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論文

張凱銘

「威脅平衡」視角下的美國對中國海底電纜競爭戰略趨向探析

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The Laos-China Railway and Lessons for the Vietnam North - South High-Speed Railway Project

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衡諸 21 世紀國防事務發展趨勢，為整合國防政策之專業研究能量，拓展國際交流合作，以提升整體國防思維，建構符合國家發展、最適資源配置之政策建議，國防部參酌各先進國家國防智庫運作與發展經驗，捐助設立「財團法人國防安全研究院」，並發行本刊。本院設立宗旨：

一、增進國防安全研究與分析。
二、提供專業政策資訊與諮詢。
三、拓展國防事務交流與合作。
四、促進國際戰略溝通與對話。

本刊《戰略與評估》係財團法人國防安全研究院發行之綜合性政策研究期刊，《戰略與評估》以探討國防事務、區域安全情勢及戰略研究等議題為宗旨，意在提供機關領域專家與學者之專業交流平台，提升我國國防安全研究能量。本刊歡迎各界之學者、專家踴躍投稿。

稿約

一、《戰略與評估》（以下簡稱本刊）為具雙向匿名審查機制之國防政策綜合性專業期刊，凡符合國防事務、國際安全情勢、戰略研究、中共軍事、國防科技等主題之文稿，竭誠歡迎投稿。
二、本刊為定期出版之期刊，每年至少發行一期，歡迎各界針對相關主題踴躍投稿。
三、請勿一稿兩投，來稿請依本刊撰稿規範撰寫，不符合者，本刊有權退回要求修改後再予受理。
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「威脅平衡」視角下的美國對中國海底電纜競爭戰略趨向探析*

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摘　要

海底電纜作為支撐全球數據傳輸與網際網路運作的關鍵基礎設施，因與各國政務運作、經濟民生及國防安全密切相關而具高度戰略價值。隨著跨國纜線網絡的興建、管理及維護日益牽動國家安全及地緣政治競爭，海纜議題逐漸成為當代國際政治中的新興外交課題。美國和中國近年除於國際海纜建案中相互競爭，也密切關注彼此海纜建設技術及攻防能力發展趨向，圍繞海底電纜展開的角力態勢日趨顯著。本文以美國政府近年於海纜領域針對中國的競爭舉措和戰略規劃為研究主題，結合國際關係學界的「威脅平衡」理論進行分析，藉以探討傳統國際關係理論應用於新興資訊基礎設施議題的可能性、中國在海纜領域是否構成對美國的安全威脅，以及美國對中海纜政策是否反映威脅平衡邏輯等問題。研究結果顯示，中國近年的海纜能力建設、國際建案參與及相關技術發展，已逐漸引發美國政府的威脅感知，促使華府當局兼採強化行政管制、提升海底戰力、聯合盟邦抵制中國海纜企業，以及推動國際海纜治理規範等措施加以因應。相關作為分別映現「內部平衡」、「外部平衡」及其他新型平衡策略的運作邏輯，顯示海底電纜已逐漸由資訊基礎設施轉化為大國戰略競爭的重要場域。

關鍵詞：美中關係、海底電纜、關鍵資訊基礎設施、威脅平衡

* 本文為國家科學及技術委員會專題研究計畫（NSTC 114-2410-H-025-013）之部份研究成果，謹此致謝。

An Analysis of Strategic Trends in U.S. Undersea Cable Competition against China from a Balance of Threat Perspective

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Abstract

As a critical infrastructure supporting global data transmission and the operation of the Internet, undersea cables possess significant strategic value due to their close connection with governmental operations, economic activities, and national security. As the construction, management, and maintenance of transnational cable networks increasingly affect national security and geopolitical competition, undersea cable issues have gradually emerged as a new diplomatic concern in contemporary international politics. In recent years, the United States and China have not only competed over international undersea cable projects, but have also closely monitored each other's technological development and offensive and defensive capabilities in the undersea cable domain, making strategic rivalry surrounding undersea cables increasingly pronounced. This study examines the competitive measures and strategic planning undertaken by the United States against China in the undersea cable sector in recent years through the lens of the Balance of Threat theory. It explores the applicability of traditional international relations theory to emerging information infrastructure issues, whether China's activities in the undersea cable domain constitute a security threat to the United States, and whether U.S. policies toward China in this area reflect a balance of threat logic. The findings indicate that China's expanding undersea cable capabilities, participation in international cable

projects, and related technological development have gradually heightened threat perceptions within the U.S. government, prompting Washington to adopt measures such as strengthening administrative controls, enhancing undersea warfare capabilities, coordinating with allies to restrict Chinese cable companies, and promoting international governance norms for undersea cables. These actions reflect the operation of internal balancing, external balancing, and other emerging balancing strategies, demonstrating that undersea cables are gradually transforming from information infrastructure into an important arena of great-power strategic competition.

