined as 1. the negative effect on the level-one and level-two core interests of the Netherlands and the EU, if the supply from a country or a group of countries is disrupted. The severity of the negative effect depends on 1a. the criticality of the baseline supply of the good of service from one or several countries for

the Netherlands and the EU now and in five years and 1b. the availability of alternatives to that baseline supply.[17] The function of the baseline supply of strategic goods and services for the recipient country's vital sectors, economy, society and ongoing digitalisation hence ought to be assessed carefully by technical and supply chain experts.

Both intentions and capabilities of the supplier country, as well as war-related threats to the supplier country and its supply lines ought to be assessed carefully to gauge risk levels. Strategic dependencies ought to be considered high-risk strategic dependencies, if supply disruptions are likely to occur. Geopolitical disruptions are either due to 2a. unwillingness or 2b. inability by the supplier and/or the supplier state to continue supply. After all, the probability that a supply-related shock occurs depends both on the intentions of the supplier, as its interests determine whether the supplier/supplier state will halt the supply of a good or service to the EU, and on the likelihood that war-related disruption renders a supplier/supplier state unable to continue supply.

Table I. Strategic dependence risk framework: aims, indicators and guiding questions

Aim		Indicator (including weight)	Main guiding question
1. Identifying strategic dependence (impact assessment)	1a. Assessing criticality of baseline supply	1. Criticality – 2x	What is the effect on the security (i.e., physical or financial), safety, and health of Dutch and Europeans (level-one core interest) and on the continuation of the digital transition (level-two core interest) if the baseline supply of the good and service from one or several countries is entirely disrupted?
		2. Dependence on maintenance, updates or resupply – 1x	If the good or service is no longer supplied, when will this have an impact on level-one and/or level-two core interests?
		3. Demand projection – 1x	Total demand: Is national, regional and/or global demand for the good or service likely to outpace global supply, leading to shortages of the good or service on top of the risks of supply-related shocks? Total use of good or service to enable vital processes: Will more vital processes come to rely on the supply of the good or service in the next five years?
	1b. Assessing alternatives to baseline supply	4. Diversification - 1x	Do companies in allied, likeminded, or at least non-rival, non-EU states effectively supply the same good or service?
		5. Internal production - 1x	Can the production of the good or service be effectively moved to the Netherlands or another EU member-state?
		6. Substitution - 1x	Can the function of the good or service be performed effectively, meaning at the same level of quality, in similar quantities and at comparable prices, by a different good or service?
		7. Illicit exchange -1x	Can the good or service provided by the original suppliers still be effectively accessed, in spite of an export boycott through direct or indirect illicit flows?
2. Assessing risk levels (probability assessment)	2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply	8. Relationship with supplier country - 3x	Does the Netherlands and the EU enjoy good relations with the country of origin of the company that supplies the good or service?
		9. State influence over supplier - 1x	Does the supplier state have the means to force the supplier to no longer provide the good or service?
		10. Cost of weaponization to supplier - 2x	What are the costs of halting the supply of the good or service to the state imposing the boycott?
	2b. Assessing likelihood of inability of supplier and/or supplier state to continue supply	11. Threats to supplier country -5x	Does the supplier state of the good or service face a military threat?
		12. Threats to supply lines - 1x	Are the supply lines (e.g., maritime routes, airways, communication cables and satellite connections) via which the good or service is supplied likely to be disrupted?

[17] A "baseline" is commonly known as "a starting point for comparisons". In this risk assessment framework, "baseline supply" should be understood as the current level of supply of a good or service by one country or the joint supply provided by several countries. From 'Baseline', Cambridge Dictionary, accessed 21 December 2023, https://dictionary.cambridge.org/dictionary/english/baseline.

On the basis of the framework, several characteristics can be identified that increase the risk-level of dependencies. All things being equal, dependencies for goods or services that require regular maintenance, updates or resupply ought to be considered more severe than those that do not. If maintaining the function of the good or service requires the original supplier to execute additional actions, the receiving party remains structurally dependent on the willingness and ability of the supplier and supplier country to continue supply.

Looming shortages and a broader application of the good or service in vital sectors increase the relative value of baseline supply over time. All things being equal, dependencies for goods and services for which national, regional or global demand is set to strongly increase in the near future should be considered more severe, as supply may fail to keep track with demand. Growing reliance on the good or service throughout vital sectors likewise makes dependence on baseline supply more severe.

Even if disruptions in the baseline supply of a good or service have a devastating effect on the Netherlands core interests immediately and demand for that product is multiplying in the upcoming five years, then this still does not automatically mean that the Netherlands and the EU are strategically dependent. In theory, the availability of "perfect alternatives" can entirely undo the risk of dependence for the baseline supply. Bringing online alternatives to baseline supply can be achieved by pursuing four strategies: *diversification*, *internal production*, *substitution* and maintaining access to the baseline supply through *illicit exchange*. Alas, for almost all "high criticality-goods and services" perfect alternatives do not exist, as alternative supplies are not immediately available, not available at scale or more expensive.

Even if a dependence is considered to be of high strategic importance, this does not automatically mean that strategic dependence is also high risk. A geopolitical assessment of the *likelihood* that baseline supply is disrupted is as important as a technical and supply chain assessment of the *impact*, if a disruption occurs. The relationship with the supplier country, the state influence over the supplier and the cost of weaponization to the supplier determine the probability that the supplier or supplier country may become unwilling to continue supply. As a result of military threats to the supplier country or the supply lines, namely maritime routes, aerial approaches and communication cables, a supplier may become unable to continue supply.

Figure II. Strategic dependence risk framework (1): Assessing *impact* of disruptions in supply of goods and services

Identifying strategic dependence

	Impact indicators (weighted)	Impact level 1	2	3	4	5
1a. Assessing criticality of baseline supply	1. Criticality 2x	No effect on security, safety and health. No obstacles to digitalisation.	Minor effect on security, safety and health; Somewhat impedes digitalisation.	Substantial effect on security, safety and health; Impedes digitalisation.	Major effect on security, safety and health; Disrupts digitalisation.	Devastating effect on security, safety and health; Entirely halts digitalisation.
	2. Dependence on maintenance, updates or resupply 1x	No maintenance, updates or resupply required for the entire lifespan of the product. Timing of impact delayed.	Maintenance, updates or resupply required every 5 years. Timing of impact delayed, but long-term: In 5-to-10 years.	Biannual to once in four-year maintenance, updates or resupply required; Timing of impact delayed, medium term: in 6-months to 4 years.	Monthly or biannual maintenance, updates or resupply required; Timing of impact delayed, but short-term: in 1-month to 6-months.	Constant maintenance, updates or resupply required; Timing of impact immediate.
	3. Demand projection 1x	Sharp fall in total demand (-75%-to-100%) in next 5-years	Major fall in total demand (-50%-to –75%) in next 5-years	Slight rise or fall in total demand (-50% or +50%) in next 5-years	Total demand rising 50-to-100% in next 5-years	Total demand multiplying in next 5-years
		Very low criticality 1	2	3	4	Very high criticality 5
1b. Assessing alternatives to baseline supply	4. Diversification 1x	Complete effective, immediate diversification possible (100%); alternative suppliers offer same quality product, in same quantities at comparable prices.	Majority effective, immediate diversification possible (75%); alternative suppliers offer slightly inferior quality, in slightly lower quantities at slightly higher prices.	Partial effective, immediate diversification possible (50%); alternative suppliers offer inferior quality, half of the quantity at higher prices.	Limited effective, immediate diversification possible (25%); alternative suppliers offer far inferior quality, a quarter of the quantity at far higher prices.	No effective, immediate diversification possible (0%); alternative suppliers offer no quantities of the material, good or service.
	5. Internal production 1x	Complete effective internal production possible (100%); Indigenisation possible in 1-year.	Majority effective internal production possible (75%); Indigenisation possible in 2-to-4 years.	Partial effective internal production possible (50%); Indigenisation possible in 5-to-10 years.	Limited effective internal production possible (25%); Indigenisation possible in 11-to-15 years.	No effective internal production possible (0%); Indigenisation possible in 15-to-40 years.
	6. Substitution 1x	Complete effective substitution possible (100%); no additional technological advances are required; complete substitution possible in 1-year.	Majority effective substitution possible (75%); some additional technological advances are required; complete substitution possible in 2-to-4 years.	Partial effective substitution possible (50%); additional technological advances are required; complete substitution possible in 5-to-10 years.	Limited effective substitution possible (25%); many additional technological advances are required; complete substitution possible in 11-to-15 years.	No substitutes possible (0%); many additional technological advances are required; complete substitution possible in 15-to-40 years.
	7. Illicit exchange 1x	Complete continued supply through illicit exchange possible (100%); boycotting state has no effective direct and indirect enforcement means.	Majority continued supply through illicit exchange possible (75%); boycotting state has limited effective direct and indirect enforcement means.	Partial continued supply through illicit exchange possible (50%); boycotting state has some effective direct and indirect enforcement means.	Minority continued supply through illicit exchange possible (25%); boycotting state has strong direct and indirect enforcement means.	No continued supply through illicit exchange possible (0%); boycotting state has complete effective direct and indirect enforcement means.
		Perfect alternatives 1	2	3	4	No alternatives 5
		Very low impact (if supply disrupted) 1	2	3	4	Very high impact (if supply disrupted) 5

Figure III. Strategic dependence risk framework (2): Assessing *probability* of disruptions in supply of goods and services

Assessing risk level of strategic dependence

	Probability indicators (weighted)	Probability level 1	2	3	4	5
2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply	8. Relationship with supplier country — 3x	Very good; relations sharply improved or were already very good; country is a full democracy with the same core interests as NL/EU.	Good; relations improved or were already good; country is a full or flawed democracy but has slightly different core interests from NL/EU.	Neutral; relations remained stable; country is a flawed democracy, hybrid regime or autocracy, but has no conflicting core interests with NL/EU.	Poor; relations deteriorated; supplier country is an autocratic rival with core interests opposite to NL/EU.	Very poor; relations sharply deteriorated; supplier is an autocratic rival engaged in a proxy war with NL/EU.
	9. State influence over supplier — 1x	Very weak; supplier has no (legal) obligations to act in service of state interests, country has no history of exerting pressure on private companies nor imposing export controls.	Weak; supplier has no (legal) obligations to act in service of state interests, country only seldomly exerted pressure on private companies and seldomly imposes export controls.	Modest; supplier has limited (legal) obligations to act in service of state interests, country has history of only seldomly exerting pressure on private companies and occasionally imposes export controls.	Strong; supplier has some (legal) obligations to act in service of state interests, country has history of occasionally exerting pressure on private companies and often imposes export controls.	Very strong; supplier has many (legal) obligations to act in service of state interests, country has consistent history of exerting pressure on private companies and structurally imposes export controls.
	10. Cost of weaponisation to supplier — 2x	Very high; great financial/economic self-harm in halting supply, political, diplomatic, and institutional cost to halting supply; possibly also military response.	High; substantial financial/economic self-harm in halting supply. Great political, diplomatic, institutional cost; low chance of military response.	Medium; limited financial/economic self-harm in halting supply. substantial political, diplomatic, institutional cost; very low chance of military response.	Low; almost no financial/economic self-harm in halting supply. Limited political, diplomatic, institutional cost; Close to zero chance of military response.	Very low; almost no financial/economic self-harm in halting supply; No political, diplomatic, institutional cost; Close to zero chance of military response.
		Low boycott likelihood				**High boycott likelihood**
		1	2	3	4	5
2b. Assessing likelihood of inability by supplier and/or supplier state to continue supply	11. Threats to supplier country — 5x	Non-existent; source country does not face a military threat; and only a limited possibility to face a large-scale cyber-attack.	Mild; in the next decade, limited possibility that source country faces a high-level military threat, but possible that the source country experiences a large-scale cyber-attack.	Medium; in the next decade, source country possibly faces a high-level military threat and is more likely than not to experience a large-scale cyber-attack.	Substantial; in the next decade, the risk that the source country faces a high-level military threat is substantial; it is likely that the source country experiences a large-scale cyber-attack.	Severe; in the next decade, source country is likely to face an existential military threat and faces constant hybrid attacks such as large-scale cyber-attacks.
	12. Threats to supply lines — 1x	Non-existent; Supply lines are entirely secure.	Mild; Supply lines face low-level hybrid threats.	Medium; Supply lines face occasional medium-level hybrid threats and low-level military threats.	Substantial; Supply lines face constant high-level threats, hybrid threats and occasional medium-level military threats.	Substantial; Supply lines face constant high-level hybrid threats and occasional medium-level military threats.
		Low likelihood war-related disruption				**High likelihood war-related disruption**
		1	2	3	4	5
		Low likelihood of supply disruption				**High likelihood of supply disruption**
		1	2	3	4	5

4. Broader strategic dependence risks in the digital domain

The Netherlands and the EU face strategic dependence-related geopolitical risks in the digital domain

The Netherlands and the EU face strategic dependence-related geopolitical risks in the digital domain , other than the risk that a supplier or supplier state becomes unwilling or unable to supply a good or service.

States controlling central communication nodes in networked systems can intercept information passing through these nodes. The information obtained through such strategic dependencies, meaning through reliance on communication networks, can increase the risks of successful state-directed or state-tolerated cyber-attacks and industrial espionage. This may put the supplying party in a position to acquire knowledge about the digital ecosystem of the dependent party. This can be shared with state or non-state actors with malicious intentions and the means to execute cyber-attacks. As cyber-attacks become more commonplace, it becomes increasingly important to shield network vulnerabilities.

Furthermore, central positions in networks may help a state or company to engage in industrial espionage. Strategic dependence may help parties to illicitly acquire valuable knowledge, data, intellectual property, corporate secrets, or proprietary technology. Industrial espionage contributes to the erosion of the EU's tech-edge and strategic indispensability.

Strategic dependence on private firms can enable these firms to engage in monopolistic commercial behaviour such as price-setting through lock-in effects. In extreme cases, private tech firms may even use their monopolistic position to exert geopolitical influence, for instance by taking decisions that influence military operations.

Finally, Dutch and EU prosperity can be threatened by demand-related dependence shocks. Companies that are overly reliant on a single foreign market for their exports risk losing revenue, if their market access is limited or entirely cut-off. A state may enact punitive barriers by imposing tariffs, quotas or official or unofficial exclusionary regulatory measures. In an extreme situation, a state can even impose outright import bans.

5. Dutch strengths in digital value chains

In a world characterised by great power competition, a blossoming digital economy is no longer just a means to secure the Netherlands and the EU's capacity to ensure a prosperous life for citizens and generate sufficient tax income for social services. In today's world, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy: effectively, a state makes a payment upfront to dissuade rivals from taking coercive actions.

A heavy sample of technologies and industries is presented in which the Netherlands already has or can achieve an indispensable role. These technologies were identified on the basis of desk research, expert interviews, an expert survey executed by HCSS in 2021 and a round table with technical and industry experts from universities, industry and the government in 2023. The Netherlands has a very strong foundation in digital industries, especially when taking into account the country's size. The Netherlands is home to some advanced

companies in the digital domain, particularly in lithography, atomic layer deposition, radar, radio frequency semiconductor technology and photonics.

The Netherlands lacks an ASML-style world leader in the fields of quantum technologies, artificial intelligence, cyber security products and chip design. Nonetheless, the Netherlands has a very strong (and in some cases leading) position in basic research in these fields. Much of the potential of this strong foundations remains untapped as the link between basic research and the start-up ecosystem on the one hand and major companies on the other hand remains weak, especially when compared to the U.S.. In order to achieve Dutch and European strategic indispensability, the valorisation chain has to be strengthened.

With the right innovation and industrial policies the Netherlands can strengthen its business climate and the valorisation chain. This is needed to gain a stronger foothold in digital industries. The Netherlands –and by extension the EU– may as a result become more geopolitically shock-resistant over the next decades.

6. Policy implications, opportunities and recommendations

During the Cold War, the U.S. and the Soviet Union engaged in military arms races. Government-sponsored semiconductor development initiatives not only revolutionised warfare and enhanced American military capabilities. These also kickstarted a commercial semiconductor industry through parties such as Texas Instruments and Intel. This transformed industries around the world.[18] Some analysts go as far as saying that "today's Silicon Valley is an accidental by-product of 1960s Cold War terrors."[19]

The government is advised to execute the following policy recommendations to strengthen the strategic indispensability of the Netherlands and EU in digital value chains.[20] A more extensive, detailed and actionable version of these policy opportunities and recommendations is included in the restricted version of this report. These interventions aim to enhance the depth and number of strategic dependencies of the rest of the world on the Netherlands and the EU in the digital domain. This centrality may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms. It finds that in order to enhance strategic indispensability, the Netherlands and the EU should:

1. Better align an already world-class basic research system with societal and geopolitical needs;
2. Strengthen the valorisation chain to foster industry champions;
3. Strengthen the overall business climate through targeted incentives for strategic industries;
4. Cooperate with allies and partners to deter rivals from weaponizing strategic dependence.

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18 Chris Miller, *Chip War: The Fight for the World's Most Critical Technology. 9781982172008.* (Scribner, 2022).

19 Henry Farrell and Abraham L. Newman, *Underground Empire: How America Weaponized the World Economy* (Henry Holt and Company, 2023), 205.

20 The recommendations do not include policy-recommendations that help the Netherlands and the EU alleviate high-risk strategic dependencies, since these have already been presented in earlier HCSS reports such as Joris Teer and Mattia Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry' (The Hague Centre for Strategic Studies, October 2022) and Irina Patrahau et al., 'Advancing European Mineral Security: Insights from the Dutch Industry', November 2023, https://hcss.nl/report/advancing-european-mineral-security-insights-from-the-dutch-industry/.

Table II. Overview of policy opportunities and recommendations

Policy opportunity	Policy recommendation
1. Better align an already world-class basic research system with societal and geopolitical needs	1.1 Expand investment in STEM-education
	1.2 Expand access to STEM-education in the Netherlands and the EU for international talent
	1.3 Expand international cooperation in STEM-fields, especially with likeminded countries
	1.4 Prevent unwanted knowledge and technology transfer
2. Strengthen the valorisation chain to foster industry champions	2.1 Make valorisation an integral part of the research process
	2.2 Dedicate more public and private funds
	2.3 Foster an entrepreneurial culture
	2.4 Deepen ties between civilian and defence industries
3. Strengthen the overall business climate through targeted incentives for strategic industries	3.1 Prioritise strategic regions and companies
	3.2 Attract international talent
4. Cooperate with allies and partners to deter rivals from weaponizing strategic dependence	4.1 Coordinate with allies and likeminded partners to prevent weaponization by rivals
	4.2 Formulate and engage in industrial policy and diplomacy

Lexicon

ACI	Anti-coercion instrument
ASM	Advanced Semiconductor Materials
AI	Artificial Intelligence
AIVD	Algemene Inlichtingen- en Veiligheidsdienst
AWS	Amazon Web Services
CAI	Comprehensive Agreement on Investment
CRM	Critical raw materials
CRMA	Critical Raw Materials Act
DARPA	Defence Advanced Research Projects Agency
DTF	Deep Tech Fund
DOSA	Digital Open Strategic Autonomy
DUV	Ultraviolet
ETCI	European Tech Champions Initiative
EIB	European Investment Bank
EIS	Enterprise Investment Scheme
EU	European Union
EUV	Extreme Ultraviolet
IEA	International Energy Agency
IPCEI	Important Projects of Common European Interest
INSTEX	Support of Trade Exchanges
IoT	Internet of Things
IRA	Inflation Reduction Act
JCPOA	Joint Comprehensive Plan of Action
KEP	EU Knowledge Exchange Platform
LNG	Liquified Natural Gas
LM	Language model
MAMAA	Meta, Apple, Microsoft, Amazon and Alphabet
MinEZK	Ministry of Economic Affairs and Climate
NIMBY	Not-in-my-backyard
NXP	Next eXPerience
OEM	Original Equipment Manufacturing
R&D	Research and development
SEIS	Seed Enterprise Investment Scheme
SME	Semiconductor manufacturing equipment
SOEs	State-Owned Enterprises
STEM	Science, Technology, Engineering and Mathematics
TSMC	Taiwan Semiconductor Manufacturing Company
TEM	Transmission Electron Microscopes
US	United States
UvA	University of Amsterdam
VC	Venture Capital
VDL	Van Der Leegte Groep
VU	Vrije Universiteit Amsterdam

1. Introduction

Context: interdependence at a time of great power competition

"For want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the battle was lost. For the failure of the battle the kingdom was lost – All for the want of a horse-shoe nail."

Variations of this rhyme, attributed to a variety of people, have appeared over the last 1000 years.

In the Post-Cold War era the global economy grew more intertwined than ever before. The last thirty years of hyper globalisation bound the world's great economic powers, China, the U.S. and the EU, in a web of value chains stretching the globe.[21] In the last seven years, however, the norms, rules and institutions governing international trade have rapidly eroded, mainly due to rapidly intensifying competition between great powers. After all, their actions to a large extent determine the rules of the game.

Within value chains, states increasingly leverage strategic dependencies to exert power.

Within value chains, states increasingly leverage strategic dependencies to exert power : they manipulate "money, goods and information" flows by making use of chokepoints in the global economy to achieve their preferred policy outcomes.[22] The Trump Administration used extra-territorial sanctions to block the completion of the Nord Stream 2 pipeline, fearing European overdependence on Russian natural gas. Putin halted exports of natural gas, in order to punish European states for export of weapons to Ukraine and sanctions against Russia. The Trump and Biden Administrations, together with allies in Europe and Asia, instituted increasingly expansive export boycotts to prevent China from developing an advanced, domestic semi-conductor industry. The G7, Taiwan and South Korea imposed a near-comprehensive ban on chip exports to Russia following its invasion of Ukraine. To punish and deter, China restricted

[21] Subramanian and Kessler, 'The Hyperglobalization of Trade and Its Future - Working Paper'. Great powers are states with exceptional political, economic and military power. This study refers to China, the US, Russia and the EU as great powers, even though only China and the US meet all the conditions to be considered great powers. The EU, on the other hand, has exceptional political and economic power, but is not a world leader militarily. Russia, owner of the largest nuclear arsenal in the world, has exceptional military power, some political power – but no exceptional economic power. As a result, the report refers to only China, the U.S. and the EU when it speaks of "economic great powers."

[22] States that have "political authority" over chokepoints, or "central nodes in the international networked structures through which money, goods, and information travel," can use these nodes to coerce adversaries, by either threatening to cut-off or actually cutting off "adversaries from [these] network flows." Farrell and Newman, 'Weaponized Interdependence', 45, 46.

access of small and middle powers, such as Norway, Lithuania and Australia, and of companies, like the US semiconductor-manufacturer Micron, to its domestic market.[23]

Beijing also leveraged its export of critical economic inputs, namely its dominant position in the production of critical raw materials.[24] Since 1 August 2023 the export of gallium and germanium, two critical raw materials that are used to produce semiconductors and defence technologies, requires a license by China's Ministry of Commerce. In addition, China introduced export limitations on graphite, a crucial material for the energy transition and obliged exporters to report the quantities and destinations of shipments of Rare Earth Elements (REE).

In response, first China, then the U.S. and finally the EU expanded innovation and industrial policies to make their economies more geopolitically shock-resistant.[25] Through these initiatives, the economic great powers aim to enhance security of supply of critical economic inputs. In other words, they attempt to undo chokepoints in the global economy that are controlled by rivals. Critical inputs can be found all across supply chains. They can be end-products or applications (e.g., cloud services), components (e.g., semiconductors) and materials (e.g., rare earths). The Made in China-2025 initiative, the U.S. CHIPS and Science Act, the Inflation Reduction Act (IRA), the European Chips Act and the EU's Critical Raw Materials Act (CRMA) are all examples of initiatives that seek to achieve greater security of supply. These initiatives confirm that the world economy is moving away from a neoliberal model, based on global, just-in-time supply chains with cost-efficiency as its central organizing principle, to a new competitive model in which economic resilience and security of supply became increasingly important.[26]

Digitalisation and the fourth industrial revolution have gone hand in hand with the rise of new winner-take-all industries.

