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Weakening Effect of Concentrated Supply Chains on Traditional Alliance Frameworks: A Comparative Study of NATO and Quad

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ABSTRACT

Traditional alliances such as NATO and Quad were built mainly for military defence and political coordination among member states. In the present period, global supply chains for semi-conductors, critical minerals, and other important goods are concentrated in a small number of places. This concentration creates new economic risks that traditional alliance frameworks were not first designed to handle. This paper asks the following question: to what extent does reliance on concentrated supply chains weaken traditional alliance frameworks such as NATO and Quad? Using a qualitative comparative method, and drawing on complex interdependence theory and weaponised interdependence theory, the paper studies official documents, policy reports, and academic literature on NATO and Quad. The findings show that supply chain concentration creates new strain points inside alliances, mainly through disagreement over trade policy and uneven exposure among member states. However, this strain is partial rather than total, because both alliances have started new economic cooperation tracks. The paper concludes that concentrated supply chains change, but do not destroy, alliance cohesion.

Introduction

Alliances such as the North Atlantic Treaty Organization (NATO) and the Quadrilateral Security Dialogue (Quad) were created to manage military and political threats among member states. NATO was formed in 1949 as a collective defence pact between North American and European states, built around Article 5, which treats an attack on one member as an attack on all members. Quad is a newer and looser grouping of Australia, India, Japan, and the United States (US), formed to support a free and open Indo-Pacific region. Both frameworks were designed with security threats in mind, mainly military threats from a rival state or coalition. Neither framework was originally designed around economic dependence on global supply chains.

In the last two decades, the world economy has become organised around long and thin supply chains. A small number of countries and companies now control key stages of production for goods such as semiconductors, batteries, and critical minerals. For example, a large share of advanced semiconductor manufacturing is concentrated in Taiwan, and a large share of rare earth processing is concentrated in a small number of countries (Atlantic Council, 2024; Beyond the Horizon ISSG, 2025). This concentration means that a disruption in one place, whether caused by a natural disaster, a political dispute, or an export control policy, can affect many countries at the same time. Such disruptions do not stop at the border of one country. They can create disagreement between allies who depend on the same supply chain but who face different levels of risk.

This new form of economic dependence raises an important question for the study of alliances. Alliance theory has traditionally explained cohesion and cooperation through shared threat perception (Walt, 1987). It has not fully explained what happens when allies depend on the same concentrated economic network but disagree about how to respond to risks in that network. Supply chain concentration can turn an economic issue into a security issue, and it can create friction between allies with different economic interests, even when their security interests are aligned. This paper studies this problem directly.

The research question guiding this paper is: to what extent does the reliance on concentrated supply chains weaken traditional alliance frameworks, using NATO and Quad as examples? The purpose of this paper is not to blame any single country for supply chain concentration. Concentration is a structural and economic outcome that has built up over many decades of trade, investment, and specialisation. The purpose is instead to understand how this structural condition affects the working of alliances that were built for a different kind of threat.

This paper argues that concentrated supply chains do put real strain on traditional alliance frameworks, but the strain is partial and manageable rather than fatal. Supply chain concentration adds a new source of disagreement among allies, because member states are not equally exposed to the same risks and do not always agree on the correct policy response. At the same time, NATO and Quad have both responded by building new consultation mechanisms and new economic initiatives. This suggests that alliances are adapting to the new economic environment rather than simply breaking down.

This question has practical significance beyond academic theory. Governments in North America, Europe, and the Indo-Pacific region are currently deciding how much to invest in domestic production, how to coordinate export rules with partners, and how to balance open trade with supply security. These decisions are shaped by assumptions about whether alliances can manage economic risk together or whether each member state must mainly protect itself. A clearer understanding of how supply chain concentration actually affects alliance cohesion can help these decisions rest on evidence rather than on assumption alone.

The paper is organised into four main sections. The first section presents the theoretical framework and the research methodology used in the paper. The second section explains how concentrated supply chains create structural pressure on alliance frameworks in general. The third section compares NATO and Quad directly, looking at how each alliance has responded to supply chain risk. The fourth section discusses the overall extent of the weakening effect and considers the limits of the argument.

Theoretical Framework and Methodology

This paper uses two theories together to study the research question. The first theory is complex interdependence, developed by Keohane and Nye (2012). This theory says that in a world with many economic and social connections between countries, military force becomes less useful and less central compared to earlier periods in history. Countries become linked through trade, investment, and information flows, and these links create both cooperation and vulnerability at the same time. Complex interdependence theory is useful here because it explains why economic connections, such as supply chains, matter for security relationships and not only for trade relationships.