Keywords: *U.S.–China Relations, Undersea Cables, Critical Information Infrastructure, Balance of Threat Theory*

壹、前言：近代國際關係中的海底電纜議題

1990 年代後期以來迅速演進的資訊科技，歷經多次技術創新突破，已成為支撐當代人類文明運作發展的關鍵動力。今日各國的政務治理、經濟產業、國防戰備，乃至於民生日常活動，無不深切依賴網路服務。大眾對網路科技的理解，往往因其與「虛擬」、「無國界」、「行動」等語彙相連結，形塑出一種輕盈、迅捷且高度流動的想像。然而，這種想像很大程度上遮蔽了網路運作高度仰賴的物質基礎。事實上，串接全球通訊的網路體系，是由眾多具體存在、規模龐大且高度集中化的硬體設施交錯支撐而成，包括跨越陸地和海域的通訊纜線、分布各地的資料中心，以及通訊衛星及其地面控制站等。這些實體基礎設施對於網路服務的穩定運作至為關鍵，既有關於資訊科技政經意涵的討論，多聚焦於技術應用影響或法規監管問題，對於資訊基礎設施本身蘊含的權力結構與安全意涵，則相對缺乏系統性分析。[1]

各類資訊基礎設施中，海底電纜（下文簡稱海纜）可能是最具國際關係研究價值的項目之一。首先，就規模與功能而言，全球海纜總量截至 2025 年已達約 570 條，另有 81 條仍在規劃或建造之中，這些纜線網絡承載了全球高達九成以上的跨國資料流通，構成現代國家推動科技研發、數位治理和民生網路應用的物質基底。[2]其次，海纜的鋪設營運往往超越國界，橫跨多個主權管轄區，甚至途經如南海等存在領土爭議的海域，使其無可避免地與外交折衝、海權競逐和地緣政治格局交織連動。最後，隨著各國對網路服務的依賴程度日益加深，海纜逐漸被視為脆弱且極富戰略價值的標的，一旦因事故或人為破壞而中斷，將對國家日常運作、社會安定及防務效能造成嚴重衝擊；因此在高度對抗的國際衝突情境中，攻擊他國海纜設施將被視為削弱對手的可行手段。正因如此，海纜議題已成為當代國家擘劃國家安全與國防戰略時難以忽視的重要面向。

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[1] Richard Maxwell and Toby Miller, “Greening Media Studies,” in Richard Maxwell, Jon Raundalen and Nina Lager Vestberg eds., *Media and the Ecological Crisis* (New York: Routledge, 2014), pp. 88-98.

[2] Lionel Carter, et al., *Submarine Cables and the Oceans: Connecting the World* (Cambridge, UK: UNEP World Conservation Monitoring Centre, 2009), p. 8; Lane Burdette, “How Many Submarine Cables are There, Anyway?” *TeleGeography*, February 27, 2025, https://blog.telegeography.com/how-many-submarine-cables-are-there-anyway.

事實上，海纜與戰略安全議題的連結並非新興現象，而是早已存在於近代國際關係的歷史經驗之中。自十九世紀末起，海纜設施便屢屢在國際衝突中成為各國攻防目標。舉例而言，1898 年美西戰爭期間，美軍即透過切斷菲律賓周邊海纜網絡，成功打擊西班牙海軍的通訊和調度能力，進而影響戰局發展。[3]第一次世界大戰中，英國與德國在大西洋地區相互攻擊並監聽對方的海纜線路以爭奪情報優勢；[4]第二次世界大戰期間，英國切斷德國的跨大西洋海纜，並和日本於太平洋戰區交相攻擊彼此的海纜設施。[5]冷戰時期，海纜更成為美蘇從事長期且隱蔽的情蒐行動標的，例如美國海軍（U.S. Navy）曾與中央情報局（Central Intelligence Agency, CIA）及國家安全局（National Security Agency, NSA）合作發起「常春藤之鈴行動」（Operation Ivy Bells），對蘇聯海纜進行近十年的秘密監聽。[6]即使在冷戰結束後，這類經由海纜獲取情資的國家行動亦未消失，反有更具規模且更精密的現象（請見表 1）。2013 年由美國國家安全局承包商員工史諾登（Edward J. Snowden）揭露的「稜鏡計畫」（PRISM Program），便呈現了美國政府如何利用監聽海纜，長期蒐集包含多個歐洲盟邦在內的機敏情報。[7]直至近年，國際社會中仍不乏疑似強權國家試圖破壞、滲透或控制他國海纜的事例，顯示海纜設施始終是高度敏感且具戰略意義的關鍵存在。[8]

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[3] George O. Squier, “The Influence of Submarine Cables upon Military and Naval Supremacy,” *National Geographic*, Vol. 12, No. 1, January 1901, pp. 1-12.

[4] Gordon Corera, “How Britain Pioneered Cable-cutting in World War One,” *BBC News*, December 16, 2017, https://www.bbc.com/news/world-europe-42367551.

[5] Andrew Boyd, “The Security of Subsea Cables: An Enduring Naval Challenge,” *Maritime Foundation*, December 1, 2022, https://www.maritimefoundation.uk/publications/maritime-2023/the-security-of-subsea-cables-an-enduring-naval-challenge/.

[6] Marcia Wendorf, “Operation Ivy Bells: The U.S. Top-Secret Program that Wiretapped a Soviet Undersea Cable,” *Interesting Engineering*, January 3, 2022, https://interestingengineering.com/innovation/operation-ivy-bells-the-us-top-secret-program-that-wiretapped-a-soviet-undersea-cable.

[7] Craig Timberg, “NSA Slide Shows Surveillance of Undersea Cables,” *The Washington Post*, July 10, 2013, https://www.washingtonpost.com/business/economy/the-nsa-slide-you-havent-seen/2013/07/10/32801426-e8e6-11e2-aa9f-c03a72e2d342_story.html.