During the same period, digitalisation and the fourth industrial revolution have gone hand in hand with the rise of new winner-take-all industries . This led to market consolidation instead of the preferred diversification. Microsoft 365 takes up almost 90 percent of the global market for productivity suites.[27] Google Cloud, Microsoft Azure and Amazon Web Services (AWS) dominate the cloud services market, having a conjoint market share of around 70 percent in the Netherlands and the EU. The biggest European provider of cloud services, Deutsche Telekom, has a mere market share of two percent in Europe.[28] Only three companies domi-

23 This phenomenon is often described as Beijing "slaughtering the chicken to scare off the monkeys". Recent examples are an import ban outlawing salmon from Norway in 2010; a temporary embargo of rare earth exports to Japan in 2010; a ban on South Korean supermarkets operating in China in 2016/2017; a ban on wine, barley, beef, timber, cotton, lobsters and coal imports from Australia in 2020; and an import ban of all Lithuanian goods in 2021. Teer and Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry', 47.

24 In 2010, China imposed temporary restrictions on the export to Japan of rare earths, a key raw material for the production of semiconductors, smartphones, computers, MRI scanners and pacemakers, after the Japanese coastguard seized a Chinese fishing trawler around disputed islands in the East-China Sea.

25 "As a result of two developments - globalization and the return of competition between great powers - the world's power blocs currently depend on countries they deeply distrust for the supply of vital resources for their prosperity, well-being and security." Joris Teer, Mattia Bertolini, and Benedetta Girardi, 'Competitie Tussen Grootmachten En Maatschappelijke Stabiliteit in Nederland: De Risico's van Russisch Gas, Chinese Grondstoffen En Taiwanese Chips Voor Vitale Sectoren' (The Hague: The Hague Centre for Strategic Studies (HCSS), April 2023), II, https://hcss.nl/report/competitie-grootmachten-en-maatschappelijke-stabiliteit-nederland/.

26 For an early appreciation of the "securitisation of economic policy and economisation of strategic policy" please see Roberts, Choer Moraes, and Ferguson, 'Toward a Geoeconomic Order in International Trade and Investment'.

27 Roth, 'Should Microsoft Office 365 Be Afraid of Google Workspace?', 30 July 2021; Roth, 'Should Microsoft Office 365 Be Afraid of Google Workspace?', 6 August 2021.

28 Synergy Research Group, 'Q1 Cloud Spending Grows by Over $10 Billion from 2022; the Big Three Account for 65% of the Total', 27 April 2023, https://www.srgresearch.com/articles/q1-cloud-spending-grows-by-over-10-billion-from-2022-the-big-three-account-for-65-of-the-total; 'EU Strategic Dependencies and Capacities: Second Stage of In-Depth Reviews' (European Commission, 22 February 2022), 63. ; 'Market Study into Cloud Services', 34.

nate the 5G network market in Europe, with China's Huawei initially offering substantially lower prices than Nokia and Ericsson.[29] Whereas in the year 2000 more than 20 companies made the world's most advanced chips, there were only two left by 2022, namely South Korea's Samsung and Taiwan's Taiwan Semiconductor Manufacturing Company (TSMC).[30] The enormous research & development (R&D) investments required and the advantages of economies of scale have gone hand-in-hand with task specialisation across borders and continents in these highly specialised digital markets.

But also the upstream parts of digital value chains have witnessed task specialization and consolidation. The production of rare earths, around 60 percent of mining and 90 percent of refining globally, is done by a smaller and smaller number of Chinese State-Owned Enterprises (SOEs). China's dominant position in the production of other critical raw materials necessary for digitalisation, such as gallium, cobalt, germanium and manganese, is of a slightly lower, similar or even higher level.[31] In short, globalisation and the fourth industrial revolution have led to new and deeper strategic dependencies between the great powers, despite state-led initiatives to diversify supplies over the past five-to-ten years.[32]

CRM and 5G networks from China, cloud services and productivity software from the U.S., and advanced semiconductors from South Korea and Taiwan currently all underpin Dutch and European vital processes. They form layers in a stack that underpin our current security and prosperity.[33] Critical raw materials should be regarded as the skeleton of the modern, digital economy. Semiconductors can be best described as its central nervous systems. Without CRM such as silicon, gallium and rare earths, no semiconductors or other electronic components can be produced. Without either CRM or semiconductors, 5G-infrastructure, open source and proprietary software (for instance for cloud services) and productivity software like Office Suites cannot be created. Network technologies, both goods and services, have a similar centrality in enabling vital processes. Not coincidentally, the German government in September 2023 in an internal report described the importance of the 5G mobile network in similar terms. This network is "the 'central nervous system' of Germany as a business location."[34] Losing access to a strategic good or service in a previous layer in the digital stack is therefore as detrimental as the loss of access to a (seemingly frivolous) nail in the poem *For want of a Nail*. It goes: "for want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the battle was lost. For the failure of the battle the kingdom was lost."[35]

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29 Taga, Uferer, and McInroy, '5G Supply Market Trends', 27; Satake, 'Nokia Hopes for Slice of 5G Pie on Huawei's Home Turf'.

30 Eloy et al., 'Chip Shortages'.; "Most advanced chip" is defined as those chips with the smallest transistors, as these co-determine the computing power of a semiconductor. The report acknowledes that other definitions of "advanced" are also used in the semiconductor industry.

31 Foss and Kolsch, 'Of Chinese Behemoths'.

32 Manen et al., 'Taming Techno-Nationalism', II.

33 The 'stack model' is inspired by the work of the American philosopher of technology Benjamin Bratton. 'Toekomstverkening Digitalisering 2030', 22.

34 Mathieu Pollet et al., 'Nordstream Trauma Leads Berlin to Draw up Fresh Huawei Bans', *POLITICO*, 19 September 2023, https://www.politico.eu/article/germany-draws-up-partial-ban-on-huawei/.

35 Variations of this rhyme, attributed to a variety of people, have appeared over the last 1000 years.

The Netherlands and the EU in the great game of chokepoints

In this great game of chokepoints, strengthening the Digital Open Strategic Autonomy (DOSA) of the Netherlands and the European Union (EU) has become important and increasingly urgent. Strategic dependencies in the digital domain may threaten the digital open strategic autonomy of the Netherlands and the EU. These dependencies can limit "the ability [of the EU] as a global player, in collaboration with international partners, to safeguard its public interests on the basis of its own insights and choices and to be resilient in an interconnected world."[36] This report seeks to help policymakers and industry leaders in the Netherlands and the EU to navigate the great game of chokepoints in two ways:

Centrality in value chains may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms.

- It presents a strategic dependence risk framework tool to identify high-risk strategic dependencies both within and outside of the digital domain. By doing so, it seeks to provide policymakers, experts and industry leaders with tools to complete thorough strategic dependence risk assessments, including both technical and supply chain-focused impact-assessments and actor-based geopolitical risk assessments. By making the risk levels of a wide variety of strategic dependencies comparable, this assessment tool facilitates policymakers, experts and industry leaders with prioritising strategic dependencies for risk mitigation measures. The framework also provides insight into what mitigation measures would be most and least effective.[37] With the strategic dependence risk framework the authors seek to help policymakers beyond the Netherlands. In June 2023, the European Commission announced the need to develop a framework for "assessing risks affecting the EU's economic security".[38] With the risk assessment framework presented in this report, the authors seek to help fulfil that need too.
- It presents policy opportunities and recommendations aiming to enhance the strategic indispensability of the Netherlands and EU in digital value chains. A party is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply chains and to the global economy as a whole."[39] In today's era of great power competition, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy. Effectively, a state makes a payment upfront to achieve greater centrality in international value chains. This centrality may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms.

36 Hoekstra, Adriaansens, and Schreinemacher, 'Kamerbrief Open Strategische Autonomie', 3.

37 Third, a full but restricted version of this report demonstrates how the strategic dependence risk framework ought to be used, by applying it to five strategic dependencies in the digital domain. The full version provides a preliminary assessment of the risk levels of five of the EU's key dependencies in the digital domain. In other words, the report gives a quantified judgment of the risks of dependence on China for 5G networks and CRM, on the US for cloud services and productivity software and on South Korea and Taiwan for advanced semiconductors. The report highlights the dependencies that should be prioritised for mitigation.

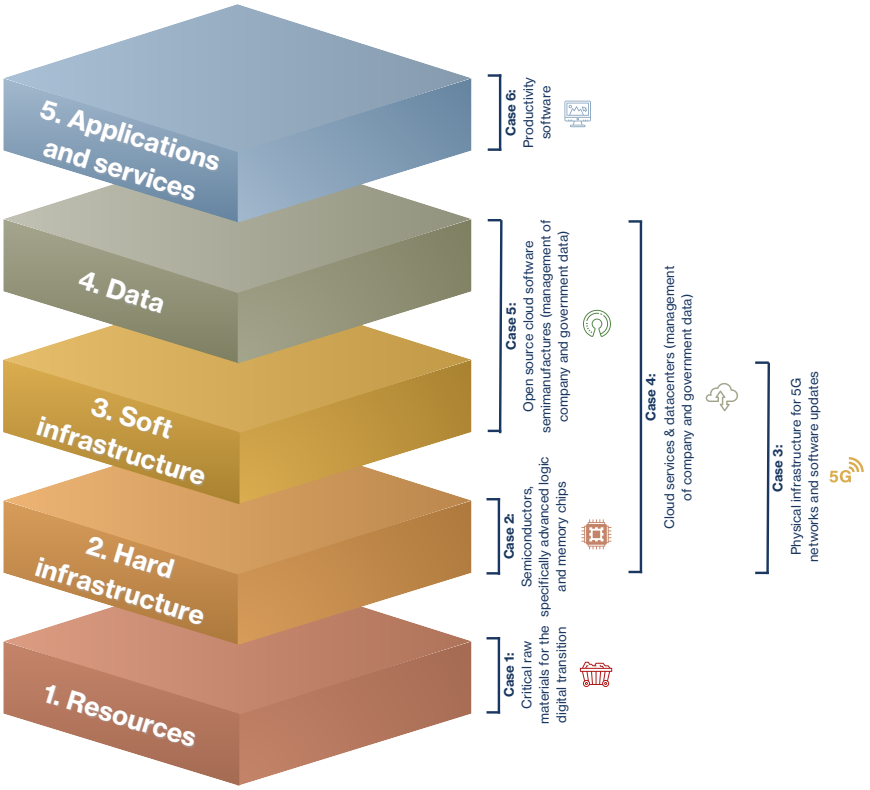
38 'An EU Approach to Enhance Economic Security', Press release (European Commission, 20 June 2023), 14, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3358.

39 Julian Ringhof and Tobias Gherke, 'Indispensable Leverage: How the EU Can Build Its Technological Edge', 12 September 2023, https://ecfr.eu/article/indispensable-leverage-how-the-eu-can-build-its-technological-edge/. The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on both enhancing Japan's self-reliance as well as making its technologies more "indispensable." 'National Security Strategy of Japan (Provisional Translation)' (Tokyo: Ministry of Foreign Affairs of Japan, December 2022), 30, https://www.cas.go.jp/jp/siryou/221216anzenhoshou/nss-e.pdf.

Full, restricted version of this report

A full, but restricted version of this report demonstrates how the strategic dependence risk framework ought to be used, by applying it to five strategic dependencies in the digital domain. That version provides a preliminary assessment of the risk levels of five of the EU's key dependencies in the digital domain. In other words, the report gives a quantified judgment of the risks of dependence on China for 5G networks and CRM, on the US for cloud services and productivity software and on South Korea and Taiwan for advanced semiconductors. The report highlights the dependencies that should be prioritised for mitigation. In addition, the full report lays out what the most promising strategies for mitigation are for each case.

Figure 1. Six key dependencies of the Netherlands and the EU in the digital domain[40]



The findings of those case studies are based on desk research, including on the literature on geopolitical risk, strategic dependence, weaponized interdependence (WI) and on the topics of the case studies. This includes thinktank reports, policy documents of governments and international organizations, newspaper- and academic articles. Furthermore, HCSS completed an internal workshop, held two workshops with technical experts from TNO and finetuned results during a round table with representatives of the Ministry of Economic Affairs and Climate (MinEZK) of the Netherlands and ten technical experts from knowledge institutes, industry and business associations (see Annex 2: List of round table participants, expert workshop participants and expert interviews for a full list of the participants). In addition, HCSS conducted ten interviews with (cyber) security, technical (e.g., semiconductor), telecommunications, emerging technologies, and geo-economics experts to fill out the framework and expand the content of the case studies (see Annex 3).

[40] For the different DOSA-layers, please see: 'Toekomstverkening Digitalisering 2030' (Freedom Lab, 26 April 2021), 22, https://uploads-ssl.webflow.com/60c8c09220a68c595992bca4/615c427d33f9c3976619e61f_Toekomstverkenning%20Digitalisering%202030.pdf.

Chapter two outlines definitions of strategic dependence-related concepts in order to arrive at a definition best suited to assess risk levels of strategic dependencies in the digital domain. Examples of discussed concepts are digital open strategic autonomy, strategic dependence, strategic indispensability, weaponized interdependence and chokepoints. To illustrate the role these concepts play in interstate competition, this chapter highlights a variety of events in recent history that relate to their use (see section 2.1). This definition serves as the basis of the strategic dependence risk framework presented in the next chapter (see Chapter 3). The chapter was completed on the basis of a mapping of policy, thinktank and academic literature on strategic dependencies and weaponized interdependence and an internal workshop.

Chapter three presents an analytical tool that can be used to assess the risk-level of strategic dependencies, focusing on supply-related shocks initiated by other (great) powers against the Netherlands and the EU. The framework combines impact indicators, determining whether a dependence should be considered of strategic importance, with probability indicators, which are helpful in assessing the likelihood that the supply of a strategic good or service will be disrupted.[41] This methodology includes often used indicators that determine risk levels, such as options for diversification and (demand) substitution, whilst also introducing lesser-known indicators, such as the possibility to still access the strategic good or service through illicit exchange (in spite of a boycott by a rival state) and military threats to supply lines, like maritime shipping routes and subsea cables.

The framework was designed on the basis of studying existing strategic dependence risk frameworks and during internal workshops. The risk framework was reviewed and finetuned during a round table with representatives of the Ministry of Economic Affairs and Climate (MinEZK) of the Netherlands and ten technical experts from knowledge institutes, industry and business associations (see Annex 2: List of round table participants, expert workshop participants and expert interviews for a full list of the participants). HCSS finetuned the framework by applying it to case studies during two workshops with technical experts from TNO.

Chapter four presents a heavy sample of strategic dependence-related risks in the digital domain, other than the risk that a supplier or supplier states becomes unwilling or unable to supply a good or service. Indeed, cyber-attacks, industrial espionage, monopolistic commercial practices or the exerting of geopolitical influence, and demand-related dependency shocks can all be the result of being strategically dependent. Findings are based on desk research and internal workshops.

Chapter five maps the geopolitical leverage that the Netherlands and the EU have today or may have in the upcoming decade and beyond because of its strengths in the global network of value chains. Specifically, this chapter presents a heavy sample of digital industries and technologies in which third parties have a strategic dependence on the digital technologies and industries of the Netherlands. The chapter's findings are based on desk research, expert

[41] This risk assessment framework embraces the principles behind open-source software: the presentation of the framework should be read as an invitation to policymakers and other scholars to critique and further improve the tool, as well as to build other products based on the tool. After all, this risk assessment tool also draws inspirations from the efforts of SEO, Clingendael and TNO. In addition, previous HCSS research was leveraged. Supply chain risks that are not directly related to geopolitical competition, such as natural disasters like earthquakes disrupting the supply of semiconductors from Taiwan or consequential accidents such as the blockage of the Suez Canal by the Ever Given freight ship, do not receive any specific attention in this report. Nonetheless, some policy-recommendations will also mitigate general, non-geopolitical strategic dependence risks if executed.

interviews and a 2021 HCSS expert survey. Finally, a round table with technical and industry experts from the Netherlands' technical universities, industry and the government was for the most part dedicated to outlining these industries and technologies (see Annex 3 for a list of participants).

Chapter six presents policy opportunities and recommendations to strengthen the strategic indispensability of the Netherlands and EU in digital value chains.[42] A party is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply chains and to the global economy as a whole."[43] These interventions, hence, aim to enhance the depth and number of strategic dependencies of the rest of the world on the Netherlands and the EU. This centrality may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms.

[42] The recommendations do not include policy-recommendations that help the Netherlands and the EU alleviate high-risk strategic dependencies, since these have already been presented in earlier HCSS reports such as Joris Teer and Mattia Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry' (The Hague Centre for Strategic Studies, October 2022) and Patrahau et al., 'Advancing European Mineral Security'.

[43] Ringhof and Gherke, 'Indispensable Leverage'. The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on both enhancing Japan's self-reliance as well as making its technologies more "indispensable." 'National Security Strategy of Japan (Provisional Translation)', 30.

2. Strategic dependence risks in the digital domain

Key Takeaways

1. Strategic dependencies in the digital domain may threaten the digital open strategic autonomy of the Netherlands and the EU. These dependencies can limit "the ability [of the EU] as a global player, in collaboration with international partners, to safeguard its public interests on the basis of its own insights and choices and to be resilient in an interconnected world."[44]
2. Strategic dependencies can be leveraged to deter, compel or simply to corrode (i.e., to destroy or degrade capabilities). The supplier does not have to actually withhold or threaten to withhold the strategic good or service in order to exert influence.
3. In contrast to traditional forms of economic coercion, making use of weaponized interdependence "endows critical actors with sufficient leverage to coerce unilaterally".[45] Control over "chokepoints" in the global networks provides the sanctioner-state with the luxury to sidestep the process of forming multilateral sanctioning coalitions. The likelihood of weaponization increases as a result.
4. One area of strategic dependence in isolation may not be sufficient to exert geopolitical leverage. "Asymmetric network structures [that are not contained to one product or service category] create the potential for *weaponized interdependence*".[46] Given the globalised nature of today's world economy however, it is more realistic for the EU to nurture strategic indispensability in digital value chains than to aim for the control of as many chokepoints as possible or for the undoing of its strategic dependencies.
5. The intensification of geopolitical competition in general, but especially the risk of crises such as military conflicts occurring makes states more fearful of strategic dependencies on rivals. After all, it was Russia's full-fledged invasion of Ukraine that led European-Russian relations to finally reach breaking point.
6. This report judges strategic dependencies that threaten "the security and safety, the health of Europeans" to be more severe, than those that 'merely' threaten the supply of "goods services and technologies [...] for the green and digital transition".[47] The direct and immediate human suffering of Dutch and EU citizens, for instance as a result of physical or financial insecurity, is estimated to be greater than the negative impact of disruptions in the twin transitions.
7. As a result, the report adopts the following definition of strategic dependence: "One can speak of a level-one strategic dependence in the digital domain, if at the moment a supply-related shock occurs (meaning one or more strategic materials, goods or services are no longer supplied) then the function(s) of the digital society and/or economy that enable the Netherlands and the EU to secure its first line of core interests, meaning the security (i.e., physical or financial), safety, and health of Dutch and Europeans, are disrupted. When a supply-related shock only disrupts the continuation of the digital transition of the Netherlands and the EU, one can speak of a level-two strategic dependence in the digital domain."

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44 Hoekstra, Adriaansens, and Schreinemacher, 'Kamerbrief Open Strategische Autonomie', 3.

45 Farrell and Newman, 'Weaponized Interdependence', 45–46.; Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 11.

46 Farrell and Newman, 'Weaponized Interdependence', 45–46.

47 'Commission Staff Working Document Strategic Dependencies and Capacities', 1. Clingendael and SEO echo this definition. They note that strategic dependencies are "dependencies that are considered of critical importance to the EU and its Member States' strategic interests such as security, safety, health and the green and digital transformation." Michiel Bijlsma et al., 'Geo-Economische Monitor: Strateggische Afhankelijkheiden, Economische Beïnvloeding, Kennispositie En Investeringsstromen' (SEO, Clingendael, TNO, December 2022), 180–82, https://www.clingendael.org/sites/default/files/2022-12/Geo_economische_monitor.pdf.

"We must tighten international production chains' dependence on China, forming a powerful countermeasure and deterrent capability against foreigners who would artificially cut off supply [to China]."

General-Secretary of the Chinese Communist Party, Xi Jinping, April 2020

Strategic dependencies in the digital domain may threaten the digital open strategic autonomy of the Netherlands and the EU. The influence third parties wield through these dependencies can limit...

> "the ability [of the EU] as a global player, in collaboration with international partners, to safeguard its public interests on the basis of its own insights and choices and to be resilient in an interconnected world."[48]

In the same vein, high risk strategic dependencies also threaten the EU's DOSA. The EU warns that strategic dependencies risk "limiting the EU's ability to shape the new system of global economic governance" and can obstruct the EU's ability to "protect itself from unfair and abusive trade practices."[49]

Strategic dependencies can be leveraged to deter, compel or simply to corrode.

In order to gauge the risk-level of a strategic dependency, one should consider both the impact if a strategic good or service is no longer provided and the probability that a supplier may become unwilling or unable to provide the service or good. A supply-related shock may occur because of a boycott installed against the dependent party or war-related disruption making the production or transport of the good impossible. This chapter outlines definitions of strategic dependence-related concepts in order to arrive at a definition best suited to assess risk levels of strategic dependencies in the digital domain. Examples of discussed concepts are digital open strategic autonomy, strategic dependence, strategic indispensability, weaponized interdependence and chokepoints. To illustrate the role these concepts play in interstate competition, this chapter highlights a variety of events in recent history that relate to their use (see section 2.1).

First, the chapter shows that strategic dependencies can be leveraged to deter, compel or simply to corrode (i.e., destroy or degrade capabilities), providing examples from recent history. The section stresses that the supplier does not have to actually withhold (or threaten to withhold) the strategic good or service in order to exert influence. The very existence of strategic dependencies may be enough to deter the dependent party from taking action or compel it to take action. Second, the chapter discusses the difference between more traditional forms of economic coercion and the recent proliferation of uses of weaponized interdependence. In contrast to traditional forms of economic coercion, making use of weaponized interdependence "endows critical actors with sufficient leverage to coerce unilaterally".[50] The likelihood of weaponization increases as a result. Third, the chapter points out that one area

48 Hoekstra, Adriaansens, and Schreinemacher, 'Kamerbrief Open Strategische Autonomie', 3.

49 The EC's full definition of Open Strategic Autonomy (OSA) is "the ability to shape the new system of global economic governance and develop mutually beneficial bilateral relations, while protecting the EU from unfair and abusive practices, including to diversify and solidify global supply chains to enhance resilience to future crises." From 'Commission Staff Working Document Strategic Dependencies and Capacities', 7.

50 Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 11.

of strategic dependence may not be sufficient to exert geopolitical leverage, as states are bound by a broader international web of positive and negative strategic dependencies. Every state faces a different balance of strategic dependencies. In other words, the more economic chokepoints a state controls, the greater its geopolitical leverage. Fourth, the chapter highlights that the intensification of geopolitical competition in general, but especially the risk of crises such as military conflicts occurring, makes states more fearful of their strategic dependencies on rivals. Fifth, the chapter compares and contrasts definitions of strategic dependence, provided by the European Commission and by Dutch research institutes. Finally, the chapter builds on these key concepts and on these definitions of strategic dependence to arrive at a definition of strategic dependence, tailored to the digital domain. This definition serves as the basis of the strategic dependence risk framework presented in the next chapter (see Chapter 3).