The second theory is weaponised interdependence, developed by Farrell and Newman (2019). This theory builds on complex interdependence but adds an important idea. It says that global economic networks are not flat or equal. Some countries sit at central points, or chokepoints, in these networks, such as a hub in a financial system or a key stage in a production chain. A country or company sitting at a chokepoint can gain extra bargaining power, because it can restrict or slow the flow of goods, money, or information through that point. Weaponised interdependence theory is useful here because it explains why supply chain concentration is not just an economic risk but also a possible source of political leverage between states, including between allied states.

Alongside these two theories, this paper also uses classical alliance theory, mainly the balance of threat framework developed by Walt (1987). This framework explains that states join and stay in alliances mainly because of shared threat perception, not only because of shared economic interest. This framework is useful as a baseline, because it helps to show what alliance cohesion usually depends on, so that the paper can then ask what happens when a new and different kind of dependence, namely economic and supply chain dependence, is added on top of the traditional security logic.

Combining these three ideas gives a clear framework for the paper. Complex interdependence explains why economic ties matter for security. Weaponised interdependence explains why concentrated supply chains can become tools of pressure between states. Balance of threat theory explains what alliance cohesion is normally built on. Together, they allow the paper to ask whether concentrated supply chains add a new layer of strain to alliance frameworks that were built mainly around military threat perception.

This paper uses a qualitative, comparative case study method. Two cases are chosen for comparison: NATO, an older and more formal military alliance, and Quad, a newer and more informal security dialogue. These two cases are useful for comparison because they represent different types of alliance frameworks, yet both face similar pressure from supply chain concentration, especially in semiconductors and critical minerals. Comparing a formal alliance with a looser dialogue helps to show whether the effect of supply chain concentration depends on the type of alliance structure, or whether it appears across different types of frameworks.

The data for this paper comes from secondary sources. These sources include official statements and communiqués from NATO and Quad meetings, reports from research institutions such as the Atlantic Council, the Center for a New American Security (CNAS), and the Center for Strategic and International Studies (CSIS), and peer reviewed academic articles on supply chain concentration and alliance politics. It uses a method called qualitative document analysis, where existing documents are read closely and compared to identify patterns of cooperation, disagreement, and adaptation across the two cases.

The method has some limits, which are stated openly. First, official documents from alliances do not always show internal disagreement clearly, since these documents are usually written to show unity in public. Second, this paper focuses mainly on semiconductors and critical minerals as examples of concentrated supply chains, because these two sectors have generated the most policy discussion and academic literature at the time of writing. Other sectors, such as pharmaceuticals or energy, could show different patterns and are not covered in depth here. These limits are discussed again in the final section of the paper.

Concentrated Supply Chains and Structural Pressure on Alliance Frameworks

Supply chain concentration means that the production of a good, or one important stage of its production, is located mainly in a small number of countries or firms. This pattern has grown for economic reasons, including cost efficiency, specialization, and long-term investment in specific locations. Semiconductor manufacturing is a clear example of this pattern. A small number of firms, based mainly in East Asia, carry out most of the world's advanced chip manufacturing, while a smaller number of firms based in a few countries supply the specialized equipment needed for this manufacturing (Atlantic Council, 2024). Critical minerals show a similar pattern. Processing and refining of many critical minerals, including rare earth elements, cobalt, and lithium, is concentrated in a limited number of countries (Beyond the Horizon ISSG, 2025).

This kind of concentration was not originally a security problem. It became a security concern only when supply disruptions, whether from natural events, pandemics, or trade restrictions, showed how quickly a bottleneck in one place could affect industries and defense production in many other places. The COVID-19 pandemic showed this clearly, when a shortage of semiconductors affected car production, electronics, and other industries around the world at the same time (Maksakova, 2025). Once supply concentration was linked to national security and defense production, it stopped being purely an economic issue and became an alliance issue as well.

Weaponised interdependence theory explains why this shift matters for alliances (Farrell & Newman, 2019). When a chokepoint in a supply chain sits within the territory or control of one state, that state gains a form of structural power over other states that depend on the same chain, even when those other states are close allies. This structural power does not have to be used aggressively to matter. Its mere existence changes how allies plan their industrial policy, their defense procurement, and their trade relationships. Beaumier and Cartwright (2024) show, using network analysis, that different stages of the semiconductor supply chain, such as chip design, raw materials, manufacturing equipment, and assembled chips, are controlled by different sets of countries. This means that power in the supply chain is spread unevenly across countries, including across countries that are formal allies of one another.