[8] 請參考：John Mooney, “Russian Agents Plunge to New Ocean Depths in Ireland to Crack Transatlantic Cables,” *The Times*, February 16, 2020, https://www.thetimes.com/article/russian-agents-plunge-to-new-ocean-depths-in-ireland-to-crack-transatlantic-cables- fnqsmgncz; Jon Henley, “Denmark Helped US Spy on Angela Merkel and European Allies

表 1、近年國際間海纜線路遭人為破壞與滲透事例概覽

日期	事件概述
2020 年 2 月	英國媒體《泰晤士報》（*The Times*）揭露俄羅斯派駐歐洲各國的情報人員似正協力探尋歐洲地區海纜系統的脆弱環節，作為後續發起竊聽和攻擊行動的標的。
2021 年 5 月	丹麥媒體「丹麥廣播公司」（Danmarks Radio）揭露美國國家安全局透過丹麥海纜竊取歐洲多國政府高層通訊資料。
2021 年 11 月	挪威「海洋研究所」（Institute of Marine Research）表示該國北部海域海纜疑似遭到俄羅斯軍艦破壞，導致海域內佈置的感測系統及周邊地區通訊運作中斷。
2022 年 1 月	連接挪威本土與斯瓦爾巴群島（Svalbard Archipelago）的海纜線路疑似遭俄羅斯軍艦破壞致通訊中斷。
2023 年 2 月	連接臺灣本島與馬祖的臺馬 2 號海纜和臺馬 3 號海纜分別於 2 月 2 日與 2 月 8 日遭中國漁船及貨輪破壞，導致馬祖地區通訊中斷。
2024 年 11 月	中國貨輪「伊鵬 3 號」（Yi Peng 3）疑似刻意破壞波羅的海兩條海纜線路，瑞典與丹麥政府啟動調查並扣留該船艦。

資料來源：作者整理自 John Mooney, “Russian Agents Plunge to New Ocean Depths in Ireland to Crack Transatlantic Cables,” *The Times*, February 16, 2020, https://www.thetimes.com/article/russian-agents-plunge-to-new-ocean-depths-in-ireland-to-crack-transatlantic-cables-fnqsmgncz; Jon Henley, “Denmark Helped US Spy on Angela Merkel and European Allies - Report,” *The Guardian*, May 31, 2021, https://www.theguardian.com/world/2021/may/31/denmark-helped-us-spy-on-angela-merkel-and-european-allies-report; Thomas Newdick, “Norwegian Undersea Surveillance Network Had Its Cables Mysteriously Cut,” *The Warzone*, November 11, 2021, https://www.twz.com/43094/

- Report,” *The Guardi*an, May 31, 2021, https://www.theguardian.com/world/2021/may/31/denmark-helped-us-spy-on-angela-merkel-and-european-allies-report; Thomas Newdick, “Norwegian Undersea Surveillance Network Had Its Cables Mysteriously Cut,” *The Warzone*, No*vember 11,* 20*21, https://ww*w.t*wz.com/43*0*94/norwegia*n-undersea-surveillance-network-had-its-cables-mysteriously-cut.

norwegian-undersea-surveillance-network-had-its-cables-mysteriously-cut; Thomas Newdick, "Undersea Cable Connecting Norway with Arctic Satellite Station has been Mysteriously Severed," *The Warzone*, January 11, 2022, https://www. twz.com/43828/undersea-cable-connecting-norway-with-arctic-satellite-station-has-been-mysteriously-severed; 蘇思云，〈台馬海纜中斷，NCC：初判皆被中國籍船損害〉，《中央社》，2023 年 2 月 17 日，https://www.cna. com.tw/news/aipl/202302170039.aspx；Bojan Pancevski, "Chinese Ship's Crew Suspected of Deliberately Dragging Anchor for 100 Miles to Cut Baltic Cables," *The Wall Street Journal*, November 29, 2024, https://www.wsj.com/world/europe/chinese-ship-suspected-of-deliberately-dragging-anchor-for-100-miles-to-cut-baltic-cables-395f65d1。

承上所述，可發現海纜建設對現代國家而言兼具經濟發展、防務安全、創新研發與外交經略等多重價值。就經濟層面而言，海纜設施的興建、更新和營運，維繫著數據流通及跨國數位連結，構成國際經貿、金融交易與各類產業活動運作的基礎；就防務安全而言，海纜線路作為軍事通訊管道，不僅影響指揮調度，也關乎情報蒐集和機密資訊傳遞；就科技發展而言，人工智慧（Artificial Intelligence, AI）等新興技術對網路傳輸速度、規模及穩定性提出更高要求，使海纜擴建與升級成為技術進化重要條件；就外交經略而言，海纜作為經常跨越國界的基礎設施，其布建和管理長期缺乏完善國際規範，各國勢將透過外交協商及制度建構尋求拓展自身影響力。換言之，海纜雖看似為單純的硬體設施，實則是資訊科技、地緣政治及國家安全三者交會的重要場域，具有高度政策暨學術研究價值。

在此一背景下，國內外國際關係學界近年對海纜議題的關注逐漸增加。我國學界已有部分論著自戰略與外交視角討論海纜建設的重要性。[9]例如國立臺灣海洋大學海洋法政學士學位學程助理教授楊名豪等人的合著專書《海洋國家數位韌性：海底電纜遭中共侵擾凸顯關鍵數位基礎建設的戰略安全》指出，海纜通訊系統同時維繫軍事指揮與民生活動，面對中國近年頻繁干擾我國周邊海域，政府應積極強化纜線防護以提升

[9] 請參考：蔡堯欽，〈馬祖海底電纜中斷事件對我國防安全之影響〉，《國防安全雙週報》，第 81 期，2023 年 6 月，頁 81-85；王伊文，《海底電纜的安全化理論研究：以臺琉海纜與臺馬海纜為例》（台北：國立臺灣大學政治學系碩士學位論文，2024 年）。