2.1. Exerting influence through strategic dependencies: Deterrence, compellence and corrosion

Leaders in the recent past have been explicit about their intent to make use of strategic dependencies to deter rivals from acting against their interests .

Strategic dependencies can be leveraged to deter, compel or simply to corrode (i.e., degrade or destoy capabilities). Leaders in the recent past have been explicit about their intent to make use of strategic dependencies to deter rivals from acting against their interests . General-Secretary Xi Jinping stressed that China's centrality in the world economy helps deter its rivals. He calls on the Chinese state to further "tighten international production chains' dependence on China, forming powerful countermeasure and deterrent capability against foreigners who would artificially cut off supply [to China]."[51] He delivered this line during a speech in April 2020, when China slowly came out of a Covid-19 lockdown whilst the rest of the world went into one. China's top leadership is hence fully aware that its control over "chokepoints" in the world economy, meaning its "political authority" over "central nodes in the international networked structures through which money, goods, and information travel", provide it with a means to keep rivals in check.[52] The effects can be subtle. The then leader of the then largest Parliamentary Party in the Netherlands admitted that he exercised caution when speaking on China's lack of transparency in handling the outbreak of the COVID-19 pandemic and the poor quality of some of the face masks imported from China. Reliance on medical goods from China he cited as the reason for his restraint.[53]

Examples of successful deterrence through strategic dependencies, meaning "the practice of discouraging or restraining someone – in world politics, usually a nation-state, - from taking

51 Xi Jinping 'Major Issues Concerning China's Strategies for Mid-to-Long-Term Economic and Social Development', CSIS Interpret: China, 31 October 2020, 3, https://interpret.csis.org/translations/major-issues-concerning-chinas-strategies-for-mid-to-long-term-economic-and-social-development/.

52 Farrell and Newman, 'Weaponized Interdependence', 45–46.

53 The original quote is: "I have the idea that China was not very generous in informing the world of the origin and severity of the corona virus. However, in the first months I did not speak out on this, because we tried to get face masks airlifted to Europe." [...] "We couldn't immediately start making face masks ourselves, so we had to rely on other countries, especially China. A Dutch company will simply continue to sell its stuff to a customer from a country that trashes our Prime Minister, but I think that is different in China. [...] When I said something along the lines of "some of these Chinese face masks are junk" [...] I did get a hint that that was not helpful with a view to [...] maintaining the supply from China. Then I started formulating things more carefully." Klaas Dijkhoff and Tim Versnel, *Alles komt goed* (Prometheus, 2021), 25, https://uitgeverijprometheus.nl/boeken/alles-komt-goed-e-boek/.

unwanted actions," can also be found between allies.[54] President Trump's withdrawal from the Joint Comprehensive Plan of Action (JCPOA), more commonly referred to as the Iran Nuclear Deal, in 2018 went hand-in-hand with the reimposition of extraterritorial sanctions on Iran. This led European energy companies to leave Iran within months. Their reliance on trade in dollars the central currency in global capital markets, the US-based dollar clearing system and access to the US market was enough to deter EU energy companies from continuing business. They left in spite of insistence by European governments, institutions and parliamentarians that they should continue their activities in Iran. The EU even adopted legislation, making it illegal for companies to leave Iran for reasons of US sanctions.[55] In addition, to facilitate companies in continuing their business in Iran, the governments of Germany, France and the UK even launched the Instrument in Support of Trade Exchanges (INSTEX), a system to conduct payments in Euros to Iranian entities. This mechanism has been of little consequence, only made its first payment during COVID medical relief efforts in March 2020 and was finally terminated in 2023.[56]

Similarly, the European companies involved in operating the Nord Stream 2 pipeline did not dare taking the pipeline into use after the Trump Administrations imposed sanctions, in spite of Nord Stream 2's completed construction. These dependencies, hence, enable the US compel its allies. In other words, these enable Washington to force policies on the EU member-states that they otherwise would not have adopted. These force the EU "to do something".[57] Dependence on the US dollar has provided ample leverage to the US. EU leaders have, however, expressed concern that strategic dependencies in other domains may empower Washington to force more foreign policy concessions from the Netherlands and the EU. As US-China rivalry intensifies, European Commissioner Thierry Breton has expressed concern that overdependence in the digital domain on Washington may force the EU into "a forced and unconditional alignment" with the US.[58]

Even though the weaponization of dependencies through sanctions has seldomly changed the behaviour of the primary targeted state or group of states (compellence), their imposition has inflicted considerable costs to populations and industries (corrosion). Russia halting its natural gas supply to Europe is an example of attempted coercion by leveraging strategic dependencies, which largely failed to reach its stated objectives. Russia's stated aim was to compel the EU, as it demanded payments for gas supplies in Rubles.[59] An additional goal

54 Michael J. Mazarr, 'Understanding Deterrence' (RAND Corporation, 19 April 2018), 2, https://www.rand.org/pubs/perspectives/PE295.html.

55 In fact, the choice for these energy companies became relatively easy, as it boiled down to "cutting themselves off from U.S. dollars and U.S. business" or to "abandon Iran". Farrell and Newman, *Underground Empire: How America Weaponized the World Economy*, 120.

56 Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 4. ; 'The 10 INSTEX Shareholder States Have Decided to Liquidate INSTEX Due to Continued Obstruction from Iran: E3 Statement', GOV.UK, accessed 22 June 2023, https://www.gov.uk/government/news/the-10-instex-shareholder-states-have-decided-to-liquidate-instex-due-to-continued-obstruction-from-iran. ; Henry Farrell Newman Abraham, *Underground Empire*, 2023, 121, https://www.penguin.co.uk/books/455209/underground-empire-by-newman-henry-farrell-and-abraham/9780241624517.

57 Mazarr, 'Understanding Deterrence', 2.

58 Thierry Breton, 'Géopolitique Technologique : Il Est Temps Pour l'Europe de Jouer Ses Cartes', *LinkedIn* (blog), 11 October 2021, https://www.linkedin.com/pulse/g%C3%A9opolitique-technologique-il-est-temps-pour-leurope-de-breton/?originalSubdomain=fr. cited in Alice Pannier, 'Software Power: The Economic and Geopolitical Implications of Open Source Software' (Institut français des relations internationales, December 2022), 44, https://www.ifri.org/en/publications/etudes-de-lifri/software-power-economic-and-geopolitical-implications-open-source.

59 "Compel" in this context means that Russia attempted to "force [the EU] to do something". Frances D'Emilio, 'Russia Demands Natural Gas Payments in Rubles, Leaves a Loophole', *PBS NewsHour*, 31 March 2022, sec. World, https://www.pbs.org/newshour/world/russia-demands-natural-gas-payments-in-rubles-leaves-a-loophole. ; Mazarr, 'Understanding Deterrence', 2.

of Russia's eventual decision to cut back its gas exports to the EU by 80 percent in August was to punish, meaning to raise the cost for what the Kremlin described as taking "unfriendly actions against Russia."[60] Indeed, Russia's *de facto* embargo imposed high costs on Europe. Whereas in January 2022 still 54 percent of the EU's total gas imports came from Russia, only 32 percent of total EU imports still came from Russia in April 2022 and only 12 percent in October 2022.[61]

In spite of Russia's mixed success in achieving its stated objectives (some payments in Rubles appear to have been made by individual companies from EU states, but the EU and US even expanded their financial and military support for Ukraine), the primary effect of Moscow's weaponization of the EU's gas dependence is the imposition of major humanitarian and economic costs on European societies.[62] The corrosion of the EU's business climate and costs to human lives have sometimes been underplayed by European policymakers and analysts. Between September 2021 and October 2022 "average euro area consumer and producer energy prices increased by 49.5% and 93.4% respectively". This put great pressure on the economic and financial security of EU populations.[63] This development together with government policy to reduce demand resulted in about 12 percent lower gas use in the EU in 2022, 18 percent in 2023 Q1 and 22 percent in May 2023.[64] The human cost still has to be mapped in its entirety. One model suggests high energy prices can explain 68.000 of the excess death in the winter of 2022. This number is higher than COVID-19-related deaths in the same period.[65]

There are strong indications of substantial headwinds for industry too, even though it is too early to grasp the energy crisis' long-term effect. During the same period, energy-intensive companies that produce important semimanufactures that the EU needs for (digital) open strategic autonomy struggled to maintain production levels and in at least one case closed factories altogether. Chemical companies like BASF play a central role in the semiconductor manufacturing chain. In turn, semiconductors are essential components for the functioning of the EU's digital economy and society. The chemical industry in Germany, traditionally a European stronghold, showed a decline in manufacturing output in 2022, substituting

60 'Russia Issues List of "Unfriendly" Countries amid Ukraine Crisis', *Al Jazeera*, 8 March 2022, https://www.aljazeera.com/news/2022/3/8/russia-deals-with-unfriendly-countries-require-moscow-approval.

61 'Where Does the EU's Gas Come from?', 7 February 2023, https://www.consilium.europa.eu/en/infographics/eu-gas-supply/. This number has since stabilised, as Russia supplied 12% of natural gas imports to the EU in Q3 of 2023. 'EU Trade with Russia - Latest Developments', Eurostat, November 2023, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_trade_with_Russia_-_latest_developments.

62 America Hernandez, 'Rubles for Gas: Who's Paid so Far?', *POLITICO*, 25 May 2022, https://www.politico.eu/article/ruble-gas-paid-russia-eu/.

63 Francesco Chiacchio et al., 'How Have Higher Energy Prices Affected Industrial Production and Imports?' (European Central Bank, 14 February 2023), https://www.ecb.europa.eu/pub/economic-bulletin/focus/2023/html/ecb.ebbox202301_02~8d6f1214ae.en.html.

64 Demand was measured against an average of gas demands in the five years prior to 2022. Ben McWilliams and Georg Zachmann, 'European Natural Gas Demand Tracker', Bruegel | The Brussels-based economic think tank, 8 August 2023, https://www.bruegel.org/dataset/european-natural-gas-demand-tracker?trk=feed_main-feed-card_feed-article-content.

65 The Economist found: "Although wholesale costs have now fallen across the continent, the prices of domestic electricity and gas, compared with two years earlier, were up by an eye-watering 69% and 145% last winter. [...] High energy prices can cost lives. They discourage people from heating their homes properly, and living in cold conditions raises the risk of cardiac and respiratory problems. [...] If electricity last winter had cost the same as it did in 2020, our model would have expected 68,000 fewer deaths across Europe, a decline of 3.6%. [...] As wholesale energy prices fall and temperatures rise, the immediate threat may be over, but it is clear Mr Putin's energy weapon was deadly." From 'Expensive energy may have killed more Europeans than covid-19 last winter', *The Economist*, 10 May 2023, https://www.economist.com/graphic-detail/2023/05/10/expensive-energy-may-have-killed-more-europeans-than-covid-19-last-winter.

production with imports.[66] BASF even announced the closure of several factories in Germany, including laying-off 1000s of employees. The board cited high energy prices. In spite of geopolitical tension, months earlier the company greenlighted a ten-billion-euro petrochemical project in China.[67]

In reverse, Russia's rivals also leveraged strategic dependencies that sought to compel and corrode. Following Russia's invasion of Ukraine, the EU together with the U.S., Japan, South Korea and Taiwan sanctioned key Russian individuals and banks and imposed a near-comprehensive embargo on the export of semiconductors to Russia. The intention was first of all to force Moscow to change course (compel), but also to cripple Russia's fighting capability (corrode). Compellence was not achieved, as Moscow did not stop its war in Ukraine. Both National Security Advisor Jake Sullivan and European Commission President von der Leyen, however, lauded the success of semiconductor sanctions to corrode. They both claim that these are "forcing Russia to use chips from dishwashers in military equipment."[68]

States are more likely to impose sanctions if they can weaponize interdependence instead of using traditional forms of economic coercion.

2.2. Economic coercion and weaponized interdependence

States and especially great powers in recent years impose sanctions increasingly often, in spite of the overall failure of economic coercion to change state behaviour.[69] The literature on economic coercion shows that "sanctions are more likely to work when the demands are clear, when there is multilateral cooperation supporting the sanctions, when no 'black knights' are willing to step in and economically support the target, and when expectations of future conflict between the target and sender are muted."[70] China's ban on Australian imports following Canberra's demand for an inquiry into the origins of COVID-19 was unilaterally imposed and undercut by other states continuing to buy Australian products. In spite of financial costs, companies partially made up for lost revenue in China by selling in other markets.[71]

66 Industrial production in general, during the same period, increased, most likely due to "easing of supply bottlenecks, a related workout of backlog orders and recovering demand" following the end of the COVID-19 pandemic and its related lockdowns. Chiacchio et al., 'How Have Higher Energy Prices Affected Industrial Production and Imports?'

67 Haryono Lim, BASF's new Verbund project in China, 2022, https://www.basf.com/cn/en/media/BASF-Information/Inspirations/new-verbund-site-in-China.html. ;The CFO of BASF justified the closure by mentioning that "gas prices are twice as high as we are used to" and that these would "remain high" in the future ; Stephen Stapczynski, 'Gas Crisis Is Far From Over for Europe Inc.', *Bloomberg*, 27 February 2023, sec. Business, https://www.bloomberg.com/news/articles/2023-02-27/gas-crisis-is-far-from-over-for-europe-inc-lemsxwjb?embedded-checkout=true.. Russia's energy blow comes at a time when American industrial policy also leads to increased competition for European manufacturing. The Biden Administration's Inflation Reduction Act (IRA) and CHIPS and Science Act attempt to lure companies active in respectively the electric vehicle/battery and semiconductor supply chain to expand their presence in the United States. This comes at a time when American energy prices are much lower than European ones.

68 Jake Sullivan, 'Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit', in *The White House*, 2022, https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/09/16/remarks-by-national-security-advisor-jake-sullivan-at-the-special-competitive-studies-project-global-emerging-technologies-summit/. ; *State of the Union Speech by President von Der Leyen*, 2022, https://www.youtube.com/watch?v=K8LzZ2vgnwA.

69 The Global Sanctions Database (GSDB) shows that the total number of active sanctions imposed by states has risen from under 250 in 2012 to over 400 in 2022. Great powers, the US, Russia, China and the EU, imposed more than half of these sanctions in 2022. Teer, Bertolini, and Girardi, 'Competitie Tussen Grootmachten En Maatschappelijke Stabiliteit in Nederland: De Risico's van Russisch Gas, Chinese Grondstoffen En Taiwanese Chips Voor Vitale Sectoren', 13.

70 Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 11.

71 'Australia Has Faced down China's Trade Bans and Emerged Stronger', *The Economist*, May 2023, https://www.economist.com/asia/2023/05/23/australia-has-faced-down-chinas-trade-bans-and-emerged-stronger.

It is no coincidence that states are more likely to impose sanctions, if they can weaponize interdependence instead of just using traditional forms of economic coercion .[72] When interdependence is weaponized fewer escape routes remain. For example, the Trump Administration would have prohibited European energy companies to trade in dollars, if they had continued to trade with Iran. Weaponized interdependence is different from more general coercion, as it "alters the calculus [...] by easing the necessary conditions for coercion". Indeed, it is "extremely difficult to erect competing networks [in this case a network of payment in any other currency than dollars] from scratch."[73] The sanctioning party's "political authority" over a "chokepoint" in the network implies parties are not willing or not able to provide substitutes (i.e., there are no 'black knights'). Hence, under conditions of weaponized interdependence the "network centrality endows critical actors with sufficient leverage to coerce unilaterally".[74] The sanctioner-state then has the luxury to sidestep the process of forming multilateral coalitions, which is often time-consuming, failure-prone and requires compromise. Therefore, when a party uses its control over chokepoints in networked systems, "lower [direct] costs on the sanctioner-state are imposed" and as a result "the threshold conditions for coercing allies is significantly reduced."[75]

Powerful states are not just mapping the strategic goods and services they control. They also map the critical economic inputs that they currently do not or are in general not able to produce domestically.

2.3. Asymmetric interdependence and strategic indispensability

One area of strategic dependence in isolation may not be sufficient to exert geopolitical influence, either through compellence or deterrence. Indeed, two scholars already in the 1970s noted that "where states are asymmetrically interdependent, the less dependent may be able to manipulate the relationship to achieve its goals, not only in the area of the issue but in the form of side-payments in other issue areas as well."[76] The 2022 tit-for-tat sanctions between the EU, the US and Asian democracies on the one hand and Russia on the other show that indeed a multitude of strategic dependencies are important. Parties on both sides attempted to compel by using a wide range of tools in the interdependent relationship, including both (bilateral) trade flows to economically coerce (e.g., the U.S. and EU boycott on the import of Russian oil) or chokepoints in international networks in order to weaponize interdependence (e.g., the banning of several Russian banks from the SWIFT-payment system). Therefore, it is important to take into account the overall dependence of a state on a wide variety of international trade flows and central points in globalized networks that are controlled by others. In short, "asymmetric network structures [that are not contained to one product or service category] create the potential for *weaponized interdependence*," meaning the ability "to leverage interdependent relations to coerce others".[77]

For this reason, powerful states are not just mapping the strategic goods and services they control. Instead, they map the critical economic inputs that they currently do not or are in general not able to produce domestically . These inputs are especially cause for concern if

72 One important volume on the topic of weaponized interdependence concludes: "weaponized interdependence does not guarantee successful statecraft; it merely increases the probability of coercion being attempted." Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 12.

73 Drezner, Farrell, and Newman, 11.

74 Drezner, Farrell, and Newman, 11.

75 Drezner, Farrell, and Newman, 11.

76 Robert O. Keohane and Joseph S. Nye, 'Power and Interdependence', *Survival* 15, no. 4 (July 1973): 160, https://doi.org/10.1080/00396337308441409.

77 Farrell and Newman, 'Weaponized Interdependence', 45–46.

they travel through central nodes in international networks controlled by rivals. For example, in the same April 2020 speech President Xi urges to undo China's strategic dependencies on the rest of the world, particularly the United States (U.S.) and its allies. He states: "we must make up for our shortcomings[, meaning that] in sectors and segments related to national security, we must build a domestic supply system that is independently controllable and secure and reliable, so that self-circulation can be accomplished at critical moments, and ensure that the economy operates normally in extreme situations."[78] In Science and Technology Daily, a journal connected to the Chinese government, researchers map and lament the many areas in which the PRC still is strategically dependent on the U.S. and its allies, ranging from a complete dependence on the Netherlands for the latest generation lithography systems for the production of advanced semiconductors to German companies for advanced drilling equipment.[79]

It is more realistic for the EU to nurture strategic indispensability in digital value chains, than to aim for the control of as many chokepoints as possible or for the undoing of all strategic dependencies.

It is more realistic for the EU to nurture strategic indispensability in digital value chains, than to aim for the control of as many chokepoints as possible or for the undoing of all strategic dependencies .[80] The more economic chokepoints a state controls, the greater its geopolitical leverage. However, in today's globalised economy industries are spread out across countries and regions. This makes states heavily dependent on each other. A party is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply chains and to the global economy as a whole."[81] The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on enhancing Japan's self-reliance and making its technologies more "indispensable."[82] A successful strategy of strategic indispensability, hence, nurtures domestic industries that produce products or offer services that other states cannot do without. As a result, this enhances the ability of the supplier state to deter, compel and -if need be- corrode. In fact, a position of strategic indispensability can be used to "convince a potential attacker that the cost-benefit calculus of aggression is unfavourable, partly through emphasizing the costs of aggression but also through offering reassurances and benefits that make a world without aggression more attractive."[83]

2.4. Critical moments, extreme situations and breaking points

The probability that interdependence is weaponized is also heightened by the intensification of geopolitical rivalries. This is a result of the world's transition from a unipolar to a more bipolar or multipolar world in general and especially the risk of crises such as military conflicts occurring. The focus in Xi's speech on supply chain failures at "critical moments" and in "extreme situations" does not just relate to the risk of health crises such as pandemics and natural disasters. Beijing is instead aware that when relations between states rapidly deteriorate, the supply of strategic goods and services often are at risk. Indeed, if a military-strategic crisis

78 Xi, 'Major Issues Concerning China's Strategies for Mid-to-Long-Term Economic and Social Development'.

79 Ben Murphy, 'Chokepoints: China's Self-Identified Strategic Technology Import Dependencies' (Center for Security and Emerging Technology (CSET), May 2022), https://cset.georgetown.edu/publication/chokepoints/.

80 The 'stack model' is inspired by the work of the American philosopher of technology Benjamin Bratton. 'Toekomstverkening Digitalisering 2030', 22.

81 Ringhof and Gherke, 'Indispensable Leverage'.

82 'National Security Strategy of Japan (Provisional Translation)', 30.

83 Mazarr, 'Understanding Deterrence', 5.

between the US and China over Taiwan, the East-China Sea or the South-China Sea occurs, Beijing may face both war-related disruption and US-led export embargoes. Beijing's worries go beyond the US, as the aforementioned series of articles of Chinese researchers on the technological "chokepoints" focuses on dependencies on Europe and Japan as well.[84]

EU and US leaders have similarly highlighted increased tensions as a reason to take action on strategic dependencies. US National Security Advisor Jake Sullivan connects an intensification of geopolitical tensions to a greater need to ensure that key dependencies of China on the US and its allies are maintained. He stated in a speech in September 2022 that the US finds itself in a new "strategic environment" following Russia's invasion of Ukraine and increased assertiveness by China in the South-China Sea and around Taiwan. He concludes that this necessitates a far more active and restrictive export control policy. This new policy aims to "maintain as large a lead as possible" over rivals in "certain technologies" with a "foundational nature [...] such as advanced logic and memory chips". Export controls have an ever-greater purpose in US policy, as until then their goal was simply to remain "only a couple of generations ahead" vis-à-vis rivals.[85]

The likelihood of rivals leveraging strategic dependencies in order to deter, compel and corrode quickly rises at times of crisis.

The likelihood of rivals leveraging strategic dependencies in order to deter, compel and corrode quickly rises at times of crisis . It was Russia's full-fledged invasion of Ukraine that led European-Russian relations to finally reach breaking point: the West was no longer willing to deliver critical economic inputs to Russia, for instance semiconductors, whilst Russia halted about 80% of its exports of natural gas to Europe.[86] Interdependence between the EU and Russia, especially energy trade, had only deepened in the 15 years before the invasion (in spite of structurally rising tensions during over that period).

2.5. What is at stake? European conceptions of strategic dependence

The European Commission, traditionally an advocate of free trade both inside the Union and with the rest of the world, increasingly pays attention to the dangers of strategic dependence.[87] After all, the COVID-19 pandemic and the war in Ukraine show that "supply-related [shocks]" can have far-reaching negative effects on the citizens of the EU. The EU defines these shocks as "a given supplier within a value chain no longer producing or delivering goods and services or in reduced quantities; or the country where the supplier is based imposing certain export restrictions".[88] Dependence, the EC finds, is a "reliance on a limited number of actors for the supply of goods, services, data, infrastructures, skills and technologies combined with a limited capacity for internal production."[89] The EC speaks of a strategic

84 Murphy, 'Chokepoints: China's Self-Identified Strategic Technology Import Dependencies', 21.

85 Sullivan, 'Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit'.

86 "A breaking point is reached when friction in an interstate relationship, often related to military-strategic tensions, becomes so overwhelming that states are no longer willing to supply all or some vital resources on which the economies of their rivals depend." Joris Teer and Mattia Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry' (The Hague Centre for Strategic Studies, October 2022), 3.

87 '2023 State of the Union Address by President von Der Leyen', Text, European Commission, 13 September 2023, https://ec.europa.eu/commission/presscorner/detail/ov/speech_23_4426.

88 'Commission Staff Working Document Strategic Dependencies and Capacities', 8.