This unevenness matters directly for alliance cohesion. In a traditional alliance built around a shared external threat, member states usually accept some cost or risk sharing because the benefit, collective security, is roughly shared as well. Supply chain concentration disturbs this balance, because the economic risk from a supply disruption is not shared equally among allies. A country that hosts a large part of a critical industry, or a country that is more dependent on imports for that industry, will feel differently about trade restrictions, export controls, or industrial subsidies than a country with a different level of exposure (CSIS, 2024). This uneven exposure creates room for disagreement inside an alliance, even when all member states agree on the general security threat.

A second structural pressure comes from the difference in speed between economic policy and alliance decision-making. Military alliances such as NATO were designed for slower and more formal decision cycles, built around defense planning, joint exercises, and treaty commitments. Supply chain disruptions, however, can happen quickly, sometimes within weeks, driven by a single export control announcement or a single company's production problem (CSIS, 2024). Alliance institutions are not always built to respond at this speed, so individual member states may act on their own to protect their own supply, which can create friction with allies who feel excluded from that decision or affected by it.

A third structural pressure comes from the overlap between commercial competitiveness and national security. Many governments now treat leadership in semiconductors and other advanced technologies as both an economic goal and a security goal at the same time (Nietsche, 2023). This overlap means that industrial policy choices, such as subsidies, export controls, or investment screening, are judged not only on economic grounds but also on alliance grounds. When one ally's industrial policy is seen by another ally as harmful to their own industry, this can create tension inside the alliance relationship, even though both states may still agree closely on shared military threats.

Taken together, these three structural pressures, namely uneven exposure to risk, mismatched decision speed, and the blending of economic competitiveness with security policy, show why concentrated supply chains create a distinct kind of strain on alliance frameworks. This strain is different from the traditional strain studied in alliance theory, which usually focuses on burden sharing in defense spending or disagreement over the use of military force. Supply chain related strain instead centers on trade policy, industrial policy, and technology policy, areas that used to sit mostly outside the core work of security alliances.

It is worth noting that concentration itself is not new in economic history, but the security meaning attached to it is comparatively new. Earlier periods of trade specialization were mostly treated as ordinary economic outcomes. What has changed is that governments now connect supply concentration directly to national defense capacity, technological leadership, and long-term strategic competition (Nietsche, 2023). This shift in framing, from an economic issue to a security issue, is itself an important part of why supply chain concentration now reaches into the work of security alliances such as NATO and Quad, rather than staying inside finance or trade ministries alone.

Alliance Responses: NATO and Quad Compared

NATO was designed as a formal collective defense treaty, and for most of its history economic policy was not a central part of its agenda. In recent years, however, NATO has begun to discuss economic security more directly, mainly because member states have raised concerns about dependence on a small number of suppliers for critical raw materials used in defense production (CSIS, 2024). One report describes how dependence on concentrated supplies of critical raw materials complicates alliance cohesion and long-term planning, because member states do not want to depend on a single external supplier for materials needed in defense manufacturing (Beyond the Horizon ISSG, 2025). This shows that supply chain concentration has entered NATO's policy conversation as a genuine concern, even though NATO's founding treaty was not built around economic dependence.

At the same time, NATO has not built a strong, formal economic security structure to match its military structure. Discussions about forming an economic version of NATO, sometimes informally called an economic NATO, have taken place in policy circles, but such a structure does not yet exist in a complete form (CSIS, 2024). Instead, NATO members have mostly relied on other groupings, such as the European Union, the G7, and bilateral agreements, to manage supply chain risk. This shows a gap between the security value that member states place on supply chain resilience and the formal tools that NATO currently has to manage it. This gap is itself a sign of strain, because it means individual member states are more likely to act alone or through separate groupings, which can create uneven policy outcomes across the alliance.

Quad shows a different pattern, partly because Quad was never a formal treaty alliance in the way NATO is. Quad is a dialogue framework built on shared strategic interests among Australia, India, Japan, and the United States, mainly focused on a free and open Indo-Pacific region. Because Quad is less formal, it has been able to move faster on economic security topics. Recent Quad meetings have produced direct initiatives on supply chains, most notably the Quad Critical Minerals Initiative, launched at the Quad Foreign Ministers' meeting to secure and diversify supply chains for critical minerals and rare earth elements (Quad Critical Minerals Initiative Framework, 2026). This initiative includes cooperation on recycling, investment in alternative sources, and coordination of trade rules among the four member states.