數位韌性。[10]另有部分研究將海纜議題納入外交案例加以觀察，[11]例如國防安全研究院副研究員黃恩浩的論文〈太平洋地區強權競爭下的國際援助：以太平洋島國為例〉注意到，美國與中國近年於太平洋島國地區的外交經略，皆將海纜建設援助作為政策工具。[12]

西方與中國學界的相關研究更為豐富，其性質可大致分為三類：第一類研究著重論述海纜戰略價值，強調其與國家安全、經濟發展和權力地位密切相連。[13]例如美國智庫「戰略與預算評估中心」（Center for Strategic and Budgetary Assessments, CSBA）研究員馬丁納吉（Robert Martinage）於〈海底：公地的脆弱性〉（Under the Sea: The Vulnerability of the Commons）一文中指出，多數國家長期忽略海底電纜的脆弱性，一旦遭受敵國攻擊，將嚴重衝擊國家政經運作。[14]第二類研究聚焦個別國家的海纜能力發展及戰略布局，[15]例如美國智庫「太平洋論壇」（Pacific Forum）研究員海明斯（John Hemmings）的論文〈重塑秩序：中國數字絲綢之路的地緣政治風險〉（Reconstructing Order: The Geopolitical Risks in China's Digital Silk Road）提到，中國近年透過「帶路倡議」（Belt and Road Initiative, BRI）輸出海纜、衛星與通訊建設，藉此擴大對周邊地區

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[10] 林巧文、楊名豪等，《海洋國家數位韌性：海底電纜遭中共侵擾凸顯關鍵數位基礎建設的戰略安全》（臺北：臺灣智庫，2024 年）。

[11] 請參考：曾敏禎，〈美中的海底電纜爭奪戰：鹿死誰手？〉，《國防安全雙週報》，第 77 期，2023 年 4 月，頁 64-68；曾敏禎，〈美中「海纜戰」持續升溫－強化同盟與另起爐灶〉，《國防安全雙週報》，第 83 期，2023 年 7 月，頁 25-31。

[12] 黃恩浩，〈太平洋地區強權競爭下的國際援助：以太平洋島國為例〉，《國際開發援助現場季刊》，第 15 期，2024 年 3 月，頁 21-32。

[13] 請參考：Samuel Bashfield and Anthony Bergin, "Options for Safeguarding Undersea Critical Infrastructure," *Policy Options Paper*, No.25, June 2022, pp. 1-4; Daniel Runde, Erin Murphy, and Thomas Bryja, *Safeguarding Subsea Cables Protecting Cyber Infrastructure Amid Great Power Competition* (Washington, D.C.: Center for Strategic & International Studies, 2024); 謝永順、王成金，〈全球海底光纜網絡空間格局與戰略支點及通道的識別〉，《地理學報》，第 78 卷第 2 期，2023 年 2 月，頁 386-402。

[14] Robert Martinage, "Under the Sea: The Vulnerability of the Commons," *Foreign Affairs*, Vol. 94, No. 1, Special Entrepreneurship Issue, January-February 2015, pp. 117-126.

[15] 請參考：Raghvendra Kumar, "Securing the Digital Seabed: Countering China's Underwater Ambitions," *Journal of Indo-Pacific Affairs*, Vol. 6, No. 8, November 2023, pp. 74-90; Justin Sherman, "Beijing's Growing Influence on the Global Undersea Cable Network," *China Brief*, Vol. 21, No. 18, September 2024, pp. 21-26; 張景全、侯闖，〈全球深海基礎設施治理的現狀、挑戰與中國路徑〉，《太平洋學報》，第 32 卷第 4 期，2024 年 4 月，頁 74-88。

的政經影響。[16]第三類研究則注意到強權國家圍繞海纜設施的競爭趨勢，[17]例如「麻省理工學院安全研究計畫」（MIT Security Studies Program）副主任柯特（Owen R. Cote Jr.）於〈評估美國與中國間的海底平衡〉（Assessing the Undersea Balance between the United States and China）一文中指出，美中兩國近年均積極強化海底戰力，遍布全球的海纜線路正成為潛在攻防目標。[18]

綜覽現有研究成果，可從中察見兩項特徵。首先，既有論著較偏重政策描述與事實評論，結合國際關係理論進行系統性分析者相對有限。這導致觀察者固可藉由相關文獻理解各國海纜治理和政策動態，卻較難從理論面進一步掌握國家戰略意圖、政策目標及具體作為間的連貫邏輯。第二，各方學人除體認海纜設施的戰略價值，也注意到其於美中競逐背景下的角色。美國長年在海纜產業中居於領先地位，和同具先進技術能力的民主國家如日本和法國等，廣泛參與世界各地的纜線建設營運。然而中國自 1990 年代以來逐步成長為新興海纜大國，積極介入眾多跨國纜線建案，國際間也陸續出現多起中國船舶疑似破壞他國海纜的爭議事件。相關發展引起美國政府疑慮，導致海纜建設和管理逐漸成為美中關係的重要新興議題。

為求深入認識前述態勢，本文嘗試援引國際關係學界的「威脅平衡」理論（Balance of Threat Theory）進行分析。下文將介紹「威脅平衡」理論要旨，隨後回顧中國在海纜領域的崛起歷程與國際動向，進而分析其發展成就是否構成對美威脅，以及華府當局近年在海纜領域的行政管制、戰力建構、國際合作和制度規範等施政作為，是否反映針對中國的平衡意圖，並嘗試評估相關政策舉措的成效及影響。

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[16] John Hemmings, “Reconstructing Order: The Geopolitical Risks in China’s Digital Silk Road,” *Asia Policy*, Vol. 15, No. 1, January 2020, pp. 5-22.