89 'Commission Staff Working Document Strategic Dependencies and Capacities', 8.

dependence, if that dependence "affects the EU's core interests, [...] relating to areas [like] security and safety, the health of Europeans as well as goods, services and technologies that are key for the green and digital transition at the core of the EU's priorities". Strategic dependencies are often found in "the most sensitive ecosystems," the EC concludes.[90] The EC goes beyond just looking at the supply of materials, components and tangible end-products, as it concludes services like system updates for mobile networks ought to be considered dependencies too. It states: "the situation with 5G should be no different: we can't afford to maintain critical dependencies that could become a 'weapon' against our interests."[91]

Dutch research institutes have built on the EU's definition, but instead defined strategic dependencies in light of "public interests", meaning that the absence of a product may lead to "large scale societal damage". Examples of these public interests are the continued functioning of "vital infrastructure", "vital processes" and "the healthcare system", or the supply of "food supply", the continued development of "the six key technologies" (as identified by the European Commission) or "the green transition" and "the digital transition".[92] They also broadened the second criterium of dependence, referring in general to the unavailability of options for (timely) substitution. The EU only highlights "a limited capacity for internal production"..[93] Indeed, indigenising production is only one avenue through which import substitution can be achieved.

These institutes also included the factor of time. They find that if "substitution in the short-term is possible for a specific product" [...], then the reliance on the supply of a product from abroad "should not be considered a strategic dependence." If "substitution of a product in the medium-term (i.e., 5-years) is possible", then a reliance on the supply of a product from abroad "is only a strategic dependence if immediate damage is incurred as a result of disruptions in supply."[94]

90 'Commission Staff Working Document Strategic Dependencies and Capacities', 1. Clingendael and SEO echo this definition. They note that strategic dependencies are "dependencies that are considered of critical importance to the EU and its Member States' strategic interests such as security, safety, health and the green and digital transformation." Bijlsma et al., 'Geo-Economische Monitor: Strateggische Afhankelijkheiden, Economische Beïnvloeding, Kennispositie En Investeringsstromen', 180–82.

91 'Commission Announces next Steps on Cybersecurity of 5G', Text, European Commission, 15 June 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3309.

92 Bijlsma et al., 'Geo-Economische Monitor: Strateggische Afhankelijkheiden, Economische Beïnvloeding, Kennispositie En Investeringsstromen', 181. The translation from Dutch to English was done by HCSS.

93 Bijlsma et al., 181.; In their definition, SEO, Clingendael and TNO build on a government definition presented in Kamerbrief, Reacties op moties afhankelijkheden en mensenrechten in China, MBHOS, april 2022. HCSS translated the definition of strategic dependence in the SEO, Clingendael and TNO report from Dutch to English.

94 Bijlsma et al., 181, 182. Translated from Dutch to English by HCSS.

Definitions, definitions, definitions

Compellence: "an effort to force an actor to do something."[95]

Corrosion: To destroy or degrade capabilities.

Deterrence: "the practice of discouraging or restraining someone – in world politics, usually a nation-state, - from taking unwanted actions, such as an armed attack. [...] A state can deter using threats of economic sanctions, diplomatic exclusion, or information operations."[96]

Dissuasion: "Convince[ing] a potential attacker that the cost-benefit calculus of aggression is unfavourable, partly through emphasizing the costs of aggression but also through offering reassurances and benefits that make a world without aggression more attractive."[97]

Open Strategic Autonomy (OSA): "The capacity to, as a global player, in collaboration with international partners, safeguard public interests [of the Netherlands and the EU] based on its own insights and choices, as well as remain resilient in an interconnected world."[98]

Digital Open Strategic Autonomy: "Open strategic autonomy in the digital world, which as a result of the economic and societal role of digital processes is strongly interwoven with the physical world."

Digital stack (limited to the first five layers): "A description of digital technology as a layered system of modular components," composed of (i) raw materials, (ii) hard infrastructure, (iii) soft infrastructure, (iv) data and (v) applications and services.[99]

Chokepoint effect: "A privileged states' capacity to limit or penalize use of hubs [or in other words central nodes in interdependence networks through which goods, services or information travel] by third parties (e.g., other states or private actors)."[100]

Breaking point: The moment "when friction in an interstate relationship, often related to military-strategic tensions, becomes so overwhelming that states are no longer willing to supply all or some vital resources on which the economies of their rivals depend."[101]

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95 Mazarr, 'Understanding Deterrence', 2.

96 Mazarr, 2–4.

97 Mazarr, 5.

98 Hoekstra, Adriaansens, and Schreinemacher, 'Kamerbrief Open Strategische Autonomie', 3.

99 'Toekomstverkening Digitalisering 2030', 5.

100 Farrell and Newman, 'Weaponized Interdependence', 56.

101 Teer and Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry', October 2022, II.

Definitions, definitions, definitions (continued)

Weaponized interdependence: "a condition under which an actor can exploit its position in an embedded network to gain a bargaining advantage over others in a contained system. [...] States with political authority over central economic nodes 'can weaponize the networks to gather information or choke off economic and information flows, discover and exploit vulnerabilities, compel policy change, and deter unwanted actions."[102]

Dependence: "reliance on a limited number of actors for the supply of goods, services, data, infrastructures, skills and technologies combined with a limited capacity for internal production."[103]

Strategic dependence (EU): a dependence that "affects the EU's core interests, [...] relates to areas [like] security and safety, the health of Europeans as well as goods, services and technologies that are key for the green and digital transition at the core of the EU's priorities. [These dependences are often found in] the most sensitive ecosystems."[104]

Strategic dependence (Dutch government): "A dependence is strategic when the product, service or technology in question is crucial for safeguarding public interests of the Netherlands and/or the EU, or when the dependence poses a risk to the continuity of vital processes or third-party access to sensitive information."[105]

Strategic indispensability: A state is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply chains and to the global economy as a whole."[106]

Asymmetrical interdependence: "Where states are asymmetrically interdependent, the less dependent may be able to manipulate the relationship to achieve its goals, not only in the area of the issue but in the form of side-payments in other issue areas as well."[107]

Supply-related shock: "a given supplier within a value chain no longer producing or delivering goods and services or in reduced quantities; or the country where the supplier is based imposing certain export restrictions" [108]

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102 Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 1.; Farrell and Newman, 'Weaponized Interdependence', 45.

103 'Commission Staff Working Document Strategic Dependencies and Capacities', 8.

104 'Commission Staff Working Document Strategic Dependencies and Capacities', 1, 8. Clingendael and SEO echo this definition, as they note that strategic dependencies are "dependencies that are considered of critical importance to the EU and its Member States' strategic interests such as security, safety, health and the green and digital transformation."

105 M.A.M. Adriaansens, Wopke Hoekstra, and Liesje Schreinemacher, 'Kamerbrief over kabinetsaanpak Strategische Afhankelijkheden', kamerstuk (Ministerie van Algemene Zaken, 12 May 2023), 3, https://www.rijksoverheid.nl/documenten/kamerstukken/2023/05/12/kabinetsaanpak-strategische-afhankelijkheden.

106 Ringhof and Gherke, 'Indispensable Leverage'. The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on both enhancing Japan's self-reliance as well as making its technologies more "indispensable." 'National Security Strategy of Japan (Provisional Translation)', 30.

107 Keohane and Nye, 'Power and Interdependence', 160.

108 'Commission Staff Working Document Strategic Dependencies and Capacities', 8.

2.6. Defining strategic dependence in the digital domain

To arrive at a definition of strategic dependence in the digital domain (or in other words digital strategic dependence) that can be operationalised in the risk assessment framework, it is paramount to leverage the authoritative definitions (discussed in this section) of deterrence, compellence, dependence, strategic dependence and supply-related shocks. This report builds on the definition of the European Commission, yet opts for a different approach in two ways.

First, this report, however, attributes more weight to maintaining "the security and safety, the health of Europeans" than to "goods services and technologies [...] for green and digital transition".[109] The EC mentions "the security and safety, the health of Europeans" in one breath with "goods, services and technologies that are key for the green and digital transition at the core of the EU's priorities". By doing so, it suggests these two core interests are of equal importance. This report opts for a different approach, because the direct and immediate human suffering of EU citizens, for instance as a result of physical or financial insecurity, is estimated to be greater than the effects of disruptions in the twin transitions.

The failure to complete the digital transition can hurt the EU's future economic competitiveness and business climate, especially if competing trading blocs digitalise at a faster pace.

The failure to complete the digital transition can hurt the EU's future economic competitiveness and business climate, especially if competing trading blocs digitalise at a faster pace. This can also lead to societal exclusion of vulnerable groups. Digitalisation, however, facilitates greater access to digital goods and services in the future. Even if digitalization does not progress, the foundation of digital goods and services on which today's critical sectors already rely is maintained. Therefore, digital strategic dependencies that only threaten digitalisation but not the core functioning of critical sectors in the Netherlands and the EU are designated as level-two digital strategic dependencies.

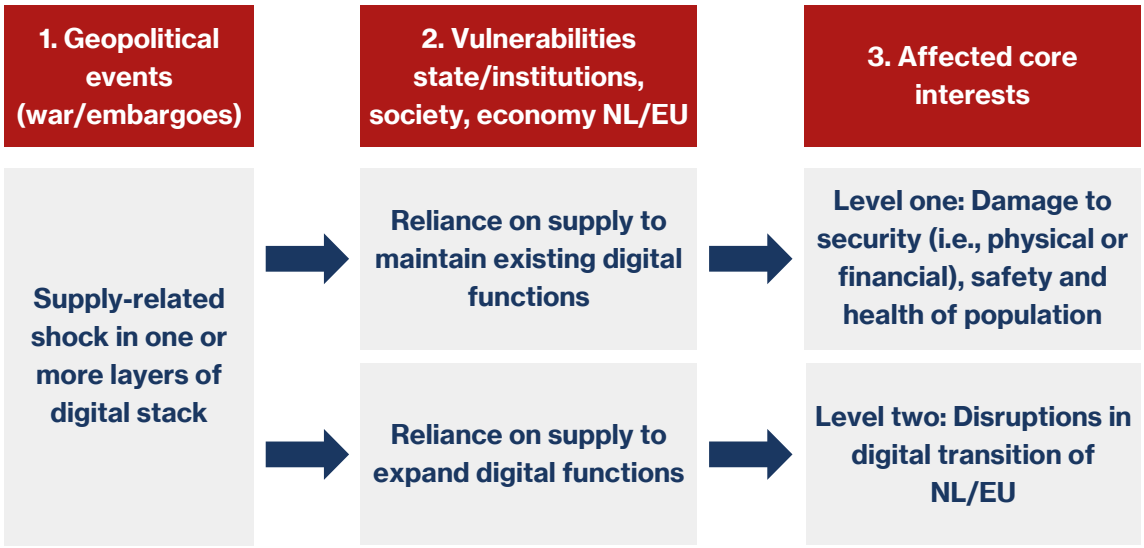
Second, as this report focuses on digital strategic dependencies (as opposed to strategic dependencies in general) the effect of supply-related disruptions on the green transition is excluded altogether. As a result, the focus of the study is on disruptions in the supply chain that impede the EU's access to materials, goods and services in the digital stack. Therefore, when analysing the second line of core interests the report focuses on the effects that a supply-related shock could have on the supply of "goods, services and technologies [...] for the [...] digital transition at the core of the EU's priorities", as opposed to also taking the EU's green transition into account. Therefore, this report proposes the following definition of strategic dependence in the digital domain:

> One can speak of a level-one strategic dependence in the digital domain, if at the moment a supply-related shock occurs (meaning one or more strategic goods or services are no longer supplied) then the function(s) of the digital society and/or economy that enable the Netherlands and the EU to secure its first line of core interests, meaning the security (i.e., physical or financial), safety, and health of Dutch and Europeans, are disrupted. When a supply-related shock only disrupts the continuation of the digital transition of the Netherlands and the EU, one can speak of a level-two strategic dependence in the digital domain (see figure 2 for a visualisation of this definition).[110]

109 'Commission Staff Working Document Strategic Dependencies and Capacities', 1, 8.

110 Hence, the definition makes use of the EU's definition of a supply-related shock, meaning "a given supplier within a value chain no longer producing or delivering certain goods and services, or in reduced quantities; or the country where the supplier is based imposing certain export restrictions." 'Commission Staff Working Document Strategic Dependencies and Capacities', 8.

Figure 2. Geopolitical events can disrupt state, society and economic digital functions, threatening core interests



3. Strategic dependence risk framework: design

Key Takeaways

1. Risk assessment tools can support policymakers, experts and industry leaders in identifying high risk strategic dependencies. By making the risk levels of a wide variety of strategic dependencies comparable, this strategic dependence risk framework aims to facilitate them with prioritising strategic dependencies for risk mitigation measures. The risk level of a strategic dependence is both determined by the *impact* if supply of the good or service is disrupted and the *probability* that a supplier or supplier country-of-origin becomes unwilling or unable to continue supply.
2. The level of disruption depends on 1a. the criticality of baseline supply and 1b. the availability of high-quality, cost-efficient alternatives to this baseline supply at scale in time. The function of the baseline supply of goods and services for the recipient country's vital sectors, economy, society and ongoing digitalisation hence ought to be assessed carefully by technical and supply chain experts.
3. Strategic dependencies ought to be considered high-risk strategic dependencies, if supply disruptions are likely to occur. Geopolitical disruptions occur either due to unwillingness or inability by the supplier and/or the supplier state to continue supply. Both intentions and capabilities of the supplier country, as well as war-related threats to the supplier country and its supply lines ought to be assessed carefully to gauge risk levels.
4. All things being equal, dependencies for goods or services that require regular maintenance, updates or resupply ought to be considered more severe than those that do not. If maintaining the function of the good or service requires the original supplier to execute additional actions, the receiving party remains structurally dependent on the willingness and ability of the supplier and supplier country to continue supply.
5. All things being equal, dependencies for goods and services for which national, regional or global demand is set to strongly increase in the near future should be considered more severe, as supply may fail to keep track with demand. Growing reliance on the good or service throughout vital sectors likewise makes dependence on baseline supply more severe. In short, looming shortages and a broader application of the good or service in vital sectors increase the relative value of baseline supply.
6. Even if disruptions in the baseline supply of a good or service have a devastating effect on the Netherlands core interests immediately and demand for that product is multiplying in the upcoming five years, then this still does not automatically mean that the Netherlands and the EU are strategically dependent. In theory, the availability of "perfect alternatives" can entirely undo the risk of dependence for the baseline supply. Bringing online alternatives to baseline supply can be achieved by pursuing four strategies: diversification, internal production, substitution and maintaining access to the baseline supply through illicit exchange. Alas, for almost all "high criticality-goods and services" perfect alternatives do not exist, as alternative supplies are not immediately available, not available at scale or more expensive.
7. Even if a dependence is considered to be of high strategic importance, this does not automatically mean that strategic dependence is also high risk. A geopolitical assessment of the *likelihood* that baseline supply is disrupted is as important as a technical and supply chain assessment of the *impact*, if a disruption occurs. The relationship with the supplier country, the state influence over the supplier and the cost of weaponization to the supplier of weaponizing supply determine the probability that the supplier or supplier country may become unwilling to continue supply. As a result of military threats to the supplier country or the supply lines, namely maritime routes, aerial approaches and communication cables, a supplier may become unable to continue supply.

This chapter presents a strategic dependence risk framework focusing on supply-related shocks. The previous chapter has formulated a definition of strategic dependence in the digital domain that will serve as the foundation of the strategic dependence risk assessment framework presented in this chapter. The framework considers a wide variety of factors in order to make a comprehensive impact assessment. In addition, if a high-impact strategic dependence has been identified, what then determines the actual risk-level? In 2022, the EU developed an even deeper dependence on imports of natural gas from Norway. Yet, European governments show no fear that the Norwegian government takes a page from Putin's play-book and halts the supply of natural gas to the EU. Is natural gas dependence on Norway therefore by definition low risk? Likely not, as the sabotage of Nord Stream 1 and 2 shows that subsea infrastructure is vulnerable to war-related disruption.

The strategic dependence risk framework provides policymakers with a tool to gauge and compare the risk-levels of strategic dependencies

The strategic dependence risk framework assesses the geopolitical risk levels of strategic dependencies. It provides policymakers with a tool to gauge and compare the risk-levels of strategic dependencies that perhaps seem too dissimilar to compare at first sight . The frame-work combines impact indicators, determining whether a dependence should be considered of strategic importance, with probability indicators, which are helpful in assessing the likeli-hood that the supply of a strategic good or service will be disrupted. As a result, policymakers can identify specific high-risk strategic dependencies and prioritize these for mitigation efforts. This methodology includes often used indicators that determine risk levels, such as options for diversification and (demand) substitution, whilst also introducing lesser-known indicators, such as the possibility to still access the strategic good or service through illicit exchange (in spite of a boycott by a rival state) and military threats to supply lines, like maritime shipping routes and subsea cables.

In the risk framework, strategic dependencies are scored on seven impact indicators and five probability indicators. Impact of a supply-related shock is defined as 1. the negative effect on the level-one and level-two core interests of the Netherlands and the EU, if the supply from a country or a group of countries is disrupted. The severity of the negative effect depends on 1a. the criticality of the baseline supply of the good of service from one or several countries for the Netherlands and the EU now and in five years and 1b. the availability of alternatives to that baseline supply.[111] Probability is defined as 2. the likelihood that baseline supply is disrupted, either as a result of 2a. unwillingness or 2b. inability by the supplier and/or the supplier state to continue supply. After all, the probability that a supply-related shock occurs depends both on the intentions of the supplier, as its interests determine whether the supplier/supplier state will halt the supply of a good or service to the EU, and on the likelihood that war-related disrup-tion renders a supplier/supplier state unable to continue supply. Some indicators carry more weight than others.

Please find the table below for an overview of the main guiding question per indicator (and see annex 1a and 1b for a full presentation of the guiding questions to fill out the risk framework). Please find Figure 2. and Figure 3. below for a full overview of the impact-assessment and probability-assessment matrices that together determine risk scores. Please see Figure 4. for a summary matrix, which can be filled out on the basis of both Figures 2 and 3.

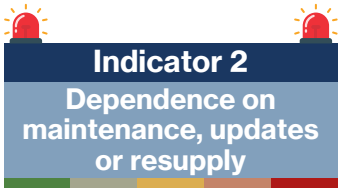
[111] A "baseline" is commonly known as "a starting point for comparisons". In this risk assessment framework, "baseline supply" should be understood as the current level of supply of a good or service by one country or the joint supply provided by several countries. From 'Baseline'.

Table 1. Strategic dependence risk framework: aims, indicators and guiding questions

Aim		Indicator (including weight)	Main guiding question
1. Identifying strategic dependence (impact assessment)	1a. Assessing criticality of baseline supply	1. Criticality – 2x	What is the effect on the security (i.e., physical or financial), safety, and health of Dutch and Europeans (level-one core interest) and on the continuation of the digital transition (level-two core interest) if the baseline supply of the good and service from one or several countries is entirely disrupted?
		2. Dependence on maintenance, updates or resupply – 1x	If the good or service is no longer supplied, when will this have an impact on level-one and/or level-two core interests?
		3. Demand projection – 1x	Total demand: Is national, regional and/or global demand for the good or service likely to outpace global supply, leading to shortages of the good or service on top of the risks of supply-related shocks? Total use of good or service to enable vital processes: Will more vital processes come to rely on the supply of the good or service in the next five years?
	1b. Assessing alternatives to baseline supply	4. Diversification - 1x	Do companies in allied, likeminded, or at least non-rival, non-EU states effectively supply the same good or service?
		5. Internal production - 1x	Can the production of the good or service be effectively moved to the Netherlands or another EU member-state?
		6. Substitution - 1x	Can the function of the good or service be performed effectively, meaning at the same level of quality, in similar quantities and at comparable prices, by a different good or service?
		7. Illicit exchange -1x	Can the good or service provided by the original suppliers still be effectively accessed, in spite of an export boycott through direct or indirect illicit flows?
2. Assessing risk levels (probability assessment)	2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply	8. Relationship with supplier country - 3x	Does the Netherlands and the EU enjoy good relations with the country of origin of the company that supplies the good or service?
		9. State influence over supplier - 1x	Does the supplier state have the means to force the supplier to no longer provide the good or service?
		10. Cost of weaponization to supplier - 2x	What are the costs of halting the supply of the good or service to the state imposing the boycott?
	2b. Assessing likelihood of inability of supplier and/or supplier state to continue supply	11. Threats to supplier country -5x	Does the supplier state of the good or service face a military threat?
		12. Threats to supply lines - 1x	Are the supply lines (e.g., maritime routes, airways, communication cables and satellite connections) via which the good or service is supplied likely to be disrupted?

3.1. Assessing impact: Criticality of and alternatives to a baseline supply

The severity of the negative effect on the level-one and level-two core interests of the Netherlands and the EU, if supply is disrupted, can be determined on the basis of seven indicators. The first and most important indicator is *1. Criticality*, meaning the function that the baseline supply of a good or service has for the Netherlands and the EU to sustain vital processes, general economic activity and continue digitalisation. If the criticality of a dependence is very low, meaning that disruptions in the baseline supply would have "no effect on security, safety and health" on Dutch and European populations, and would cause "no obstacles to digitalisation", then there is no reason to consider that specific dependence of strategic importance.



If, however, on the basis of the first indicator a vitally important baseline supply of goods and services has been identified, it is important to determine what the timing of impact is if supply is disrupted. Indeed, *2. dependence on maintenance, updates or resupply* determines whether a disruption in supply will affect Netherlands and the EU immediately, or only in the long-term. For example, a supply-related shock for a product needing constant maintenance, updates or

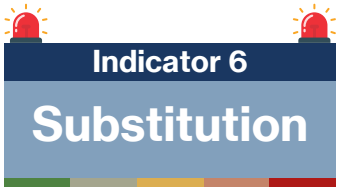
resupply (e.g., Cloud services) will result in immediate impact, whereas the impact of a disruption in the supply of goods that have a long independent lifespan from the supplier may only be noticeable years later (e.g., permanent magnets).

Another factor, namely 3. *demand projection*, determines whether the effects of a supply disruption would be more severe in the next five years. A rise in national, regional or global demand for a material, good, or service may make a once considered ubiquitous good or service scarce – and therefore highly valuable (e.g., rare earths). Indeed, the current global exponential demand increase for rare earths due to the energy transition risks creating shortages, deepening the existing strategic dependence the EU has on China (see Table 2, annex 1a and annex 1b). The importance of a good or service can also increase because it becomes of relatively greater strategic value for the Netherlands and the EU, due to the product's increased importance to maintain vital processes. The increased reliance of vital sectors on 5G telecommunications and Cloud services hence expands the reliance on the providers of these services over time.

Even if disruptions in the baseline supply of a good or service have a devastating effect on the Netherlands core interests immediately and demand for that product is multiplying in the upcoming five years (i.e., scores of "5" on the first three indicators), then this still does not mean that the Netherlands and the EU are strategically dependent. In fact, immediate alternatives to baseline supply may be available. Scores on the following four indicators help identify strategic dependencies. Indeed, they determine whether effective alternatives, meaning alternatives of similar quality, in similar quantities, at comparable prices, for the baseline supply are readily available today, or will be available in the near future.

Solutions to supply disruptions are fourfold. States may attempt to achieve *4. Diversification*, meaning alternative supply of the same product from another non-EU state (e.g., replacing China's rare earths for US-supplied rare earths).

They may attempt to bring online *5. Internal production*, meaning production of the good or service in the EU (e.g., inviting Intel and TSMC to manufacture automotive chips in Germany).



They can try *6. Substitution,* meaning the replacement of a good or service with a good or service that fulfils the same function (e.g., replacing cobalt with more lithium in lithium-ion batteries). These are all examples of accessing actual alternatives after the baseline supply is disrupted.