This comparison suggests that alliance structure affects how a framework responds to supply chain concentration. NATO, as an older and more formal military alliance, has been slower to build matching economic tools, partly because supply chain issues sit outside its original treaty purpose and partly because such issues touch on trade policy, where member states, especially in Europe, often prefer to act through other institutions. Quad, as a newer and more flexible dialogue, has been able to add supply chain cooperation to its agenda more directly, because it was not built around a single narrow treaty purpose in the first place.

However, both frameworks share one important similarity. In both cases, supply chain concentration has pushed member states to build new consultation channels rather than to abandon the alliance framework altogether. NATO members continue to discuss critical raw materials and defense industrial cooperation inside NATO meetings, even without a full formal structure (CSIS, 2024). Quad members have created a named initiative with clear goals for critical minerals cooperation (Quad Critical Minerals Initiative Framework, 2026). This suggests that both alliances are treating supply chain concentration as a problem to manage through cooperation, not as a reason to reduce their overall alliance commitment to one another.

At the same time, both cases show real limits to this cooperation. Beaumier and Cartwright (2024) point out that different countries hold different levels of power across different stages of the same supply chain, which means that even allied countries can have different bargaining positions and different interests when negotiating supply chain rules together. A report on business responses to supply chain policy also shows that companies based in allied countries, such as Germany, do not always share the same level of exposure or the same policy preference as the country leading a coordination effort, which can create quiet friction even inside a cooperative framework (Business Security Dilemma, 2025). This shows that formal cooperation efforts, such as the Quad Critical Minerals Initiative or NATO discussions on raw materials, do not fully remove the underlying structural pressure described in the previous section. They manage it, but they do not eliminate it.

Overall, the comparison between NATO and Quad shows that concentrated supply chains create pressure on both formal and informal alliance frameworks, but the pressure appears differently depending on the type of framework. NATO faces a gap between growing concern and limited formal tools. Quad has moved faster to build a named initiative, but still faces uneven interests among its own member states. In both cases, the alliances have chosen adaptation over abandonment, which is an important finding for answering the main research question of this paper.

A further point of comparison concerns transparency and public communication. NATO's discussions on critical raw materials have so far mostly appeared in policy commentary and research reports rather than in a single, clear treaty commitment (CSIS, 2024; Beyond the Horizon ISSG, 2025). Quad, in contrast, has issued a joint statement naming its critical minerals initiative directly, which gives outside observers, including researchers, a clearer public reference point for tracking progress (Quad Critical Minerals Initiative Framework, 2026). This difference in communication style does not necessarily mean one alliance is doing more than the other in private planning, but it does affect how easily each alliance's adaptation can be observed and studied from the outside, which is itself a relevant methodological point for this paper.

Discussion: The Extent of the Weakening Effect

Returning to the research question, this paper finds that concentrated supply chains do weaken traditional alliance frameworks, but only in a partial and specific way, not in a total way. The weakening effect is visible mainly in three areas. First, in the area of trade and industrial policy, where allies do not always agree on export controls, subsidies, or investment rules, even though they agree on the underlying security threat. Second, in the area of decision speed, where alliance institutions built for slower military planning struggle to match the faster pace of supply chain disruptions. Third, in the area of uneven exposure, where member states with different levels of dependence on a concentrated supply chain naturally develop different policy preferences, which can create friction inside the alliance relationship.

At the same time, the evidence gathered in this paper does not support the idea that concentrated supply chains are breaking NATO or Quad apart. Both alliances remain active, and both have added new consultation channels focused directly on supply chain risk. This matches what complex interdependence theory would predict, since that theory expects new forms of connection and vulnerability to appear alongside continued cooperation, not necessarily to replace it (Keohane & Nye, 2012). It also matches part of what weaponized interdependence theory predicts, since that theory expects states to respond to chokepoint vulnerability by trying to build new coordination tools and by trying to reduce their own exposure, rather than simply accepting the vulnerability passively (Farrell & Newman, 2019).

The comparison between NATO and Quad also suggests that alliance design matters for how the weakening effect shows up. A more formal and older alliance, such as NATO, seems to feel the pressure mainly as a gap between concern and capacity, since its formal structure was not built for economic security work. A newer and more flexible framework, such as Quad, seems to feel the pressure differently, showing faster policy movement but also more visible internal negotiation over shared goals. This suggests that the extent of weakening is not fixed, but depends partly on how much flexibility an alliance framework has to add new areas of cooperation without changing its founding purpose.

It is also useful to note what this paper does not find. It does not find that concentrated supply chains have caused any member state to leave NATO or Quad, and it does not find that either framework has lost its core military or security purpose. The evidence instead points to added strain within continuing cooperation, mainly visible in policy disagreement and slower coordination, rather than a collapse of the alliance relationship itself. This distinction matters, because it means the correct way to describe the effect is a change in the internal working of alliances, not a breakdown of alliances as a form of international cooperation.