[17] 請參考：Romain Dufetre, *The Data Roads under the Seas: American Hegemony over the Global Undersea Cable Network and its Potential Challengers* (Chicago, IL: The University of Chicago, PhD Dissertation, 2023); Brendon J. Cannon, “Undersea Cable Security in the Indo-Pacific: Enhancing the Quad’s Collaborative Approach,” *Marine Policy*, No. 171, October 2024, pp. 1-6; 武瓊，〈深入海底：中美兩國在海纜領域的戰略競爭〉，《新疆社會科學（漢文版）》，2021 年第 1 期，2021 年 5 月，頁 71-80。

[18] Owen R. Cote Jr., “Assessing the Undersea Balance between the United States and China,” in Thomas Mahnken ed., *Competitive Strategies for the 21st Century: Theory, History, and Practice* (Stanford, CA: Stanford University Press, 2012), pp. 184-205.

貳、「威脅平衡」理論的分析架構

國際關係理論研究歷經多次大型學術論戰帶動的思辯與統合後，於冷戰中後期逐漸形成「新現實主義」（Neo-realism）、「新自由主義」（Neo-liberalism）與「建構主義」（Constructivism）三大學派並立的格局。相關研究在「理性主義」（Rationalism）和「國家中心論」（State-centric Theory）等共同基礎之上，分別從權力、制度及認知等不同視角，理解國際體系本質與國家行動邏輯。其中，以無政府狀態（Anarchy）下的國家安全問題為核心關懷的「新現實主義」學派，進一步衍生出廣為人知的「權力平衡」理論（Balance of Power Theory），作為解析外交政策的重要工具。該理論指出，由於國際間欠缺可穩固維繫秩序及和平的超國家權威，理性的國家行為體勢必遵奉自助（Self-help）原則，視自身安全和生存保障為優先考量，審慎關注外部環境變化；當國際體系中的權力分布出現顯著失衡，特定國家累積過多權力時，其餘國家往往會採取相應行動設法制約，以免自身安全蒙受不利影響。相關作為可大致區分為兩種類型：一是著重提升本國實力，特別是防務能力的「內部平衡」（Internal Balancing）策略，二是藉由跨國結盟抵制對手的「外部平衡」（External Balancing）策略。[19]

由於「權力平衡」理論簡明清晰且具高度可操作性，長年來廣為各方研究者應用於學術論析與政策評估。部份學人更透過對該理論的省思、修正和延伸，探尋學理創新可能，其中以哈佛大學（Harvard University）教授華特（Stephen M. Walt）提出的「威脅平衡」理論尤具代表性。華特注意到當「權力平衡」理論應用於解釋若干歷史及當代案例時，偶爾會出現難以完全對應的異常現象。例如 1930 至 1940 年代間的德國，整體國力雖非歐陸地區最為強大者，卻引發多國聯手強力平衡；相對地，美國自 1980 年代以來逐步奠立實力卓絕的全球強權地位，國際體系中卻未曾形成訴求制約美國的廣泛同盟陣線，主要國家亦未出現積極擴軍對抗美國的情況。華特據此推論，促使國家採取平衡作為的動因，並不是特定國家掌握的權力總量，而是其對他國構成威脅程度的高低。若將觀察焦點自權力分布轉向安全威脅，前述異常事例便能獲得合理解釋：納粹黨（Nazi Party）執政下的德國儘管實力有限，卻因奉行擴

[19] Kenneth N. Waltz, *Theory of International Politics* (New York: McGraw-Hill, 1979), pp. 116-168.

張政策而遭他國視作重大威脅，進而觸發顯著平衡反應；冷戰晚期以降的美國雖擁有強大國力，卻在外交中展現自我克制且大致遵循國際規範的姿態，因此未為多數國家認定為必須平衡的威脅。[20]

「威脅平衡」理論大致承襲了「權力平衡」理論的研究基礎，將國家界定為國際體系中主要的理性行為體，優先關注自身在無政府狀態下的安全生存，必要時將採取行動平衡對手。然而該理論指出，驅使國家平衡他國的主要動因並不是對方持有的權力多少，而是其有無對本國造成威脅。為進一步釐清威脅的實質內容，華特提出四項具體構成要件（請見圖 1）：其一為總體實力（Aggregate Power），用於綜合評估一國整體國力，包含人口規模、國土面積與經濟能力等條件；其二為進攻實力（Offensive Power），體現國家發起軍事行動和侵略他國的能力，常見指標如軍隊規模、戰備水準及防務部署等；其三為地理鄰近性（Geographic Proximity），鑑於地理距離牽動軍力投射成本與難易程度，距離越接近的國家，越可能被視為潛在威脅；其四為侵略意圖（Aggressive Intentions），意指他國對於目標國家是否抱持對外侵略企圖的感知。華特認為四項構成要件中，地理距離及物質性的總體實力和進攻實力固然各具重要性，但侵略意圖對於威脅成立與否的判斷影響尤鉅：一個物質力量突出甚至地理上接近他國的強大國家，若未對外展露侵略意圖，仍可能不被他國認定為安全威脅；反之，一國物質力量即便有限，若對外表現強烈擴張傾向，也可能使周邊國家認定其為迫切威脅。[21]

「威脅平衡」理論認為一旦國家確認他國構成威脅，將在自助理性驅動下衡量敵我條件與整體國際情勢，據以選擇相應的平衡策略。該理論對於平衡策略型態的論述，大抵延用「權力平衡」理論觀點，認為國家主要透過「內部平衡」和「外部平衡」策略制約對手。[22]但華特也在後續研究中注意到，身處全球化（Globalization）時代互賴網絡中的現代國家，有可能選擇使用其他更為間接隱蔽的平衡策略；例如藉由消極抵制「妨礙」（Balking）對手外交施政、藉由機制或規範建設的作法「約束」（Binding）對手行動自由、藉由修訂或創設國際法規為對手的外交政策創造「去合法性」（Delegitimation）效果，以及藉由從事對手不樂見

[20] Stephen M. Walt, *The Origins of Alliances* (New York: Cornell University, 1987), pp. 263-266.
[21] Ibid., pp. 22-28.
[22] Ibid., pp. 5-6.