Yet, targeted states can also attempt to continuously access the original supply of a strategic good or product by turning a blind eye to 7. *Illicit exchange,* which is continued supply by the original supplier but then without consent of that company's country of origin. Continued access to semiconductors produced in the West of Russia's defence industry through Chinese and Hong-Kong-based traders comes to mind. These trade flows continue in spite of Dutch export controls, coordinated with allies. Chips are a feast for smugglers, as they are high-value, low-weight and small.[112]

[112] Alex W. Palmer, '"An Act of War": Inside America's Silicon Blockade Against China', *The New York Times*, 12 July 2023, sec. Magazine, https://www.nytimes.com/2023/07/12/magazine/semiconductor-chips-us-china.html.

Russia's weaponization of natural gas, supplied through pipelines, against the EU appears more effective than the EU's counter boycott of Russian maritime oil. This is true in spite of the fact that oil trade generates far greater income for the Kremlin. After all, oil trade is difficult to effectively boycott as it is shipped via maritime routes, can change hands easily, and can be mixed with oil products and rerouted via third countries. Russia's natural gas supplies to the EU, except for a tiny minority of Liquified Natural Gas (LNG) supplies, are constraint to pipeline networks that Moscow can switch-off (or "choke-off"). Illicit exchange of Russian natural gas, therefore, is far more difficult than the continued exchange of oil products or continued supply of Western semiconductors to Russia.

4. Diversification, 5. internal production, 6. substitution and 7. illicit exchange can all be effective answers to disruptions in the baseline supply of a good or service from a country or group of countries. In theory, the availability of "perfect alternatives" entirely undoes the risk of a baseline supply of goods or services, even if this supply currently fulfils a "very high criticality" function. As a result, even if disruptions in the baseline supply of a good or service have a devastating effect on the Netherlands core interests immediately and demand for that product is multiplying in the upcoming five years (i.e., scores of "5" on the first three indicators), then this still does not automatically mean that the Netherlands and the EU are strategically dependent on that baseline supply. Then again, in reality perfect alternatives rarely exist. Therefore, it is important to note that if one or a combination of the above four strategies cannot bring about an effective alternative for baseline supply immediately, then the dependence should be considered of strategic importance (see Figure 1 for an impact-assessment overview, annex 1a for a more detailed assessment framework and annex 1b for the guiding questions that together determine scores on each indicator).

Figure 2. Strategic dependence risk framework (1): Assessing *impact* of disruptions in supply of goods and services

Identifying strategic dependence

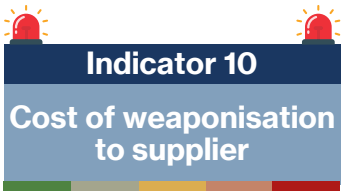
	Impact indicators (weighted)	Impact level 1	2	3	4	5
1a. Assessing criticality of baseline supply	1. Criticality 2x	No effect on security, safety and health. No obstacles to digitalisation.	Minor effect on security, safety and health; Somewhat impedes digitalisation.	Substantial effect on security, safety and health; Impedes digitalisation.	Major effect on security, safety and health; Disrupts digitalisation.	Devastating effect on security, safety and health; Entirely halts digitalisation.
	2. Dependence on maintenance, updates or resupply 1x	No maintenance, updates or resupply required for the entire lifespan of the product. Timing of impact delayed.	Maintenance, updates or resupply required every 5 years. Timing of impact delayed, but long-term: In 5-to-10 years.	Biannual to once in four-year maintenance, updates or resupply required; Timing of impact delayed, medium term: in 6-months to 4 years.	Monthly or biannual maintenance, updates or resupply required; Timing of impact delayed, but short-term: in 1-month to 6-months.	Constant maintenance, updates or resupply required; Timing of impact immediate.
	3. Demand projection 1x	Sharp fall in total demand (-75%-to-100%) in next 5-years	Major fall in total demand (-50%-to –75%) in next 5-years	Slight rise or fall in total demand (-50% or +50%) in next 5-years	Total demand rising 50-to-100% in next 5-years	Total demand multiplying in next 5-years
		Very low criticality 1	2	3	4	Very high criticality 5
1b. Assessing alternatives to baseline supply	4. Diversification 1x	Complete effective, immediate diversification possible (100%); alternative suppliers offer same quality product, in same quantities at comparable prices.	Majority effective, immediate diversification possible (75%); alternative suppliers offer slightly inferior quality, in slightly lower quantities at slightly higher prices.	Partial effective, immediate diversification possible (50%); alternative suppliers offer inferior quality, half of the quantity at higher prices.	Limited effective, immediate diversification possible (25%); alternative suppliers offer far inferior quality, a quarter of the quantity at far higher prices.	No effective, immediate diversification possible (0%); alternative suppliers offer no quantities of the material, good or service.
	5. Internal production 1x	Complete effective internal production possible (100%); Indigenisation possible in 1-year.	Majority effective internal production possible (75%); Indigenisation possible in 2-to-4 years.	Partial effective internal production possible (50%); Indigenisation possible in 5-to-10 years.	Limited effective internal production possible (25%); Indigenisation possible in 11-to-15 years.	No effective internal production possible (0%); Indigenisation possible in 15-to-40 years.
	6. Substitution 1x	Complete effective substitution possible (100%); no additional technological advances are required; complete substitution possible in 1-year.	Majority effective substitution possible (75%); some additional technological advances are required; complete substitution possible in 2-to-4 years.	Partial effective substitution possible (50%); additional technological advances are required; complete substitution possible in 5-to-10 years.	Limited effective substitution possible (25%); many additional technological advances are required; complete substitution possible in 11-to-15 years.	No substitutes possible (0%); many additional technological advances are required; complete substitution possible in 15-to-40 years.
	7. Illicit exchange 1x	Complete continued supply through illicit exchange possible (100%); boycotting state has no effective direct and indirect enforcement means.	Majority continued supply through illicit exchange possible (75%); boycotting state has limited effective direct and indirect enforcement means.	Partial continued supply through illicit exchange possible (50%); boycotting state has some effective direct and indirect enforcement means.	Minority continued supply through illicit exchange possible (25%); boycotting state has strong direct and indirect enforcement means.	No continued supply through illicit exchange possible (0%); boycotting state has complete effective direct and indirect enforcement means.
		Perfect alternatives 1	2	3	4	No alternatives 5
		Very low impact (if supply disrupted) 1	2	3	4	Very high impact (if supply disrupted) 5

3.2. Assessing probability: Unwillingness and inability to continue baseline supply

If a dependence is considered to be of high strategic importance, then this does not automatically mean it is also high risk. In order to establish the risk levels of disruptions in the supply of a strategic good or service, one needs to consider the probability that a supply-related geopolitical shocks indeed does occur (see Figure 3 for a full overview of the risk framework's probability indicators). The likelihood that baseline supply is disrupted, either is the result of 2a. unwillingness or 2b. inability by the supplier and/or the supplier state to continue supply.

Unwillingness to supply can be gauged by scoring the strategic dependence on three indicators. The *8. relationship with supplier country of origin* is the primary indicator that determines a supplier/supplier state will likely become unwilling to continue the supply of the strategic good or service. If relations with the supplier state sharply improved or were already very good previous decade and that country is a full democracy with the same core interests as the Netherlands and the EU (e.g., Norway), then there is little reason to worry about the imposition of an export boycott. Fifteen years of structurally faltering relations between the EU and Russia, however, led Russia to weaponize its supplies of natural gas to the EU.

Of secondary concern is the level of *9. state influence on supplier*. Ominous signs are if the supplier has many (legal) obligations to act in service of state interests, both in times of peace and crisis, and the country of origin has a consistent history of exerting pressure on private companies to act in state interests (e.g., China's rare earth mining SOEs). However, a lack of formal control over companies and no history of coercion is no guarantee. States can impose export controls. Therefore, a tradition of structural imposition of unilateral or mini-lateral export controls are an additional warning sign.



Finally, an important incentive for a supplier/supplier state to show restraint is *10. The cost of weaponization to the supplier*. These costs may consist of the financial or economic self-harm or the political, diplomatic, institutional or perhaps even military costs that come about as a result of weaponizing strategic dependencies. The level of financial and economic self-harm differs between strategic goods. For example, dollar sanctions are in the short-term low cost, since the US does not necessarily experience a loss of sales as a consequence. In contrast, an exclusion of companies in specific countries from accessing Microsoft's Cloud services would lead to a sharp decline of trust in American tech companies.

Supply disruptions can also come about due to a supplier/supplier state inability to supply. By far the most important indicator to gauge this risk is *11. (military) threats to the supplier country*. The Ukrainian government had no intention to disrupt the supply of neon gas to Western chip manufacturers. Yet, Russia's 2022 bombardment of the Azovstal factory in Mariupol caused supply disruptions nonetheless. Together with factories in Odesa, the Azovstal produced 50 percent of neon gas globally. Therefore, if in the next decade the source country is likely to face an existential military threat (e.g., invasion/bombardment or blockade) and faces constant hybrid attacks such as large-scale cyber-attacks, then being strategically dependent on that state is also high risk.

Another cause for a state to become unable to supply are *12. Threats to supply lines.* The majority of the world's natural gas goes through pipelines. 98 percent of all internet traffic goes through subsea cables. Oil is majority transported via increasingly contested sea-lanes. High value electronic products are shipped by air. These global commons ought to be considered the arteries of the world economy.[113] The costs of war-related disruptions to these supply lines can be high. The Taiwanese Matsu-islands experienced a 50-day isolation from the world after its cables were cut, allegedly by Chinese-flagged vessels.[114]

[113] Paul van Hooft, Benedetta Girardi, and Tim Sweijs, 'Guarding the Maritime Commons | What Role for Europe in the Indo-Pacific' (The Hague Centre for Strategic Studies, 24 March 2022), https://hcss.nl/report/guarding-the-maritime-commons-europe-in-indo-pacific/.

[114] Lii, 'After Chinese Vessels Cut Matsu Internet Cables, Taiwan Seeks to Improve Its Communications Resilience', 15 April 2023, https://thediplomat.com/2023/04/after-chinese-vessels-cut-matsu-internet-cables-taiwan-shows-its-communications-resilience/.

Figure 3. Strategic dependence risk framework (2): Assessing *probability* of disruptions in supply of goods and services

Assessing risk level of strategic dependence

	Probability indicators (weighted)	Probability level 1	2	3	4	5
2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply	8. Relationship with supplier country 3x	Very good; relations sharply improved or were already very good; country is a full democracy with the same core interests as NL/EU.	Good; relations improved or were already good; country is a full or flawed democracy but has slightly different core interests from NL/EU.	Neutral; relations remained stable; country is a flawed democracy, hybrid regime or autocracy, but has no conflicting core interests with NL/EU.	Poor; relations deteriorated; supplier country is an autocratic rival with core interests opposite to NL/EU.	Very poor; relations sharply deteriorated; supplier is an autocratic rival engaged in a proxy war with NL/EU.
	9. State influence over supplier 1x	Very weak; supplier has no (legal) obligations to act in service of state interests, country has no history of exerting pressure on private companies nor imposing export controls.	Weak; supplier has no (legal) obligations to act in service of state interests, country only seldomly exerted pressure on private companies and seldomly imposes export controls.	Modest; supplier has limited (legal) obligations to act in service of state interests, country has history of only seldomly exerting pressure on private companies and occasionally imposes export controls.	Strong; supplier has some (legal) obligations to act in service of state interests, country has history of occasionally exerting pressure on private companies and often imposes export controls.	Very strong; supplier has many (legal) obligations to act in service of state interests, country has consistent history of exerting pressure on private companies and structurally imposes export controls.
	10. Cost of weaponisation to supplier 2x	Very high; great financial/economic self-harm in halting supply, political, diplomatic, and institutional cost to halting supply; possibly also military response.	High; substantial financial/economic self-harm in halting supply. Great political, diplomatic, institutional cost; low chance of military response.	Medium; limited financial/economic self-harm in halting supply. substantial political, diplomatic, institutional cost; very low chance of military response.	Low; almost no financial/economic self-harm in halting supply. Limited political, diplomatic, institutional cost; Close to zero chance of military response.	Very low; almost no financial/economic self-harm in halting supply; No political, diplomatic, institutional cost; Close to zero chance of military response.
		Low boycott likelihood				**High boycott likelihood**
		1	2	3	4	5
2b. Assessing likelihood of inability by supplier and/or supplier state to continue supply	11. Threats to supplier country 5x	Non-existent; source country does not face a military threat; and only a limited possibility to face a large-scale cyber-attack.	Mild; in the next decade, limited possibility that source country faces a high-level military threat, but possible that the source country experiences a large-scale cyber-attack.	Medium; in the next decade, source country possibly faces a high-level military threat and is more likely than not to experience a large-scale cyber-attack.	Substantial; in the next decade, the risk that the source country faces a high-level military threat is substantial; it is likely that the source country experiences a large-scale cyber-attack.	Severe; in the next decade, source country is likely to face an existential military threat and faces constant hybrid attacks such as large-scale cyber-attacks.
	12. Threats to supply lines 1x	Non-existent; Supply lines are entirely secure.	Mild; Supply lines face low-level hybrid threats.	Medium; Supply lines face occasional medium-level hybrid threats and low-level military threats.	Substantial; Supply lines face constant high-level threats, hybrid threats and occasional medium-level military threats.	Substantial; Supply lines face constant high-level hybrid threats and occasional medium-level military threats.
		Low likelihood war-related disruption				**High likelihood war-related disruption**
		1	2	3	4	5
		Low likelihood of supply disruption				**High likelihood of supply disruption**
		1	2	3	4	5

3.3. **Conclusion**

The risk level of a strategic dependence is both determined by the *impact* if supply of the good or service is disrupted and the *probability* that a supplier or supplier country-of-origin becomes unwilling or unable to continue supply. Dependencies should be considered level-one strategic dependencies if a disruption in the baseline supply either threatens the function(s) of the digital society and/or economy that enable the Netherlands and the EU to secure its first line of core interests, meaning the security (i.e., physical or financial), safety and health of Dutch and Europeans. If a discontinuation of baseline supply only disrupts digitalization, then one should consider this a level-two strategic dependence.

The level of disruption depends on 1a. the criticality of baseline supply and 1b. the availability of high-quality, cost-efficient alternatives to baseline supply at scale in time. The function of the baseline supply of strategic goods and services for the recipient country's vital sectors, economy, society and ongoing digitalisation hence ought to be assessed carefully by technical and supply chain experts.

Strategic dependencies ought to be considered high-risk strategic dependencies, if supply disruptions are likely to occur. Geopolitical disruptions are either due to 2a. unwillingness or 2b. inability by the supplier and/or the supplier state to continue supply. Both intentions and capabilities of the supplier country, as well as war-related threats to the supplier country and its supply lines ought to be assessed carefully to gauge risk levels.

All things being equal, dependencies for goods or services that require regular maintenance, updates or resupply ought to be considered more severe than those that do not. If maintaining the function of the good or service requires the original supplier to execute additional actions, the receiving party remains structurally dependent on the willingness and ability of the supplier and supplier country to continue supply.

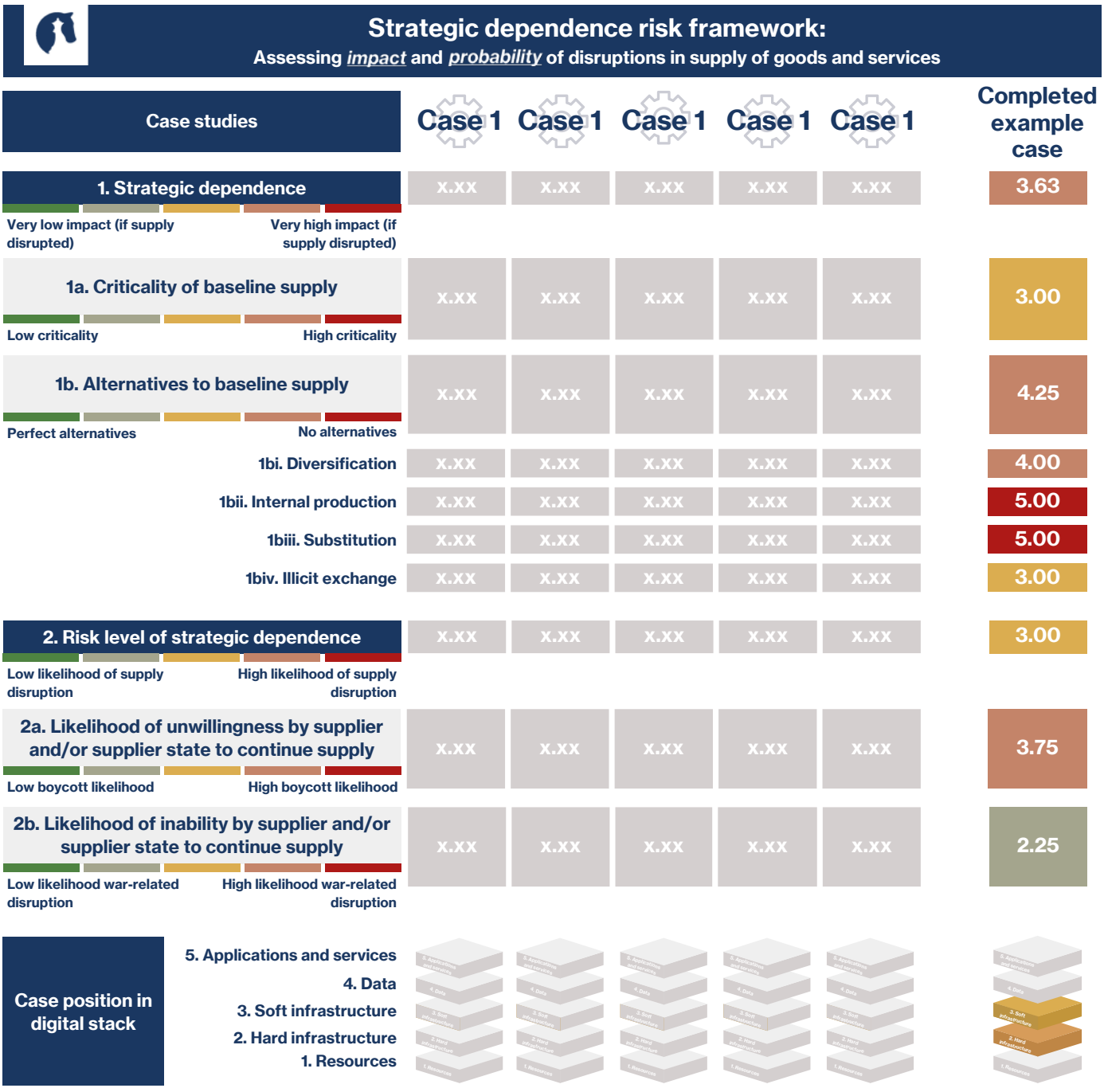
All things being equal, dependencies for goods and services for which national, regional or global demand is set to strongly increase in the near future should be considered more severe, as supply may fail to keep track with demand. Growing demand for the good or service throughout vital sectors likewise makes dependence on baseline supply more severe. In short, looming shortages and a broader application of the good or service in vital sectors increase the relative value of baseline supply.

Even if disruptions in the baseline supply of a good or service have a devastating effect on the Netherlands core interests immediately and demand for that product is multiplying in the upcoming five years, then this still does not automatically mean that the Netherlands and the EU are strategically dependent. In theory, the availability of "perfect alternatives" can entirely undo the risk of dependence for the baseline supply. Bringing online alternatives to baseline supply can be achieved by pursuing four strategies: diversification, internal production, substitution and maintaining access to the baseline supply through illicit exchange. Alas, for almost all "high criticality-goods and services" perfect alternatives do not exist, as alternative supplies are not immediately available, not available at scale or more expensive. As a result, governments ought to assess carefully which quantities, what quality and in what timeframe alternatives to the baseline supply of strategic goods or services can be accessed.

Even if a dependence is considered to be of high strategic importance, this does not automatically mean that strategic dependence is also high risk. A geopolitical assessment of the *likelihood* that baseline supply is disrupted is as important as a technical and supply

chain assessment of the *impact*, if a disruption occurs. The relationship with the supplier country, the state influence over the supplier and the cost of weaponization to the supplier of weaponizing supply determine the probability that the supplier or supplier country may become unwilling to continue supply. As a result of military threats to the supplier country or the supply lines, namely maritime routes, aerial approaches and communication cables, a supplier may become unable to continue supply.

Figure 4. Strategic dependence risk framework: Assessing impact and probability of disruptions in supply of goods and services



4. Broader strategic dependence risks in the digital domain

Key Takeaways

1. The Netherlands and the EU face strategic dependence-related geopolitical risks in the digital domain, other than the risk that a supplier or supplier state becomes unwilling or unable to supply a good or service.
2. States controlling central communication nodes in networked systems can intercept information passing through these nodes.
3. The information obtained through such strategic dependence, meaning through reliance on communication networks, can increase the risks of successful state-directed or state-tolerated cyber-attacks and industrial espionage.
4. This may put the supplying party in a position to acquire knowledge about the digital ecosystem of the dependent party. This can be shared with state or non-state actors with malicious intentions and the means to execute cyber-attacks. As cyber-attacks become more commonplace, it becomes increasingly important to shield network vulnerabilities.
5. Furthermore, central positions in networks may help a state or company to engage in industrial espionage. Strategic dependence may help parties to illicitly acquire valuable knowledge, data, intellectual property, corporate secrets, or proprietary technology. Industrial espionage contributes to the erosion of the EU's tech-edge and strategic indispensability.
6. Strategic dependence on private firms can enable these firms to engage in monopolistic commercial behaviour such as price-setting through lock-in effects. In extreme cases, private tech firms may even use their monopolistic position to exert geopolitical influence, for instance by taking decisions that influence military operations.
7. Finally, Dutch and EU prosperity can be threatened by demand-related dependence shocks. Companies that are overly reliant on a single foreign market for their exports risk losing revenue if their market access is limited or entirely cut-off. A state may enact punitive barriers by imposing tariffs, quotas or official or unofficial exclusionary regulatory measures. In an extreme situation, a state can even impose outright import bans.

Apart from the risk that a supplier or supplier state becomes unwilling or unable to supply a good or service, the digital domain is characterised by other strategic dependence-related geopolitical risks. First, the information obtained through strategic dependence can increase the risks of successful cyber-attacks and industrial espionage . This is the result of the "panopticon effect", which is the ability to weaponize interdependence by obtaining critical knowledge from information flows. In addition to political authority over a central node in a network being used to choke-off rivals from strategic information, services and goods, weaponized interdependence can also be employed "to gather information."[115] States controlling central communication nodes can intercept information passing through these nodes. Countries whose companies are placed in the centre of the panopticon can pressure their firms to share information. As a result, rival states may become better positioned to effectively execute cyber-attacks or to conduct industrial espionage.[116] Second, strategic dependence can lead to private firms engaging in monopolistic commercial behaviour such as price-setting through lock-in effects. In extremes case, private tech firms may even use their monopolistic position to exert geopolitical influence, for instance by taking decisions that influence military operations. Finally, Dutch and EU prosperity can be threatened by demand-related dependence shocks. Companies that are overly reliant on a single foreign market for their exports risk losing revenue or business operations, if their market access is limited or entirely cut-off.

The information obtained through strategic dependence can increase the risks of successful cyber-attacks and industrial espionage.

4.1. Cyber-attacks and critical infrastructure

Strategic dependencies in the digital domain may enable the supplying party to acquire knowledge about the digital ecosystem of the dependent party. This can be shared with state or non-state actors with malicious intentions and the means to execute cyber-attacks.[117] The PRC 2017 National Intelligence Law requires all Chinese companies to assist and support the Chinese government in national intelligence efforts, for instance through information gathering.[118] This can occur in vital sectors such as energy, telecommunication, health, and financial services. The information acquired via commercial parties can be used to target the dependent party more successfully through state-led or state-tolerated cyber-attacks. These attacks include hacking, DDoS, malicious software attacks, and manipulation of hardware and software, among others.[119]

If malevolent entities gain access to 5G networks, for instance, they can tamper with the speed of data transfer or latency within the network. More severely, successful cyber-attacks can result in loss of critical data, significant financial costs, and can even undermine public

115 The panopticon effect, as quoted in Drezner, Farrell, and Newman, *The Uses and Abuses of Weaponized Interdependence*, 4.