There are limits to this discussion that should be stated clearly. This paper relies on secondary sources and does not include new interviews with policymakers, so it cannot fully capture private negotiation that does not appear in public documents. It also focuses mainly on semiconductors and critical minerals, which are two of the most discussed sectors at the present time, but other sectors facing supply concentration, such as pharmaceuticals, batteries, or shipping, could show a different pattern and deserve separate study. In addition, this paper covers a period in which cooperation efforts such as the Quad Critical Minerals Initiative are still new, so their long-term effect on alliance cohesion cannot yet be fully judged and would benefit from follow-up research after these initiatives have been running for a longer period.

Even with these limits, the discussion supports a clear and moderate answer to the research question. Concentrated supply chains add a real and identifiable source of strain to traditional alliance frameworks such as NATO and Quad, mainly through uneven exposure to risk, mismatched decision speed, and the mixing of economic competitiveness with security policy. This strain is genuine and worth continued study. It has not, however, reached the point of weakening the core military and political purpose of either alliance, since both frameworks have responded through new cooperation mechanisms rather than through reduced commitment to one another.

This moderate finding also fits with a broader pattern seen in the study of international cooperation. New forms of interdependence rarely destroy existing institutions outright. More often, they force existing institutions to expand their agenda into new areas, sometimes slowly and unevenly, while the original core purpose remains intact. The evidence from NATO and Quad in this paper fits this broader pattern. Supply chain concentration has expanded the working agenda of both frameworks into trade, industrial policy, and critical minerals, areas that were not originally central to either grouping, without removing their original military and strategic purpose.

Conclusion

This paper asked to what extent reliance on concentrated supply chains weakens traditional alliance frameworks, using NATO and Quad as comparative cases. Using a qualitative comparative method and drawing on complex interdependence theory, weaponized interdependence theory, and balance of threat theory, the paper studied official statements, policy reports, and academic literature covering both alliances. The paper finds that concentrated supply chains, especially in semiconductors and critical minerals, create a genuine and identifiable source of strain inside these alliances. This strain appears mainly through uneven exposure to supply risk among member states, a mismatch between the slow pace of alliance decision-making and the fast pace of supply chain disruption, and the blending of economic competitiveness with security policy.

At the same time, the paper finds that this strain is partial rather than complete. Both NATO and Quad have responded to supply chain concentration by building new consultation channels and, in the case of Quad, a named cooperative initiative on critical minerals. Neither alliance has lost a member state because of supply chain pressure, and neither alliance has abandoned its core military and security purpose. This suggests that the correct way to understand the relationship between concentrated supply chains and alliance frameworks is one of adaptation under strain, not collapse.

The comparison between NATO and Quad also shows that the type of alliance structure shapes how this strain appears. A more formal, treaty-based alliance such as NATO shows the pressure mainly as a gap between rising concern and limited formal economic tools. A newer, more flexible framework such as Quad shows the pressure through faster but still uneven policy coordination among its member states. This finding suggests that policymakers who want to protect alliance cohesion in an age of concentrated supply chains should pay attention to how much flexibility their alliance structure allows for adding new, non-military forms of cooperation.

This paper has some limits that point toward useful future research. Future studies could look more closely at sectors beyond semiconductors and critical minerals, such as pharmaceuticals or shipping, to see whether the same pattern of partial strain and adaptation appears there as well. Future studies could also revisit NATO's and Quad's economic security initiatives after they have operated for a longer period, to see whether early cooperation efforts described in this paper actually reduce the strain identified here over time. Interview-based research with policymakers inside these alliances could also add detail that public documents alone cannot fully capture.

The comparative approach used in this paper also carries a broader lesson for the study of alliances in general. As economic networks become more central to national security thinking, students of alliance politics may need to look beyond defense budgets and troop numbers when measuring cohesion. Trade policy, industrial subsidies, and supply chain diplomacy are becoming part of the everyday work of alliance management, alongside more traditional military planning. Recognizing this shift may help future research build a fuller picture of how modern alliances hold together under mixed economic and security pressure.

In closing, concentrated supply chains represent an important new test for traditional alliance frameworks that were built mainly around shared military threats. This paper's central finding is that the test has produced real strain, but not failure. NATO and Quad are both adjusting to a security environment shaped as much by supply chains as by traditional military planning, and this adjustment, while incomplete, shows that alliance cohesion can extend into new areas of cooperation without simply breaking apart under new economic pressure.

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