事項而「勒索」（Blackmail）其改變政策方針等。相較於傳統內外部平衡策略，這類新興策略雖然強度有限，但型態更為多元靈活，操作上也更能對應利害交錯的複雜情境。[23]

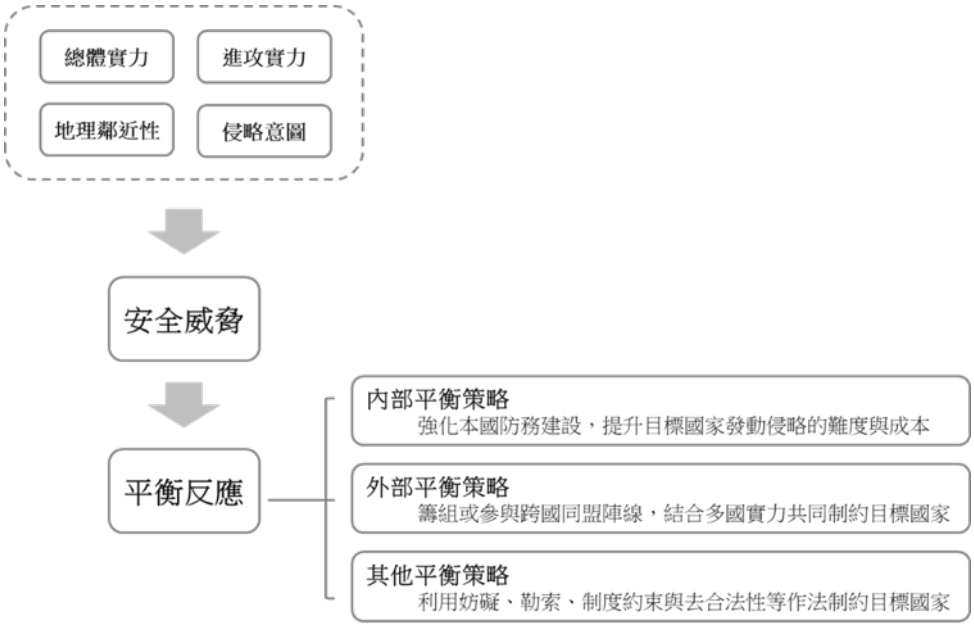

圖 1、灰色地帶衝突的態樣「威脅平衡」理論內容示意圖

資料來源：作者自行繪製。

「威脅平衡」理論在傳統研究的基礎上進行改良，透過因應威脅的視角，將物質力量、地理距離與意圖研判等多重要件納入評估範疇，同時於內外部平衡策略之外，洞見其他可能的策略選項，分自動因和策略層面完善了「平衡理論」的內涵，對於現代國家外交活動更具解釋力。近年來，美中關係在美國擴大介入西太平洋一帶和中國國力持續增長等趨勢交互影響下日益緊張，華府當局看待中國的視角映射出明顯的威脅感知（Threat Perception），例如於《印度－太平洋戰略報告》（*Indo-Pacific Strategy 2022*）中警示中國是美國在印度－太平洋地區（Indo-Pacific region，下簡稱印太地區）的首要競爭者，運用多元力量設法削弱美國，

[23] Stephen M. Walt, *Taming American Power: The Global Response to U.S. Primacy* (New York: W. W. Norton, 2005), pp. 109-178.

並在各地脅迫及侵略（Coercion and Aggression）他國；[24]或是於《國家防衛戰略》（National Defense Strategy 2026）中宣示美國將以實力遏制中國對區域安全及國際秩序造成的挑戰。[25]循此脈絡，可推論美國就各項政策議題的對中互動或皆不免蘊含「回應威脅」思路。本文因而選擇運用「威脅平衡」理論分析美國在海纜領域的對中競爭態勢，期望藉由理論輔助深入認識中國在該領域的成就及活動是否已構成對美國的安全威脅，以及美國政府近年相關施政中體現的平衡策略意涵。

參、中國在海纜領域的對美威脅態勢概覽

自全球反恐戰事於 2010 年後逐步收束以來，美國政府逐步重振於西太平洋一帶的戰略存在，密切關注中國在周邊地區的活動趨向。歷經川普（Donald J. Trump）政府與拜登（Joseph R. Biden Jr.）政府交替執政，阻遏中國勢力擴張不但成為美國國內跨越黨派的穩固共識，更是其國際戰略規劃主軸。概言之，當前美中關係雖仍存有傳統的競合並存特質，但競爭一端比重明顯高於過往，所涵括的政策面向亦由傳統的軍事和貿易抗衡，延伸至各類新興科技的開發運用。雙方除爭相投入人工智慧、量子計算（Quantum Computing）等關鍵技術研發以爭奪領先地位，更在資安攻防能力及國際網路規範制定等議題上相互較勁。其中海纜建設作為資訊科技運作的物質基礎，美國對中國在該領域的發展深為關切，相關施政也隱然映現抗衡意志，為瞭解這一情形的成因，下文援引「威脅平衡」理論框架，審視中國如何在海纜領域構成對美威脅。