116 Farrell and Newman, 'Weaponized Interdependence', 55.

117 Mike Rogers and Dutch Ruppersberger, 'Investigative Report on the U.S. National Security Issues Posed by Chinese Telecommunications Companies Huawei and ZTE' (U.S. House of Representatives, 8 October 2012), https://stacks.stanford.edu/file/druid:rm226yb7473/Huawei-ZTE%20Investigative%20Report%20%28FINAL%29.pdf; Valerie Hernandez, 'Have the Huawei Bans Achieved the US' Intended Goals?', *International Banker*, 7 September 2022, sec. Technology, https://internationalbanker.com/technology/have-the-huawei-bans-achieved-the-us-intended-goals/.

118 'PRC National Intelligence Law (as Amended in 2018)'.

119 'ENISA Threat Landscape for 5G Networks', 65–66.

confidence in government.[120]. Furthermore, these attacks might have the capacity to undermine core functions of the network, causing service disruptions or taking over vital infrastructure like power grids. In the EU, vulnerabilities of one country may also affect other member-states, as electricity infrastructure often crosses borders .[121]

As cyber-attacks become more commonplace, it becomes increasingly important to shield network vulnerabilities. As the digital transition accelerates and great power rivalry intensifies, the number of cyber-attacks has increased. Thales, a French defence company, states that Europe has seen a significant increase in cyber-attacks since Russia's full-scale invasion of Ukraine. They note that the share of global cyber-attacks targeted at the EU has risen from 9.8% to 46.5% in 2022. Of this global number of cyberattacks, more than 60 per cent come from Russian origin.[122] The attacks targeting software supply chains have also increased exponentially, as the year 2021 saw the number of attacks increase by 650% vis-à-vis the year 2020.[123] Specifically, attacks have focused on having the developers of OSS upload malware to "infiltrate the upstream [open source] software supply chain", posing risks all the way through the chain to the software end-product.[124]

In the EU, vulnerabilities of one country may also affect other member-states, as electricity infrastructure often crosses borders.

4.2. **Industrial espionage and tech-edge**

Strategic dependence can also aggravate the risk of industrial espionage. In other words, central positions in networks may help a state or company to illicitly acquire valuable knowledge, data, intellectual property, corporate secrets, or proprietary technology. Cyber-enabled theft of trade secrets comes with the risk that innovative knowledge and emerging technologies are acquired by competitor economies.[125] After acquiring technology, state-led capitalist countries, aided by considerable government subsidies, are able to attain a competitive advantage vis-á-vis the EU.[126]

Efforts to commit industrial espionage also occur more and more often. The Algemene Inlichtingen- en Veiligheidsdienst (AIVD) asserts that the most significant risk of covert knowledge extraction comes from China, although both Russia and Iran are also known to engage

120 Ryan Shandler and Miguel Alberto Gomez, 'The Hidden Threat of Cyber-Attacks – Undermining Public Confidence in Government', *Journal of Information Technology & Politics*, no. 0 (18 August 2022): 1–16, https://doi.org/10.1080/19331681.2022.2112796; Yuchong Li and Qinghui Liu, 'A Comprehensive Review Study of Cyber-Attacks and Cyber Security; Emerging Trends and Recent Developments', *Energy Reports* 7 (1 November 2021): 8176–86, https://doi.org/10.1016/j.egyr.2021.08.126.

121 '5G Roll-out in the EU', 8; Dorr et al., 'The Hidden Costs of Untrusted Vendors in 5G Networks', 27.

122 'From Ukraine to the Whole of Europe: Cyber Conflict Reaches a Turning Point', Thales Group, 29 march 2023, https://www.thalesgroup.com/en/worldwide/security/press_release/ukraine-whole-europecyber-conflict-reaches-turning-point.

123 'État de La Chaîne Logistique Logicielle En 2021; 7e Édition Du Rapport Annuel Sure La Développement Mondial Des Open Source Softwares' (Sonatype, 12 October 2021), 4, https://www.sonatype.com/hubfs/SSCR%202021%20INT%20German%20French/SSSC-Report-2021_FR_Oct12.pdf.

124 Pannier, 'Software Power: The Economic and Geopolitical Implications of Open Source Software', 16.

125 Tie Hou and Victoria Wang, 'Industrial Espionage – A Systematic Literature Review (SLR)', *Computers & Security* 98 (November 2020): 102019, https://doi.org/10.1016/j.cose.2020.102019; 'Study on the Scale and Impact of Industrial Espionage and Theft of Trade Secrets through Cyber' (PwC & European Commission, 17 April 2019), https://www.pwc.com/it/it/publications/docs/study-on-the-scale-and-Impact.pdf.

126 Keith Bradsher, 'How China Obtains American Trade Secrets', *The New York Times*, 15 January 2020, sec. Business, https://www.nytimes.com/2020/01/15/business/china-technology-transfer.html.

in espionage and cyberespionage activities.[127] ASML has experienced multiple cases of Intellectual Property theft. In 2015, a Chinese company, Dongfang Jingyuan Electron Ltd., attempted to obtain ASML's technology and transfer it to China, by, for instance, getting an engineer to steal two million lines of critical ASML source code.[128] According to the German domestic intelligence agency China's practices "jeopardise Germany's competitiveness [...] and undermine the laws of the market economy." The German intelligence agency concludes that "this threatens to result in a loss of prosperity and, as a consequence, risks to democracy, social cohesion and Germany's independence."[129]

4.3. Monopolistic commercial practices and the exercising of geopolitical influence by private companies

In extreme cases, private tech firms may even use their monopolistic position to exert geopolitical influence.

Strategic dependence can lead to private firms engaging in monopolistic commercial behaviour such as price-setting through lock-in effects. In extremes case, private tech firms may even use their monopolistic position to exert geopolitical influence – for instance by taking decisions that influence military conflicts. Relying heavily on a single vendor opens the door to many monopolisation issues, such as lock-in effects, a lack of flexibility and adaptability, and the ability of the company to take unilateral decisions that may be distortive.[130]

For instance, as a result of vertical integration and a lack of interoperability between cloud providers, firms often become heavily reliant on a specific provider's cloud services. The EU fears that companies and governments can essentially be 'locked-in' to their end-to-end software ecosystem due to the high costs and challenges associated with switching.[131] In essence, companies are at the mercy of the supplier's pricing, policies, and technology changes. This may also negatively impact the financial space for innovation by other firms.[132] These forces are powerful. American tech companies, Meta, Apple, Microsoft, Amazon and Alphabet (MAMAA) have a greater market capitalisation than the total GDP of many countries. In early July 2023, Apple's market cap closed above three trillion USD for the first time ever.[133]

127 'AIVD-jaarverslag 2022' (Algemene Inlichtingen- en Veiligheidsdienst, 17 April 2023), https://www.aivd.nl/documenten/jaarverslagen/2023/04/17/aivd-jaarverslag-2022; 'AIVD: China biggest threat to knowledge security', Delta: Journalistic Platform TU Delft, 11 May 2022, https://www.delta.tudelft.nl/article/aivd-china-biggest-threat-knowledge-security.

128 'Annual Report 2021', ASML, 2 September 2022, 117, https://www.asml.com/en/investors/annual-report/2021; Jordan Robertson and Michael Riley, 'Engineer Who Fled Charges of Stealing Chip Secrets Now Thrives in China (Repeat)', *Bloomberg*, 6 June 2022, https://www.bloomberg.com/news/articles/2022-06-06/engineer-who-fled-us-charges-of-stealing-chip-technology-now-thrives-in-china.

129 'Verfassungsschutzbericht 2022' (Budesministerium des Innern und für Heimat, June 2023), https://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/sicherheit/vsb2022-BMI23007.pdf?__blob=-publicationFile&v=3; Erika Solomon, 'German Spy Agency Says China and Russia Are After Its Secrets', *The New York Times*, 20 June 2023, sec. World, https://www.nytimes.com/2023/06/20/world/europe/foreign-spies-germany-serious-threat.html.

130 'Commission Staff Working Document Strategic Dependencies and Capacities', 94.

131 'Commission Staff Working Document Strategic Dependencies and Capacities', 95.

132 Purushottam Kumar and Prakash Kumar, 'Vendor Lock-In Situation and Threats in Cloud Computing', *International Journal of Innovative Science and Research Technology* 7, no. 9 (September 2022): 1440, https://ijisrt.com/assets/upload/files/IJISRT22SEP948.pdf; 'EU Strategic Dependencies and Capacities: Second Stage of In-Depth Reviews', 63.; Expert interview Pieter Nooren and Hans Stokking, TNO, 25 May 2023

133 Hayden Field, 'Apple's Market Cap Closes above $3 Trillion for the First Time Ever', *CNBC*, 30 June 2023, https://www.cnbc.com/2023/06/30/apples-market-cap-passes-3-trillion-in-early-trading.html.

This is greater than the GDP of France. If Apple were a country, it would have the seventh largest economy in the world.[134]

In an escalating conflict with the Australian government over a new law requiring payment to publishers for content shared on its network, Facebook banned all users from sharing links to Australian news sources. As a result, Australian users were barred from sharing news links and suspended local news pages for a short period of time.[135] Given the importance of social media platforms, such as Facebook, in providing the public with educational and journalistic content, the reliance on a small set of social media providers creates the risk of denial to these services as a result of unilateral decisions by big multinationals.

Monopolists have also exerted their influence in the geopolitical realm. Today, SpaceX founder Elon Musk takes decisions that may well co-determine the outcomes of conflicts. By employing the Starlink system, he managed to enable the Ukrainian military and government to maintain internet connectivity in war-torn border regions. However, in September 2022, he refused Ukraine's request to enable Starlink's services to extend to Crimea, in order to launch an attack on Russian forces there. Musk cited the risk of nuclear escalation between Russia and its adversaries as his reason for refusing the request.[136] As mentioned in the previous chapter, Microsoft moved almost everything stored in Ukrainian government servers abroad in the first weeks of the war in Ukraine. By moving this out of reach of the Russian military, the Ukrainian government was able to maintain its functions. In short, states have developed important dependencies in the digital realm on the capabilities provided by private companies like SpaceX and Microsoft.

Companies that are overly reliant on a single foreign market for their exports risk losing revenue or business operations if their market access is restricted or entirely cut-off.

4.4. **Demand-related dependence shock**

Finally, Dutch and EU prosperity can be threatened by demand-related dependence shocks. Companies that are overly reliant on a single foreign market for their exports risk losing revenue or business operations if their market access is restricted or entirely cut-off . A state may enact punitive barriers by imposing tariffs, quotas or official or unofficial exclusionary regulatory measures, for instance citing national security.[137] In an extreme situation, a state can even impose outright import bans. Decisions to limit market access may be a consequence of the increased volatility of international relations, domestic economic goals and other unpredictable factors within the sales market.[138] Losses incurred by the overdependent party may lead to substantial declines in revenues and the destabilisation of business models. Through the value chain, these measures may even affect suppliers, consumers, and other stakeholders tied to these businesses.

134 'GDP - Countries - List', Trading Economics, 2022, https://tradingeconomics.com/country-list/gdp.

135 Sara Morrison, 'Why Facebook Reversed Its News Ban in Australia', *Vox*, 18 February 2021, https://www.vox.com/recode/22287971/australia-facebook-news-ban-google-money.

136 Steven T. Dennis and Roxana Tiron, 'Musk's Denial of Ukraine's Starlink Request Prompts Senate Probe', *Bloomberg*, 14 September 2023, https://www.bloomberg.com/news/articles/2023-09-14/elon-musk-s-denial-of-ukraine-s-starlink-request-prompts-senate-query.

137 'European Business in China Position Paper 2023-2024', The European Union Chamber of Commerce in China, 20 September 2023, https://www.europeanchamber.com.cn/en/publications-archive/1167/European_Business_in_China_Position_Paper_2023_2024.

138 'How to Succeed—and Fail—as a Foreign Business in India', *The Economist*, 30 November 2023, https://www.economist.com/business/2023/11/30/how-to-succeed-and-fail-as-a-foreign-business-in-india.

In 2023, Micron Technology suffered a demand-related dependence shock. The American chipmaker got partially locked out from China's market, seemingly in retaliation against the US-led chip export curbs against China. The Cyberspace Administration of China (CAC) stated that "Micron's products have serious network security risks" and therefore pose a threat to Chinese national security.[139] For this reason, Micron's products will be banned from key infrastructure projects in China. The corporation has publicly stated that it expects to see a substantial effect on around half of its revenues derived from sales to companies located in China. This accounts for a modest double-digit percentage of its total revenue.[140]

[139] Kevin Yao, 'China Fails Micron's Products in Security Review, Bars Some Purchases', *Reuters*, May 2023, sec. Technology, https://www.reuters.com/technology/chinas-regulator-says-finds-serious-security-issues-us-micron-technologys-2023-05-21/.

[140] Chavi Mehta, 'Micron Warns of Bigger Revenue Hit from China Ban', *Reuters*, 16 June 2023, sec. Technology, https://www.reuters.com/technology/micron-says-half-china-headquarter-revenue-risk-due-ban-2023-06-16/.

5. Dutch strengths in digital value chains

Key Takeaways

1. In a world characterised by great power competition, a blossoming digital economy is no longer just a means to secure the Netherlands and the EU's capacity to ensure a prosperous life for citizens and generate sufficient tax income for social services. In today's world, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy: effectively, a state makes a payment upfront to dissuade rivals from taking coercive actions.
2. This chapter presents a heavy sample of technologies and industries in which the Netherlands already has or can achieve an indispensable role. These technologies were identified on the basis of desk research, expert interviews, an expert survey executed by HCSS in 2021 and a round table with technical and industry experts from universities, industry and the government in 2023.
3. The Netherlands has a very strong foundation in digital industries, especially when taking into account the country's size. The Netherlands is home to some advanced companies in the digital domain, particularly in lithography, atomic layer deposition, radar, radio frequency semiconductor technology and photonics.
4. The Netherlands lacks an ASML-style world leader in the fields of quantum technologies, artificial intelligence, cyber security products and chip design. Nonetheless, the Netherlands has a very strong (and in some cases leading) position in basic research in these fields.
5. Much of the potential of this strong foundations remains untapped as the link between basic research and the start-up ecosystem on the one hand and major companies on the other hand remains weak, especially when compared to the U.S..
6. In order to achieve Dutch and European strategic indispensability, the valorisation chain has to be strengthened.
7. With the right innovation and industrial policies the Netherlands can strengthen its business climate and the valorisation chain. This is needed to gain a stronger foothold in digital industries. The Netherlands –and by extension the EU– may as a result become more geopolitically shock-resistant over the next decades.

> "Ensuring economic resilience and economic security globally remains our best protection against the weaponization of economic vulnerabilities."
>
> – G7 Hiroshima Communiqué

This chapter maps the geopolitical leverage that the Netherlands and the EU have today or may have in the upcoming decade and beyond because of its strengths in the global network of value chains. Specifically, this chapter presents a heavy sample of digital industries and technologies in which third parties have a strategic dependence on the digital technologies and industries of the Netherlands.

Like the EU, its rivals worry about strategic dependencies. Chinese leaders acknowledge that their country has many technological gaps to overcome in order to achieve self-reliance. In 2018, the Chinese state-media outlet *Science & Technology Daily,* which is affiliated with the PRC Ministry of Science and Technology, has self-identified a number of strategic dependencies for China.[141] A vast number of these "chokepoint" products or services, defined as "key and core technologies" which are "controlled by others",[142] can be found throughout the stack of the digital domain.[143] In addition to EU production and assembly of the most advanced SME, Extreme Ultraviolet (EUV) Lithography Systems, other European firms produce products that constitute "bottlenecks" in international value chains.[144] Assessing each of these technologies is out of the scope of this paper. However, the fact that Chinese state-media and government officials have self-identified these as chokepoints is a strong indication that the control over these central nodes provides the EU with leverage in the global network of economic interdependencies.

Other research suggests that the foundation of the EU to expand its control over a larger number of chokepoint industries in the future may be shockingly weak, as European countries have fallen behind in research publications in the field of 44 critical technologies. In the Australian Strategic Policy Institute's *Critical Technology Tracker,* the EU leads in zero out of 44 critical technologies. The US leads in 7 and China in 37.[145] The methodology of this tool, which is primarily based on scientific (high-impact) citations, can be critiqued as focussing too much on fundamental research, with too little attention being paid to the valorisation of

141 Murphy, 'Chokepoints: China's Self-Identified Strategic Technology Import Dependencies', 2.

142 Murphy, 1.

143 This includes technology such as underwater connectors, essential in establishing seafloor observation networks, and vacuum evaporators, indispensable in the production of premium OLED displays. Similarly, China is dependent on foreign companies for high-end radio frequency components utilised in mobile devices, and microspheres, a vital element in the manufacture of LCD panels and microchips. Their dependence extends to Transmission Electron Microscopes (TEM), a crucial tool in biotechnology, and the Operating Systems integral to the functionality of mobile devices. Murphy, 6–9.

144 This includes German company ZEISS, which produces the highly specialised lenses inside ASML's lithography systems. SKF, a steel manufacturer from Sweden, and Timkensteel from the US, "basically monopolise" the market for high-end bearing steel manufacturing, which is a critical input for aircraft, cars, precision machinery and high-speed rail. Heavy duty gas turbines, which are "irreplaceable" in China's power generation capacity, are supplied by four Western companies, two of which, Siemens and Ansaldo, are European. Likewise, aviation design software, which is indiscernible for military and civilian aircraft, is dominated by North American and European firms. Murphy, 6–9.

145 Jamie Gaida et al., 'Policy Brief: ASPI's Critical Technology Tracker: The Global Race for Future Power' (Australian Strategic Policy Institute, 2023), 8. https://ad-aspi.s3.ap-southeast-2.amazonaws.com/2023-03/ASPIs%20Critical%20Technology%20Tracker_0.pdf?VersionId=ndm5v4DRMfpLvu.x69Bi_VUdMVLp07jw.

knowledge.[146] Nonetheless, the shockingly low score of the EU vis-à-vis the world's other two great economic powers underlines the need for the Netherlands and the EU to nurture the growth of more globally competitive technologies.

This chapter presents a sample of six digital industries and technological research fields in which Dutch industries or research institutes are leading today or have the potential to become leaders in the next ten years.

5.1. Dutch leadership in digital industries and research

What technologies and industries in the digital domain should the Netherlands and the EU invest in to increase their strategic indispensability? Lithography, 5G/6G, photonics, quantum computing and cryptography are all technologies that are often mentioned. Without ASML's EUV lithography systems it is not possible to (efficiently) manufacture the most advanced semiconductors. ASML is also the world's leading provider of the lithography systems that make use of the second-to-last technology: Deep Ultraviolet (DUV). Aside from lithography, the Netherlands has a strong industry foothold in atomic layer deposition (ADL), radar, components related to radio frequency and photonics. Furthermore, it is among the world's best in some cutting-edge and upcoming research fields. Examples are quantum computing, AI, and cyber security. This may lead to new world-leading Dutch and European industries by 2035, similar to how ASML originally grew out of the Philips Physics Laboratory many decades ago. The following section presents six technologies in which the Netherlands and the EU have the potential to become leading in the next ten years. The technologies were identified for their potential to transform national industries and indirectly defence capabilities. These were selected on the basis of expert interviews, the outcome of a technical expert round table with university and industry representatives (see annex 5) and on an expert survey conducted by HCSS in 2021.

5.1.1. World-leading national champions: Lithography, atomic layer deposition, radar, radio frequency semiconductor technology and photonics

Dutch industry is leading in SME, as ASML is the undisputed world leading manufacturer in lithography systems and Advanced Semiconductor Materials (ASM) International is one of the companies leading in Atomic Layer Deposition (ALD) systems, another technique used to manufacture semiconductors.[147] One of the reasons ASML is able to maintain its position are close relations with a network of European suppliers of critical components. ASML's lithography systems rely on a cooperation with ZEISS, a German world-leading manufacturer for the highly specialised optical systems inside EUV and Trumpf Group, a German producer

146 Gaida et al., 57–64.

147 A lithography system refers to the "process whereby highly complex circuit patterns drawn on a photomask made of a large glass plate are reduced using ultra-high-performance lenses and exposed onto a silicon substrate known as a wafer.", from 'Semiconductor Lithography Systems | Product Technology |', Nikon, accessed 5 June 2023, https://www.nikon.com/company/technology/product/semiconductor/.; ALD refers to a "surface-controlled layer-by-layer process that results in the deposition of thin films one atomic layer at a time." From 'ALD (Atomic Layer Deposition)', ASM, accessed 5 June 2023, https://www.asm.com/ald.

of specialised laser technology.[148] The Netherlands' central role in SME in theory provides the Netherlands with geopolitical leverage , as the technology can be used to unlock both economic and military advantages. In fact, an HCSS expert survey among technical experts indicated that semiconductor lithography already has a "significant to revolutionary" effect on national industries and a "significant" effect on warfighting capabilities (i.e., the military domain).[149]

In the same vein, the Netherlands is home to world-leading manufacturers of radars, components related to radio frequency and in photonics. Thales Netherlands, a subsidiary of the French conglomerate Thales Group, has a world-leading position in radar technology. NXP, a Dutch semiconductor manufacturer, is leading in radio frequency semiconductor technology.[150] Thales radar systems are exported to allies and may hence provide the Netherlands with strategic leverage vis-à-vis them. Leverage within alliances may help the Netherlands to ensure that its interests are taken into account when the alliance takes action against rivals. Signify, a spin-off of Philips N.V., is one of the world's leading companies in lighting for professionals, consumers and the Internet of Things (IoT).[151] Signify is a world leader in horticultural lighting, as it uses artificial lights to expand food production without using more energy, water and land. As world population is expected to be 10 billion in 2050 whilst water becomes increasingly scarce, food will increasingly become a strategic resource.[152] The success of the Netherlands in photonics, especially in integrated nano photonics, is not limited to just one company.[153] This is also reflected in the high-number of impactful Dutch scientific publications in this field. The ecosystems in and around Eindhoven and Twente are both strong in the area of photonics, respectively specialising in indium phosphide and silicon nitride-based photonic

The Netherlands' leading role in semiconductor manufacturing equipment in theory provides it with geopolitical leverage.

148 'About ZEISS', accessed 18 December 2023, https://www.zeiss.com/corporate/en/about-zeiss.html. ; 'Trumpf - Company Profile', accessed 18 December 2023, https://www.trumpf.com/en_INT/company/profile/company-profile/.

149 "*Modest* indicates that the technology will lead to a limited increase of the performance of military equipment or systems or increase economic growth only by a few percent. *Significant* suggests a much larger increase in performance or growth, at a minimum in the double digits. *Revolutionary* signifies that the technology will potentially render current military equipment/systems obsolete or create entirely new economic categories or processes. *Now* indicates that the technology currently has a substantial impact. *Soon* suggests a substantial impact by 2030. *Long-term* predicts a substantial impact after 2030. Hugo van Manen et al., 'Taming Techno-Nationalism: A Policy Agenda', HCSS Progress (The Hague: The Hague Centre for Strategic Studies, September 2021), ii, https://hcss.nl/wp-content/uploads/2021/09/Taming-Techno-Nationalism-Sept.-2021.pdf.

150 Radio frequency semiconductors are electronic devices that are designed to operate at the frequencies used for radio and microwave communications. These semiconductors are key components in various applications such as telecommunications, wireless networking, radar, and satellite systems. From Behzad Razavi, *RF Microelectronics*, 2nd edition (Pearson, 2011).

151 The Internet of Things (IoT) refers to the network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and connectivity, which allows these things to connect, collect, and exchange data over the internet. This connectivity provides increased automation, integration, and communication between devices, leading to improved efficiency and accuracy. From: 'What Is the Internet of Things?', McKinsey Explainers (McKinsey & Company, 17 August 2022), https://www.mckinsey.com/~/media/mckinsey/featured%20insights/mckinsey%20explainers/what%20is%20the%20internet%20of%20things/what_is_the_internet_of_things.pdf.

152 'Global and Regional Population Estimates, US Census Bureau vs. UN', Our World in Data, accessed 23 February 2023, https://ourworldindata.org/grapher/global-and-regional-population-estimates-us-census-bureau-vs-un.

153 Photonics is the science and technology of generating, controlling, and detecting photons, which are particles of light. Integrated nanophotonics, on the other hand, is a subfield of photonics that focuses on the manipulation of light on the nanometer scale, typically using integrated optical circuits. Daniel Pérez, Ivana Gasulla, and José Capmany, 'Programmable Multifunctional Integrated Nanophotonics', *Nanophotonics* 7, no. 8 (1 August 2018): 1351–71, https://doi.org/10.1515/nanoph-2018-0051.

chips.[154] However, the Netherlands does not have a silicon-based photonic chip industry, which is getting most attention, investment and production globally.[155]

Photon Delta, also based in the Netherlands, is the "European hub for the integrated photonics industry" aiming to produce an "end-to-end value chain for photonic chips."[156] Photonic integrated circuits are of great interest due to the possibility of integrating large numbers of miniaturised optical components on a single chip.[157] This may potentially revolutionise a wide range of technologies such as telecommunications, computing and radar systems. The ability to control light on such a small scale could lead to the development of highly efficient light sources, detectors, and other optical components, as well as enabling new quantum technologies.[158] Given that new use cases are often being discovered, demand is projected to increase sharply and suddenly.

Against this background, it is a laudable development that the Eindhoven-based Smart Photonics received a 100 million euro financial injection by the Dutch government, ASML, NXP and Van der Leegte (VDL) Group to further develop photonic integrated circuits.[159] Currently, Smart Photonics is the biggest company in Europe that makes on-demand photonic chips and CEO Johan Feenstra sees the potential to become the "TSMC of the photonic chip industry".[160] Likewise, New Origin, a photonics spin-off from the University of Twente, also raised 100 million euros in funding to build a new factory earlier this year.[161] The Netherlands government invested 20 million in 2020, reportedly to ensure that a Chinese party did not invest instead.[162]

Photonics is generally considered a more mature technology than quantum computing. Partially as a result of that, photonics requires less up-front capital and time to move from research to new applications in industry. An HCSS expert survey concluded that photonics likely has, or at least by 2030 will have, a "significant" transformative effect on the military domain, and already has a "significant" effect on industry.[163]

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154 Bijlsma et al., 'Geo-Economische Monitor: Strateggische Afhankelijkheiden, Economische Beïnvloeding, Kennispositie En Investeringsstromen', 64, 66.

155 Sandra Olsthoorn, 'Wordt Nederland wereldmacht met supersnelle chips?', *Het Financieele Dagblad*, 11 July 2023, https://specials.fd.nl/wordt-nederland-wereldmacht-met-supersnelle-chips.

156 'Integrated Photonics | Design, Development & Manufacturing of PICs', PhotonDelta, accessed 18 December 2023, https://www.photondelta.com/photondelta/.

157 Olsthoorn, 'Wordt Nederland wereldmacht met supersnelle chips?'

158 Wim Bogaerts et al., 'Programmable Photonic Circuits', *Nature* 586, no. 7828 (October 2020): 207–16, https://doi.org/10.1038/s41586-020-2764-0; 'What Is a Photonic Integrated Circuit?', PhotonDelta, 12 December 2022, https://www.photondelta.com/news/what-is-a-photonic-integrated-circuit/.

159 Sandra Olsthoorn, 'Overheid, ASML en NXP steken miljoenen in Eindhovense chipbelofte', *Het Financieele Dagblad*, 11 July 2023, https://fd.nl/bedrijfsleven/1482143/overheid-asml-en-nxp-steken-miljoenen-in-eindhovense-chipbelofte.

160 Olsthoorn, 'Wordt Nederland wereldmacht met supersnelle chips?'

161 Olsthoorn.

162 Olsthoorn.

163 Manen et al., 'Taming Techno-Nationalism', II.

5.1.2. Strengths in basic research and intelligence: Quantum technologies, artificial intelligence and cyber security products

The Netherlands lacks an ASML-style world leader in the fields of quantum technologies, AI, cyber security products and chip design.[164] However, the Netherlands has a very strong (and in some cases leading) position in basic research in these fields. Quantum computing has far-reaching commercial and security implications, as advances in quantum risk making current cryptography approaches obsolete. For this reason, the great powers, most explicitly the United Sates, have a major interest in leading the development of quantum technologies. Quantum cryptography on the other hand, has the potential to encrypt information in a way that cannot be broken.[165] Both the Technical University of Delft and the Technical University of Eindhoven conduct world-leading research on quantum technologies, with various spin-offs already being established. The EU is home to world leading startups in quantum computing components. The Netherlands is also home to Quantum Delta NL, "a diverse ecosystem that includes members of academia, technology developers, startup leaders and workers and industry participants." Quantum Delta NL sets out to "contribute to a historic opportunity in quantum by accelerating quantum technology development in the Netherlands [...] that fosters international collaborations with the world's top scientific institutions, businesses, students, and professionals."[166]

The Netherlands is particularly strong in quantum computing, especially on components (or "Qbits"), but less so in quantum communication and sensing. Quantum computing has been described as "a rapidly-emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers."[167] McKinsey & Company asserts that Quantum will have the most profound short-term impact on pharmaceuticals, chemicals, automotive and finance. These are all strategic sectors and therefore of geopolitical importance.[168] Within quantum computing the Netherlands has some smaller parties which specialise in Original Equipment Manufacturing (OEM), meaning companies that integrate quantum chips into products.

In spite of a thriving research and start-up ecosystem for quantum computing, the Netherlands has not yet produced any unicorns , meaning privately-held start-up companies

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164 Quantum computing uses quantum bits (qubits) to perform complex calculations rapidly, exploiting quantum mechanics principles like superposition and entanglement. This makes it capable of solving problems unfeasible for traditional computers. 'What Is Quantum Computing?', McKinsey Explainers (McKinsey & Company, May 2023), https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-quantum-computing#/.; Artificial Intelligence (AI) refers to the computational discipline that aims to create systems capable of performing tasks traditionally requiring human intelligence, including but not limited to pattern recognition, language comprehension, and strategic problem-solving. These systems, developed through complex algorithms and computational models, may utilize techniques from machine learning, neural networks, and other AI subsets to achieve their goal of simulating intelligent behaviour.'What Is AI?', McKinsey Explainers (McKinsey & Company, April 2023), https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-ai#/.; Cybersecurity is the practice of safeguarding digital systems, networks, and data from unauthorized access or harm. It employs diverse strategies such as encryption, firewalls, and education to combat cyber threats like malware and data breaches. From 'What Is Cybersecurity?', McKinsey Explainers (McKinsey & Company, April 2023), https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-cybersecurity#/.

165 S. Pirandola et al., 'Advances in Quantum Cryptography', *Advances in Optics and Photonics* 12, no. 4 (31 December 2020): 1012–1236, https://doi.org/10.1364/AOP.361502.

166 'Programme & Ecosystem', Quantum Delta NL, accessed 6 June 2023, https://quantumdelta.nl/programme-ecosystem.

167 'What Is Quantum Computing?', IBM, accessed 6 June 2023, https://www.ibm.com/topics/quantum-computing.

168 'Quantum Computing: An Emerging Ecosystem and Industry Use Cases' (McKinsey & Company, December 2021), https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/quantum%20computing%20use%20cases%20are%20getting%20real%20what%20you%20need%20to%20know/quantum-computing-an-emerging-ecosystem.pdf.

worth over a billion US dollars. This is not surprising, given the relative immaturity of quantum technologies. As a result, even if the Netherlands had a world-class valorisation chain, indefinite access to venture capital (VC) and to talent, the achievement of a quantum unicorn is still unlikely. The pay-off for a leadership position in quantum technologies, however, may be bigger than a leadership position in photonics. Quantum is expected to have a greater number of strategic applications. It is however critical to appreciate the interconnectedness between quantum and photonics. In fact, most quantum technologies rely on photonics, which functions as an enabling technology. Quix Quantum, a company founded in Enschede the Netherlands in 2019, focuses on the development of quantum computing using integrated photonics.[169] Future computer systems may take the form of heterogeneous integrated systems that integrate electronics with photonics and quantum. This highlights the importance for the Netherlands to focus on fostering heterogenous integration capabilities and having access to strategic technologies across the board.

Irrespective of Dutch efforts, the gains of Quantum computing are likely to only materialize further into the future. Quantum is in an earlier stage of development. These conclusions are in line with an HCSS expert survey, which in 2021 indicated that quantum technologies will likely have a "revolutionary" effect on warfighting capabilities, by or after 2030, and a "significant to revolutionary" effect on national industries, already by 2030.[170] American universities are the primary competitors for Dutch research institutes in this field. Unsurprisingly, third states have taken note of the progress the Netherlands has made on quantum. US industry, mainly Microsoft and Google, heavily invest in Quantum Delta NL, with a particular interest in the "testbeds" for quantum technologies around Eindhoven. SMART Photonics, the aforementioned manufacturer of photonic integrated circuits, already has many customers that are (potential) users for such quantum test beds. This again highlights the synergies between the photonics and quantum ecosystems.

In addition, the Netherlands has a strong position in specific types of Data Science and AI, in particular applied AI such as face recognition, language models (LMs), and operations research. Dutch research in particular at universities is leading in the development of LMs. The University of Amsterdam (UvA) and de Vrije Universiteit (VU) have a strong position in big data. However, this has not led to development of digital end-products such as OpenAI's ChatGPT by Dutch companies. Eindhoven University of Technology and Delft University of Technology have a strong position in operations research. This has translated into a strong position in the operations research software industry with companies such as Ortec, Quintiq, EyeOn.

Likewise, the Netherlands is not yet a cyber security leader in the commercial realm, in spite of the Netherlands' intelligence agency, AIVD, which has world-leading cyber capabilities. Israel shows how policies that promote civil-military cooperation can lead to industry champions in the cyber security realm. Notably, Brainport Eindhoven has developed a "Cyber Resilience Centre". This initiative supports companies in the knowledge-intensive manufacturing industry by enhancing their resilience against digital espionage and sabotage.[171]

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169 'QuiX Quantum - Company', accessed 15 December 2023, https://www.quixquantum.com/company#about.

170 "*Modest* indicates that the technology will lead to a limited increase of the performance of military equipment or systems or increase economic growth only by a few percent. *Significant* suggests a much larger increase in performance or growth, at a minimum in the double digits. *Revolutionary* signifies that the technology will potentially render current military equipment/systems obsolete or create entirely new economic categories or processes. *Now* indicates that the technology currently has a substantial impact. *Soon* suggests a substantial impact by 2030. *Long-term* predicts a substantial impact after 2030. S Manen et al., 'Taming Techno-Nationalism', II.

171 'Primeur Brainport Eindhoven Voor Ketenweerbaarheid Cybersecurity', Brainport Eindhoven, accessed 18 September 2023, https://brainporteindhoven.com/nl/ondernemen-en-innoveren/cases/primeur-brainport-eindhoven-voor-ketenweerbaarheid-cybersecurity.

The University of Twente is also investing in fostering a semiconductor ecosystem beyond traditional Dutch strengths in semiconductor equipment manufacturing. The university is seeking to foster expertise in chip design (in which it already has a strong foothold) but also in semiconductor infrastructure for manufacturing. Companies such as ASML and NXP, work with Brainport Eindhoven to more closely integrate the development of digital technologies at universities and companies.[172]

Table 2. Dutch strengths in strategic technologies

Technology	Current position of NL	Effect on industry		Effect on warfighting capability[173]	
		Impact	Timing	Level	Timing
Quantum technologies	Leading in basic research into quantum computing, especially components	Significant/ revolutionary	By 2030	Revolutionary	By/after 2030
Photonics	Potential national champion in Smart Photonics; leading in basic research	Significant	Now	Significant	Now/by 2030
Artificial intelligence	Leading in basic research for LLM, data science and face recognition	Revolutionary	Now	Revolutionary	By/after 2030
Semiconductor lithography	World-leading national champion, ASML	Significant/ Revolutionary	Now	Significant	Now
Radar technologies/ Radio Frequency	Competitive national champion, Thales and NXP	N/A	N/A	N/A	N/A
Product cybersecurity (hardware, software, network)	World-leading intelligence service in the digital realm, AIVD.	N/A	N/A	N/A	N/A

In conclusion, the Netherlands is home to some world leading companies in the digital domain. However, much potential remains untapped as the link between basic research and the start-up ecosystem on the one hand, and major companies on the other hand appears weak, especially when compared to the U.S.. The valorisation chain in the Netherlands and the EU leaves a lot to be desired.

172 'ASML and Eindhoven University of Technology Strengthen Longstanding Collaboration', Eindhoven University of Technology, 24 April 2023, https://www.tue.nl/en/news-and-events/news-overview/24-04-2023-asml-and-eindhoven-university-of-technology-strengthen-longstanding-collaboration; 'TU/e and NXP to Collaborate on New Technology for Wireless Communication', *Eindhoven University of Technology* (blog), 24 May 2023, https://www.tue.nl/en/news-and-events/news-overview/24-05-2023-tue-and-nxp-to-collaborate-on-new-technology-for-wireless-communication.

173 Manen et al., 'Taming Techno-Nationalism', II.

5.2. **Conclusion**

In a world characterised by great power competition, a blossoming digital economy is no longer just a means to secure the Netherlands and the EU's capacity to ensure a prosperous life for citizens and generate sufficient tax income for social services. In today's world, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy : effectively, a state makes a payment upfront to dissuade rivals from taking coercive actions. In other words, controlling chokepoints can help states to discourage rivals from initiating a geopolitical crisis.

The Netherlands has a very strong foundation in digital industries, especially when taking into account the country's size. The Netherlands is home to some advanced companies in the digital domain, particularly in lithography, atomic layer deposition, radar, radio frequency semi-conductor technology and photonics. The Netherlands lacks an ASML-style world leader in the fields of quantum technologies, AI, cyber security products and chip design. Nonetheless, the Netherlands has a very strong (and in some cases leading) position in basic research in these fields.

In today's world, investing in a strategically indispensable position is akin to taking out a geopolitical insurance policy.

Much of the potential of this strong foundations remains untapped as the link between basic research and the start-up ecosystem on the one hand and major companies on the other hand remains weak, especially when compared to the U.S.. In order to achieve Dutch and European strategic indispensability, the valorisation chain has to be strengthened. With the right innovation and industrial policies, the Netherlands can strengthen its business climate and the valorisation chain. The Netherlands –and by extension the EU– may as a result become more geopolitically shock-resistant over the next decades.

6. Policy implications, opportunities and recommendations

By strengthening their valorisation chain and business climate the Netherlands and the EU can become more geopolitically shock-resistant.

During the Cold War, the U.S. and the Soviet Union engaged in military arms races. Both nations invested incessantly to advance their weapon systems as a means to outperform the adversary. This necessity for innovation catalysed substantial investments by the US Government in the American semiconductor industry, primarily through the Defence Advanced Research Projects Agency (DARPA). Government-sponsored semiconductor development initiatives not only revolutionised warfare and enhanced American military capabilities. These also kickstarted a commercial semiconductor industry through parties such as Texas Instruments and Intel. The products they championed serve as the foundation of the modern economy, as they facilitated the rapid development of information and communication technologies (ICT). This transformed industries around the world.[174] Some analysts go as far as saying "today's Silicon Valley is an accidental by-product of 1960s Cold War terrors."[175]

In a world that is characterised by both great power competition and deep interdependence a blossoming digital economy is no longer just a means to secure the Netherlands and the EU's capacity to ensure a prosperous life for citizens and generate sufficient tax income for social services. Instead, today investing in a strategically indispensable position in digital value chains is akin to taking out a geopolitical insurance policy. Effectively, a state makes a payment upfront to dissuade rivals from taking coercive actions against it. Technological leadership in some industries and a strong position in research gives the Netherlands and the EU a position of strength in international asymmetrically interdependent value chain networks.

With the right innovation and industrial policies the Netherlands can strengthen strategic indispensability in the digital domain over the next decades. By strengthening their valorisation chain and business climate the Netherlands and the EU can become more geopolitically shock-resistant . First, in an interdependent but competitive world, industrial policy aiming to secure access to or even the domestic production of critical economic inputs such as materials and semiconductors can undo some of the key chokepoints rivals or states at risk of military disruption control. Second, greater state involvement in helping industry achieve its needs can expand the number of value chains EU member-states have dominant positions in. Member-states and EU institutions can subsequently use these pressure points in international negotiations. A strategically indispensable position in these networks can even be used to deter third parties from applying pressure against the EU and the Netherlands. Likewise, these dependencies provide the Hague, other European capitals and Brussels with

174 Chris Miller, *Chip War: The Fight for the World's Most Critical Technology. 9781982172008.* (Scribner, 2022).

175 Farrell and Newman, *Underground Empire: How America Weaponized the World Economy*, 205.

new means to take punitive action against third countries, if a geopolitical or military crisis (like Russia's war against Ukraine) does occur.

Creating a more geopolitically-robust European digital industrial base requires not just advances in parts of the valorisation chain that the Netherlands and the EU are already strong in, namely basic research and start-ups. Instead, an industrial and innovation policy should facilitate the translation of basic research into applied research, start-ups, scale-ups and finally into unicorns.[176] Europe currently faces the "problem of the missing zero". The EU has launched initiatives to keep up in the geo-technological race. Nonetheless, there is "a gradual understanding that the order of magnitude for [tech investment] is lacking a zero."[177] Likewise, industry leaders have suggested that the best way to ensure geopolitical resilience and to compete with other large industrial blocs is "relentless investment in innovation".[178] Ultimately, much larger structural investment is needed to strengthen the EU's digital industrial base.

An innovation and industrial policy focusing on digital industries can also help compensate for powerful trends that have led to the deterioration of the business climate in the Netherlands and the EU. Increasingly, Europe is a difficult location for energy-intensive manufacturing and mining, refining and processing of materials. Traditional stronghold European industries, such as the automotive and chemical sectors, are energy-intensive and face immense cost challenges. They face high energy prices, in spite of a 22% reduction of gas use in 2023 up until September, and a rise in NIMBY-movements.[179] In the upcoming decade, energy prices in the EU are likely to remain high and volatile due to Europe's extreme import-dependence, the uncertainty of the transition to a green economy and geopolitical challenges.[180] The pressures of Europe's combined labour costs (among the highest in the world) and the most stringent environmental regulation globally was in the past partially offset by a soft-bedding of constant, relatively cheap gas supply from Russia and Groningen, the Netherlands. NIMBY-protests and regulations against anything ranging from the production of natural gas, the construction of mines and datacentres are characteristic of the obstacles that the EU faces to reshore manufacturing. Indeed, the failure to construct at least 62.000 additional houses required in Brainport Eindhoven to attract international talent is a case in point. A failure to construct more housing is partially the result of nitrogen emission caps. It has hamstrung the competitiveness of the Netherlands.[181] In short, European governments and populations are unlikely to be willing to shoulder the financial and environmental costs required to reduce strategic dependencies on rivals.

As a result, it is far from certain that Europe will erect a strong energy-intensive domestic production base for critical economic inputs in digital value chains, such as raw materials and semiconductors in spite of the many policy initiatives to that effect. To hedge against

176 Unicorns are privately held companies valued at over a billion US dollars Tim Koller, 'How Much Is That Unicorn in the Window?', *McKinsey & Company* (blog), 13 January 2021, https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-strategy-and-corporate-finance-blog/how-much-is-that-unicorn-in-the-window.

177 John Thornhill, 'European Tech Investors Need to up Their Ambitions', *Financial Times*, 6 July 2023, sec. Tech start-ups, https://www.ft.com/content/a493868f-75f2-4032-85ec-adb367a743f9.

178 *CEO ASML | Peter Wennink | Buitenhof*, Buitenhof, 2020, https://www.youtube.com/watch?v=yII53vpdEMc.

179 McWilliams and Zachmann, 'European Natural Gas Demand Tracker'.

180 Jilles van den Beukel and Lucia van Geuns, 'Olie En Gas Tijdens de Energietransitie', November 2023, https://hcss.nl/report/olie-en-gas-tijdens-de-energietransitie/.

181 "Within the next decade, 70,000 jobs are expected to arrive in the region. But such expansion comes at a cost, as Eindhoven is in dire need of additional housing — 62,000 homes over the same period." [...] ""One of the biggest challenges is building, building, building," said Robert-Jan Smits, president of Eindhoven University of Technology." Pieter Haeck, 'The Scale-up City: How Eindhoven Races to Keep up with Its Tech Giants', *POLITICO*, 22 June 2023, https://www.politico.eu/article/scale-up-city-eindhoven-grows-alongside-big-tech/.

potential weaponization of these goods by supplier countries, the Netherlands and the EU should therefore not just put efforts into the undoing high-risk manufacturing-related strategic dependencies. The Netherlands and the EU should also focus on achieving strategic indispensability in less energy- and manufacturing-intensive parts of digital value chains. Indeed, the EU appears better positioned to achieve successes in R&D, innovation, software, design and equipment manufacturing. Attaining indispensable positions in these sectors and industries may help deter third countries from weaponizing economic dependence.

Attracting foreign talent to study and work in the Netherlands is vital to ensure the future success of digital industries.

The table below lists a high-level overview of policy opportunities and recommendations to strengthen the strategic indispensability of the Netherlands and EU in digital value chains.[182] A more extensive, detailed and actionable version of these policy opportunities and recommendations is included in the restricted version of this report. A party is "strategically indispensable", if it "secures leadership in specific technologies that are vital to key supply chains and to the global economy as a whole."[183] These interventions, hence, aim to enhance the depth and number of strategic dependencies of the rest of the world on the Netherlands and the EU. This centrality may help dissuade rivals from taking coercive action, both within and beyond the geoeconomic and military realms. It finds that in order to enhance strategic indispensability, the Netherlands and the EU should:

1. Better align an already world-class basic research system with societal and geopolitical needs;
2. Strengthen the valorisation chain to foster industry champions;
3. Strengthen the overall business climate through targeted incentives for strategic industries;
4. Cooperate with allies and partners to deter rivals from weaponizing strategic dependence.

Table 3. Overview of policy opportunities and recommendations

Policy opportunity	Policy recommendation
1. Better align an already world-class basic research system with societal and geopolitical needs	1.1 Expand investment in STEM-education
	1.2 Expand access to STEM-education in the Netherlands and the EU for international talent
	1.3 Expand international cooperation in STEM-fields, especially with likeminded countries
	1.4 Prevent unwanted knowledge and technology transfer
2. Strengthen the valorisation chain to foster industry champions	2.1 Make valorisation an integral part of the research process
	2.2 Dedicate more public and private funds
	2.3 Foster an entrepreneurial culture
	2.4 Deepen ties between civilian and defence industries
3. Strengthen the overall business climate through targeted incentives for strategic industries	3.1 Prioritise strategic regions and companies
	3.2 Attract international talent
4. Cooperate with allies and partners to deter rivals from weaponizing strategic dependence	4.1 Coordinate with allies and likeminded partners to prevent weaponization by rivals
	4.2 Formulate and engage in industrial policy and diplomacy

[182] The recommendations do not include policy-recommendations that help the Netherlands and the EU alleviate high-risk strategic dependencies, since these have already been presented in earlier HCSS reports such as Joris Teer and Mattia Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry' (The Hague Centre for Strategic Studies, October 2022) and Patrahau et al., 'Advancing European Mineral Security'.