「威脅平衡」理論主張國家平衡他國的主要動因是認知其對自身造成威脅，而威脅主要是由總體實力、進攻實力、地理鄰近性和侵略意圖四者共同形塑。鑑於該理論原係用以解釋國家間整體互動，而非針對單一政策領域，本文運用於分析美中海纜相競事例時，有必要適度微調威脅構成要件的界定，以免分析視角有所偏誤。首先，由於本文以海纜競爭為研究主題，對總體實力的觀察將以國家海纜建設能力為主要指標，諸如國家有無掌握鋪設海纜線路的技術與周邊設備，是否具備營運、監管和維修海纜的能力等項目皆是評估重點。其次，考慮海纜所處空間特

[24] The White House, *Indo-Pacific Strategy* (Washington, D.C.: The White House, 2022), p. 5.

[25] U.S. Department of War, *National Defense Strategy 2026* (Washington, D.C.: US Department of War, 2026), pp. 9-10.

質，國家的海底戰力及纜線破壞能力將是判斷其是否具備進攻實力的主要依據。再次，海纜線路可能長達數百公里並連接相距甚遠的國家，這種遠程連結特徵導致地理鄰近性要件的作用在本研究中較為模糊，地理距離的緩衝功能於此明顯受限。最後，為推論國家是否感知他國在海纜領域的侵略意圖，除查閱該國針對總體外交關係發表的政策文件與領導人發言等一般資訊，和海纜設施相關的專門法案及技術報告資料亦是重要參考依據。根據前述調整，可將中國在海纜領域的對美威脅態勢彙整如下。

一、總體實力

由於海纜建設對資本和技術能力要求甚高，相關工程早期多由美國、日本、法國等少數已開發國家把持。中國自 1989 年後方正式參與聯外海纜建設，首條共同投資興建的中日海底光纖電纜（China-Japan Fiber-Optic Submarine Cable System）於 1993 年 12 月建成，另一中韓海底光纖電纜（China-Korea Fiber-Optic Submarine Cable System）於 1996 年 2 月完工，而 1997 年 9 月啟動的環球海底光纖電纜歐亞段（FLAG Europe Asia）則是第一條中國參與並完成登陸的洲際海纜工程。[26]此後，中國乘經濟增長和網路普及之勢全面擴大建造聯外海纜（請見圖 2），國內海纜產業體系自此迅速成長，出現眾多製作各類纜線設備的廠商，更造就如「華海通信」（HMN Technologies，原稱「華為海洋」）這類兼具海纜設計、建造與營運能力的大型企業，成為足以和美日法並立的海纜大國，在此領域具備充足的總體實力。[27]

二、進攻實力

中國在過往數十年間逐步由傳統陸權大國轉型為陸海並重的軍事強權，在關涉海纜線路安全的海底軍力建設方面頗見成就。首先，解放軍海軍近年不僅積極建造各類水上戰艦，也致力發展以潛艦為主體的水下戰力。美國國防部 2025 年公布的《關於中華人民共和國的軍事和安全發展》（*Military and Security Developments Involving the People's*

[26] Yongshun Xie and Chengjin Wang, "Vulnerability of Submarine Cable Network of Mainland China: Comparison of Vulnerability between before and after Construction of Trans-Arctic Cable System," *Complexity*, Vol. 2021, No. 1, January 2021, p. 4.

[27] Sameer Patil and Prithvi Gupta, "The Digital Silk Road in the Indo-Pacific: Mapping China's Vision for Global Tech Expansion," *Observer Research Foundation Issue Brief*, No. 683, January 2024, pp. 10-14.

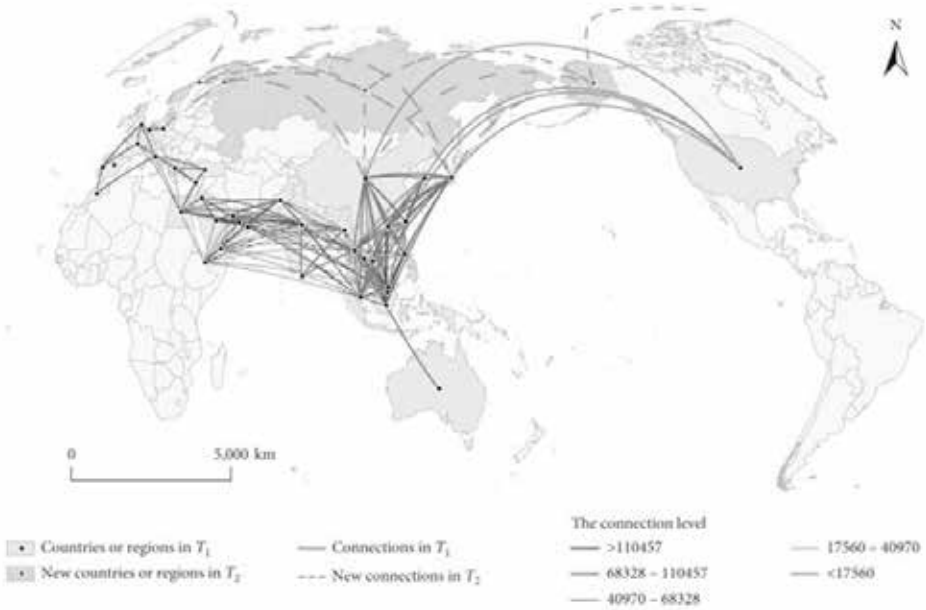

圖 2、中國聯外海纜網絡形勢概貌

資料來源：Yongshun Xie and Chengjin Wang, "Vulnerability of Submarine Cable Network of Mainland China: Comparison of Vulnerability between before and after Construction of Trans-Arctic Cable System," *Complexity*, Vol. 2021, No. 1, January 2021, p. 5。