[183] Ringhof and Gherke, 'Indispensable Leverage'. The Government of Japan, in its 2022 National Security Strategy, focuses its economic security policies explicitly on both enhancing Japan's self-reliance as well as making its technologies more "indispensable." 'National Security Strategy of Japan (Provisional Translation)', 30.

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Annex 1. Strategic dependence risk assessment framework

Annex 1a: Assessing geopolitical risk-levels of strategic dependencies: an assessment framework

Table 5: Strategic dependence risk framework (1): Assessing *impact* of disruptions in supply of goods and services

		Impact indicators (weighted)	Main guiding question	Impact level				
				1	2	3	4	5
Identifying strategic dependence	1a. Assessing criticality of baseline supply	1. Criticality – 2x	How critical is the baseline supply of the good or service from one or several countries in the digital stack for the Netherlands and the EU to secure its level-one and level-two core interests? (i.e., What is the effect on the Netherlands and the EU's level-one and level-two core interests if the baseline supply of the good and service from one or several countries is entirely disrupted?).	No effect on security (i.e., physical or financial), safety and health. No obstacles to digitalisation.	Minor effect on security (i.e., physical or financial), safety and health; Somewhat impedes digitalisation.	Substantial effect on security (i.e., physical or financial), safety and health; Impedes digitalisation.	Major effect on security (i.e., physical or financial), safety and health; Disrupts digitalisation.	Devastating effect on security (i.e., physical or financial), safety and health; Entirely halts digitalisation.
		2. Dependence on maintenance, updates or resupply – 1x	If the good or service is no longer supplied, when will this have an impact on level-one and/or level-two core interests?	No maintenance, updates or resupply required for the entire lifespan of the product. Timing of impact delayed.	Maintenance, updates or resupply required every 5 years. Timing of impact delayed, but long-term: In 5-to-10 years.	Biannual to once in four-year maintenance, updates or resupply required; Timing of impact delayed, medium term: in 6-months to 4 years.	Monthly or biannual maintenance, updates or resupply required; Timing of impact delayed, but short-term: in 1-month to 6-months.	Constant maintenance, updates or resupply required; Timing of impact immediate.
		3. Demand projection – 1x	Total demand: Is national, regional and/or global demand for the good or service likely to outpace global supply, leading to shortages of the good or service on top of the risks of supply-related shocks? Total use of good or service to enable vital processes: Will more vital processes come to rely on the supply of the good or service in the next five years?	Sharp fall in total demand (-75%-to-100%) in next 5-years.	Major fall in total demand (-50%-to—75%) in next 5-years.	Slight rise or fall in total demand (-50% or +50%) in next 5-years.	Total demand rising 50-to-100% in next 5-years.	Total demand multiplying in next 5-years .
		Assessing criticality of baseline supply (weighted average of indicators 1, 2 and 3): Score on 1-to-5 scale						

Table 5: Strategic dependence risk framework (1): Assessing *impact* of disruptions in supply of goods and services (cont.)

	Impact indicators (weighted)	Main guiding question	Impact level 1	2	3	4	5
Identifying strategic dependence (cont.) — 1b. Assessing alternatives to baseline supply	4. Diversification - 1x	Do companies in allied, likeminded, or at least non-rival, non-EU states effectively supply the same good or service?	Complete effective, immediate diversification possible (100%); alternative suppliers offer same quality product, in same quantities at comparable prices.	Majority effective, immediate diversification possible (75%); alternative suppliers offer slightly inferior quality, in slightly lower quantities at slightly higher prices.	Partial effective, immediate diversification possible (50%); alternative suppliers offer inferior quality, half of the quantity at higher prices.	Limited effective, immediate diversification possible (25%); alternative suppliers offer far inferior quality, a quarter of the quantity at far higher prices.	No effective, immediate diversification possible (0%); alternative suppliers offer no quantities of the material, good or service.
	5. Internal production - 1x	Can the production of the good or service be effectively moved to the Netherlands or another EU member-state?	Complete effective internal production possible (100%); state has immediate access to relevant skilled labour, technologies, capital, and sufficient tolerance for externalities; Indigenisation possible in 1-year.	Majority effective internal production possible (75%); state has immediate access to majority of the relevant skilled labour, technologies, capital, and high tolerance for externalities; Indigenisation possible in 2-to-4 years.	Partial effective internal production possible (50%); state has immediate access to half of the relevant skilled labour, technologies, capital, and medium tolerance for externalities; Indigenisation possible in 5-to-10 years.	Limited effective internal production possible (25%); state has immediate access to part of the relevant skilled labour, technologies, capital, and low tolerance for externalities; Indigenisation possible in 11-to-15 years.	No effective internal production possible (0%); state has no immediate access to relevant skilled labour, technologies, capital, and no tolerance for externalities; Indigenisation possible in 15-to-40 years.
	6. Substitution - 1x	Can the function of the good or service be performed effectively, meaning at the same level of quality, in similar quantities and at comparable prices, by a different good or service?	Complete effective substitution possible (100%); state has immediate access to relevant skilled labour and sufficient capital; no additional technological advances are required; complete substitution possible in 1-year.	Majority effective substitution possible (75%); state has immediate access to majority of relevant skilled labour and of sufficient capital; some additional technological advances are required; complete substitution possible in 2-to-4 years.	Partial effective substitution possible (50%); state has immediate access to half of relevant skilled labour and of capital; additional technological advances are required; complete substitution possible in 5-to-10 years.	Limited effective substitution possible (25%); state has immediate access to a quarter of relevant skilled labour and of capital; many additional technological advances are required; complete substitution possible in 11-to-15 years.	No substitutes possible (0%); state has no immediate access to a quarter of relevant skilled labour and of capital; many additional technological advances are required; complete substitution possible in 15-to-40 years.
	7. Illicit exchange - 1x	Can the good or service provided by the original suppliers still be effectively accessed, in spite of an export boycott through direct or indirect illicit flows?	Complete continued supply through illicit exchange possible (100%); boycotting state has no effective direct and indirect enforcement means.	Majority continued supply through illicit exchange possible (75%); boycotting state has limited effective direct and indirect enforcement means.	Partial continued supply through illicit exchange possible (50%); boycotting state has some effective direct and indirect enforcement means.	Minority continued supply through illicit exchange possible (25%); boycotting state has strong direct and indirect enforcement means.	No continued supply through illicit exchange possible (0%); boycotting state has complete effective direct and indirect enforcement means.
Assessing alternatives to baseline supply (average of indicators 4, 5, 6 and 7): Score on 1-to-5 scale							
Negative effect on level-one and level-two core interests, if baseline supply is disrupted (weighted average of indicators 1 until 7): Score on 1-to-5 scale							

Table 6: Strategic dependence risk framework (2): Assessing *probability* of disruptions in supply of goods and services

	Probability indicators (weighted)	Main guiding question	Probability level 1	2	3	4	5
Assessing risk level of strategic dependence 2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply	8. Relationship with supplier country – 3x	Does the Netherlands and the EU enjoy good relations with the country of origin of the company that supplies the good or service?	Very good; relations sharply improved or were already very good previous decade; country is a full democracy with the same core interests as NL/EU.	Good; relations improved or were already good over previous decade; country is a full or flawed democracy but has slightly different core interests from NL/EU.	Neutral; relations remained stable over previous decade; country is a flawed democracy, hybrid regime or autocracy, but has no conflicting core interests with NL/EU.	Poor; relations deteriorated previous decade; supplier country is an autocratic rival with core interests opposite to NL/EU.	Very poor; relations sharply deteriorated during previous decade; supplier is an autocratic rival engaged in a proxy war with NL/EU.
	9. State influence over supplier -1x	Does the supplier state have the means to force the supplier to no longer provide the good or service?	Very weak; supplier has no (legal) obligations to act in service of state interests, both in times of peace and crisis; country has no history of exerting pressure on private companies to act in state interests; country does not impose unilateral or mini-lateral export controls.	Weak; supplier has no (legal) obligations to act in service of state interests, both in times of peace and crisis; country only seldomly exerted pressure on private companies to act in state interests; country seldomly imposes unilateral or mini-lateral export controls.	Modest; supplier has limited (legal) obligations to act in service of state interests, both in times of peace and crisis; country of origin has history of only seldomly exerting pressure on private companies to act in state interests; country occasionally imposes unilateral or mini-lateral export controls.	Strong; supplier has some (legal) obligations to act in service of state interests, especially in time of crisis; country of origin has history of occasionally exerting pressure on private companies to act in state interests; country often imposes unilateral or mini-lateral export controls.	Very strong; supplier has many (legal) obligations to act in service of state interests, both in times of peace and crisis; country of origin has consistent history of exerting pressure on private companies to act in state interests; country structurally imposes unilateral or mini-lateral export controls.
	10. Cost of weaponization to supplier – 2x	What are the costs of halting the supply of the good or service to the state imposing the boycott? .	Very high; great financial/economic self-harm in halting supply, political, diplomatic, and institutional cost to halting supply; possibly also military response.	High; substantial financial/economic self-harm in halting supply. Great political, diplomatic, institutional cost; low chance of military response.	Medium; limited financial/economic self-harm in halting supply. substantial political, diplomatic, institutional cost; very low chance of military response.	Low; almost no financial/economic self-harm in halting supply. Limited political, diplomatic, institutional cost; Close to zero chance of military response.	Very low; almost no financial/economic self-harm in halting supply; No political, diplomatic, institutional cost; Close to zero chance of military response.
		Assessing likelihood of *unwillingness* by supplier and/or supplier state to continue supply (weighted average of indicators 8, 9, 10): score on 1-to-5 scale					

Table 6: Strategic dependence risk framework (2): Assessing *probability* of disruptions in supply of goods and services

		Probability indicators (weighted)	Main guiding question	Probability level				
				1	2	3	4	5
Assessing risk level of strategic dependence(cont.)	2b. Assessing likelihood of inability of supplier and/ or supplier state to continue supply	11. Threats to supplier country – 5x	Does the supplier state of the good or service face a military threat?	Non-existent; source country does not face a military threat; and only a limited possibility to face a large-scale cyber-attack.	Mild; in the next decade, limited possibility that source country faces a high-level military threat (e.g., invasion/ bombardment or blockade), but possible that the source country experiences a large-scale cyber-attack.	Medium; in the next decade, source country possibly faces a high-level military threat (e.g., invasion/ bombardment or blockade) and is more likely than not to experience a large-scale cyber-attack.	Substantial; in the next decade, the risk that the source country faces a high-level military threat (e.g., invasion/ bombardment or blockade) is substantial; it is likely that the source country experiences a large-scale cyber-attack.	Severe; in the next decade, source country is likely to face an existential military threat (e.g., invasion/ bombardment or blockade) and faces constant hybrid attacks such as large-scale cyber-attacks.
		12. Threats to supply lines – 1x	Are the supply lines (e.g., maritime routes, airways, communication cables and satellite connections) via which the good or service is supplied likely to be disrupted?	Non-existent; Supply lines are entirely secure.	Mild; Supply lines face low-level hybrid threats.	Medium; Supply lines face occasional medium-level hybrid threats and low-level military threats.	Substantial; Supply lines face constant high-level hybrid threats and occasional medium-level military threats.	Severe; Supply lines face numerous high-level hybrid threats and structural high-level military threats.
	2b. Assessing likelihood of *inability* by supplier and/or supplier state to continue supply (weighted average of indicators 11 and 12): score on 1-to-5 scale							
	Assessing risk level of strategic dependence (weighted average of indicators 7 until 12): score on 1-to-5 scale							

Annex 1b: Guiding questions: Determining geopolitical risk levels of strategic dependencies in the digital domain

Impact assessment: What is the *impact*, meaning the negative effect on level-one and level-two Dutch and European core interests, if the baseline supply of the good or service in the digital stack is disrupted?

1. Identifying strategic dependencies: 1a. Assessing criticality of baseline supply

1. **Criticality:** How critical is the baseline supply of the good or service from one or several countries in the digital stack for the Netherlands and the EU to secure its level-one and level-two core interests? (i.e., What is the effect on the Netherlands and the EU's level-one and level-two core interests if the baseline supply of the good and service from one or several countries is entirely disrupted?)
   a. Level-one: What is the effect on the security (i.e., physical or financial), safety and health of Dutch and European populations if the baseline supply of the good or service in the digital stack is entirely disrupted?
      i. Are level-A vital processes, namely national transport, energy production and distribution (i.e., electricity and gas), oil and drinking water supply, water management, and the storage, production and processing of nuclear material disrupted if the good or service is no longer supplied?
      ii. Are level-B vital processes, such as regional distribution of electricity and natural gas, internet and data services, internet access and data traffic, payment transactions, and communication between security services like the police and the military, disrupted when the good or service is no longer supplied?[1]
      iii. Are other sectors of the economy disrupted when the good or service is no longer supplied, resulting in large-scale economic losses that threaten the financial stability of the population?
   b. Level-two: What is the effect on the digital transition of the Netherlands and the EU, meaning their ability to expand digital functions of the state/institutions, society and economy, if the supply of the good or service in the digital stack is entirely disrupted?
      i. Does it impede generating new efficiency gains for critical sectors, such as the medical, Defence and security sectors, that can enhance the security (i.e., physical or financial), safety and health of Dutch and European citizens?
      ii. Does it impede granting larger parts of the population access to digital products, possibly leading to social exclusion?
      iii. Does it impede generating new efficiency gains for the economy, thereby reducing the capacity of industry in the Netherlands and Europe to compete internationally (e.g., semi-autonomous driving and shipping, the large-scale introduction of AI across industries)?

1 For a complete list of A and B-level vital processes, please see: https://english.nctv.nl/topics/critical-infrastructure-protection

2. **Dependence on maintenance, updates, or resupply:** If the good or service is no longer supplied, when will this have an impact on level-one and/or level-two core interests?
   a. After receiving the good or service, does the buyer rely on the supplier to complete additional actions that ensure the maintained functioning of the good or service (i.e., the product requires maintenance, updates, or resupply), or does the good or service have an independent lifespan?
   i. Is the impact immediate (e.g., Microsoft/Google not maintaining Cloud services)?
      ii. Is the impact delayed...
         1. but still felt in the short term (e.g., ASML or Huawei not providing system updates)?
         2. or only felt in the medium-term (e.g., a Chinese CRM embargo or war-related disruption of TSMC)?
      iii. Is the impact only noticeable in the long-term, once the lifespan of several years/ decades of the good or service runs out, as the good or service requires no maintenance, updates, or resupply by the supplier (e.g., permanent magnets imported from China in European-built wind turbines)?

3. **Demand projection:** Total demand: Is national, regional and/or global demand for the good or service likely to outpace global supply, leading to shortages of the good or service on top of the risks of supply-related shocks? Total use of good or service to enable vital processes: Will more vital processes come to rely on the supply of the good or service in the next five years?[2]
   a. Is demand rising (e.g., exponential demand increase for rare earths due to the energy transition)?
   b. Is demand falling because of technological innovation (e.g., demand for DVD-players, because of innovation in computer technologies)?
   c. Total use of good or service to enable vital processes: Will more vital processes come to rely on the supply of the good or service in the next five years?[3]

1b. Assessing alternatives to baseline supply

4. **Diversification:** Do companies in allied, likeminded, or at least non-rival, non-EU states effectively supply the same good or service?[4]
   a. Do these companies offer similar quality?
   b. Do these companies offer similar quantities?
      i. Do these companies have sufficient production capacity, or the means to in time create sufficient production capacity, to arrive at similar quantities in the near future?
   c. Do these companies offer comparable prices?
   d. If not, in what timeframe would it be possible for companies in allied, likeminded or at least non-rival, non-EU states to set up production to provide alternative supply, at similar quality, in similar quantities, and at comparable prices?

2 For a complete list of A and B-level vital processes, please see: 'Critical Infrastructure (Protection)', National Coordinator for Counterterrorism and Security (Ministerie van Justitie en Veiligheid, 20 February 2020), https://english.nctv.nl/topics/critical-infrastructure-protection.

3 For a complete list of A and B-level vital processes, please see: 'Critical Infrastructure (Protection)', National Coordinator for Counterterrorism and Security (Ministerie van Justitie en Veiligheid, 20 February 2020), https://english.nctv.nl/topics/critical-infrastructure-protection.

4 "Effectively supply" means supply of the same material, good or service, at the same level of quality, in similar quantities and at comparable prices.

5. **Internal production:** Can the production of the good or service be effectively moved to the Netherlands or another EU member-state?
   a. Can internal production offer similar quality, in similar quantities and at comparable prices?
   b. Can the obstacles to internal production of the good or service be overcome?
      i. Do the Netherlands and the EU have access to a labour population with the right skills to achieve indigenisation?
      ii. Do the Netherlands and the EU have access to the technologies required to achieve indigenisation?
      iii. Do the Netherlands and the EU have access to sufficient capital to achieve indigenisation?
      iv. Are Dutch and European governments, companies and populations willing to accept the costs (i.e., financial burden, environmental effects like air pollution or increased CO_2 and nitrogen emissions) to achieve indigenisation?
   c. If these obstacles are overcome, in what timeframe can internal production be achieved?
      i. Are current (e.g., European Chips Act) or upcoming (e.g., EU Critical Raw Materials Act) policy initiatives to increase internal production likely to be successful?

6. **Substitution:** Can the function of the good or service be performed effectively, meaning at the same level of quality, in similar quantities and at comparable prices, by a different good or service?
   a. Is substitution possible (e.g., replacing cobalt in Lithium-ion batteries with more lithium; generating electricity through wind turbines as opposed to with Russian gas; using external hard drives instead of Cloud services)?
      i. Is access to additional skilled labour populations required to achieve effective supply substitution?
      ii. Are additional technological breakthroughs required to achieve effective supply substitution?
      iii. Do the Netherlands and the EU have access to sufficient capital to achieve effective supply substitution?

7. **Illicit exchange:** Can the good or service provided by the original suppliers still be effectively accessed, in spite of an export boycott through direct or indirect illicit flows (e.g., illicit exchange such as smuggling; rerouting online services through servers in third countries)?[5]
   a. Is the state that initiated the boycott able to effectively impose and enforce direct boycott enforcement mechanisms (e.g., customs controls and legal enforcement)?
   b. Does the state that initiated the boycott have effective indirect boycott enforcement mechanisms?
      i. Does the state imposing the boycott have the diplomatic means to persuade third parties to impose the same export/customs controls and legal enforcement against the targeted party?
      ii. Does the state imposing the boycott have the ability to compel third states (e.g., by imposing extraterritorial sanctions, such as financial penalties) into imposing the same export/customs controls and legal enforcement against the targeted party?

5 "Effectively accessed" means access to the same material, good or service, at the same level of quality, in similar quantities and at comparable prices.

Probability assessment: What is the *probability* that the supply of this good or service in the digital stack is disrupted?

2. Assessing risk level of strategic dependence: 2a. Assessing likelihood of unwillingness by supplier and/or supplier state to continue supply

8. **Relationship with supplier country of origin:** Does the Netherlands and the EU enjoy good relations with the country of origin of the company that supplies the good or service?
   a. Are relations likely to reach breaking point in the next five and ten years?[6]
      i. Have relations improved/worsened in the last ten years?
      ii. Does the country of origin have a history of attempting using economic coercion against...
         1. the Netherlands?
         2. the EU?
         3. another EU member-state?
         4. other likeminded countries?
         5. in general?
      iii. Are the core interests of the country considered to be in opposition to the core interests of the Netherlands and the European Union?
         1. Is this country considered a "systemic rival" by the NL and the EU?
         2. Is this country part of important alliances and organisations the Netherlands and the EU are part of (e.g., NATO)?
         3. What is this country's relationship with key allies of NL and the EU, particularly the United States?
            a. Have key allies of the EU and NL imposed (extraterritorial) sanctions on the country of origin of the supplier?
      iv. Is the country a *full democracy*, a *flawed democracy*, a *hybrid regime* or an *authoritarian regime*?[7]

9. **State influence over supplier:** Does the state have the means to force the supplier to no longer provide the good or service?
   a. Does the state own the company supplying the good or service?
   b. Does the state have the ability to install export controls?
   b. Does the state have a history of exerting pressure on commercial companies in its jurisdiction to achieve national goals?
      i. Which legal obligations do these companies have to contribute to the national security objectives of their governments?
      ii. In the event of a geopolitical and/or military crisis, what means does the state likely have to exert influence over companies?

6 "A breaking point is reached when friction in an interstate relationship, often related to military-strategic tensions, becomes so overwhelming that states are no longer willing to supply all or some vital resources on which the economies of their rivals depend." Joris Teer and Mattia Bertolini, 'Reaching Breaking Point: The Semiconductor and Critical Raw Material Ecosystem at a Time of Great Power Rivalry' (The Hague Centre for Strategic Studies, October 2022), II.

7 The Economist Intelligence Unit (EIU) divides regime types into the aforementioned four groups and each year attributes a score to country-government around the world. https://www.eiu.com/n/campaigns/democracy-index-2022/?utm_source=google&utm_medium=paid-search&utm_campaign=democracy-index-2022&gclid=Cj0KCQjwy9-kBhCHARIsAHpBjHjbkqFeaY-sPHuBXus-NNGcwpsZ86sAwP7on0nHeFYHq0l_g03iYc4aArCiEALw_wcB

10. **Cost of weaponization:** What are the costs of halting the supply of the good or service to the state imposing the boycott?
    a. Financial/economic: Is the domestic economy of the state that imposes the boycott damaged by the boycott?
    a. Does the boycott damage the interests of the company supplying the good or service (e.g., due to loss of sales)?
    b. Is the target state likely to effectively retaliate economically and financially to the imposed boycott?
    b. Political: Is the international standing of the state that imposes the export boycott damaged (e.g., because the boycott runs counter to the values that the boycotting state professes or the boycott enhances the hegemonic reputation of the state)?
    c. Diplomatic: Does imposing an effective export boycott require large-scale diplomatic efforts to convince allies and other states to impose the same controls (i.e., to set up a multilateral coalition)?
    d. Military: Is the boycott likely to initiate a military response by the targeted state or one of its allies?
    e. Institutional: Is the boycott likely to initiate or speed up efforts by the targeted states to reduce dependence on the state imposing the boycott (e.g., growing call for de-dollarisation as a result of structural US use of financial sanctions)?

2b. Assessing likelihood of inability by supplier and/or supplier state to continue supply

11. **Threats to supplier country:** Does the source-country of the good or service face a military threat?
    a. Does the country of origin of the supplier face a threat of invasion or large-scale bombardment (e.g., Taiwan and South-Korea)?
    b. Does the country of origin face a threat of military blockade (e.g., Taiwan, South-Korea and Ukraine) blocking maritime and areal entry points?
    c. Is the supplier of the good or service a strategic target for a large-scale cyber-attack by a third state?

12. **Threats to supply lines:** Are the supply lines (e.g., maritime routes, airways, communication cables and satellite connections) via which the good or service is supplied likely to be disrupted?
    a. Do the waterways over which the good is transported face military risks (e.g., Iran's IRGC seizing ships in the Strait of Hormuz; possible US-navy closure of Malacca Strait in the event of a Sino-American confrontation over Taiwan)?
    b. Are the communication cables through which the service is provided likely to be sabotaged (e.g., Russian mapping of subsea cables in the North Sea and the Atlantic; China alleged severing of communication cables linking Taiwan's Matsu Islands to Taiwan)?

Annex 2. List of round table participants, expert workshop participants and expert interviews

The authors express their gratitude to the individuals listed below for providing input during the expert roundtable discussion.

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2. Pieter Nooren, Senior Scientist at TNO ICT

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