Republic of China）報告指出，中國現有 46 艘傳統動力潛艦與 12 艘核動力潛艦，考慮到解放軍對海洋戰力的重視及中國船舶工業的充沛產能，艦隊規模在可預見未來中料將持續擴大，[28]這意味著中國在海底空間發起攻擊行動的能力將隨之強化。

其次，中國近年也持續探索海纜攻防創新技術。舉例而言，中國於 2002 年進行了首次大規模光纖水聽器測試，並在 2014 年度國際防務電子展中公開展示岸基光纖水聽器陣列，展現整合軍民資源強化纜線通訊

[28] U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2025* (Washington, D.C.: U.S. Department of Defense, 2025), pp. 56, 70.

監聽能力的企圖；[29]解放軍於 2015 年 3 月時為舟山警備區船運大隊配置首艘具備鋪設、維修及監控海底纜線等功能的新型布纜船。[30]此外，「中國船舶重工集團」轄下的「中國船舶科學研究中心」在 2025 年 2 月公開其研發的深海電纜切割器，該設備可搭配無人潛水載具進入深達 4,000 公尺的海底精準切割纜線，被認為兼具工業及軍事用途。[31]上述資訊顯示，中國在海纜領域確實持有相當的進攻實力，足以對他國的纜線安全構成挑戰。

三、地理鄰近性

中國雖與美國本土相距遙遠，但其周邊海域卻是印太地區海纜網絡最為密集之處，除直接對連兩國的長程纜線外，亦涵蓋多數美國印太友邦和前沿基地所仰賴的通訊線路（如圖 2 所示）。考慮到海纜的跨國連結特性，及其鋪設範圍遍佈公海和各國沿岸海域的情形，地理距離無法為相關設施創造有效的安全屏障。此外，破壞海纜無需動用大規模軍力，中國現有約 1 萬 7 千艘長期於世界各地海域活動的遠洋漁船，只要配備電纜切割器等設備，即可轉化為潛在的纜線攻擊平臺，[32]進一步削弱地理距離緩衝效果。基於前述考量，地理鄰近性要件在海纜議題中的限制作用顯著受限，無法有效阻絕中國危害他國海纜安全的風險。

四、侵略意圖

伴隨中國在海纜領域的逐步崛起，美國政府不僅日益重視海纜設施對國家安全的影響，也持續關注中國相關活動可能衍生的挑戰。例如，美國國土安全部（U.S. Department of Homeland Security）與國家情報總

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[29]〈光纖水聽器：5 家核心公司 國內 1500 億市場靜待爆發〉，《網易新聞》，2023 年 2 月 10 日，https://www.163.com/dy/article/HT7SAP0T05198KG9.html。

[30]〈中國陸軍新一代布纜船入列，填補海底作業空白〉，《中國評論新聞網》，2015 年 3 月 28 日，https://hk.crntt.com/doc/1036/8/6/8/103686890.html?coluid=91&kindid=2710&docid=103686890。

[31] Stephen Chen, "China Unveils a Powerful Deep-sea Cable Cutter that could Reset the World Order," *South China Morning Post*, March 22, 2025, https://www.scmp.com/news/china/science/article/3303246/china-unveils-powerful-deep-sea-cable-cutter-could-reset-world-order?module=perpetual_scroll_0&pgtype=article.

[32] Miren Gutiérrez, et al., *China's Distant-water Fishing Fleet: Scale, Impact and Governance* (London: ODI Global, 2020), pp. 18-19; 陳彥名、提姆・波爾、柯喬譯，〈中共影子船隊對臺海底電纜的破壞〉，《國防雜誌》，第 40 卷第 4 期，2025 年 12 月，頁 86-87。

監辦公室（Office of the Director of National Intelligence）2017 年 9 月聯名發表了名為《海底電纜通訊威脅》（*Threats to Undersea Cable Communications*）的評估報告，首度從國家安全視角審視海纜設施的戰略意義，警示惡意行為者（Malicious Actor）可能透過破壞電纜製造政經混亂和社會癱瘓效應，或是藉由監聽纜線蒐集他國情資並滲透網路系統。[33]

白宮於 2020 年 12 月公布的《國家海洋網路安全計畫》（*National Maritime Cybersecurity Plan*）亦指出，中國的網路間諜活動持續威脅美國經濟、國防與關鍵基礎設施安全，要求國土安全部、海岸防衛隊（U.S. Coast Guard, USCG）、聯邦調查局（Federal Bureau of Investigation, FBI）及網路安全暨基礎設施安全局（Cybersecurity and Infrastructure Security Agency, CISA）等單位協力檢討「海洋關鍵基礎設施」（Maritime Critical Infrastructure）的資安防護狀態，同時和盟邦及產業部門建立合作機制。[34]

此外，美國國防部近年發表的多份政策報告均對中國利用「數字絲綢之路」（Digital Silk Road, DSR）倡議擴大纜線設備出口及參與海外海纜工程的趨勢表達關切，認為北京當局有意藉此強化資訊科技產業並拓展地緣政治影響。[35]美國國會研究處（Congressional Research Service, CRS）於 2022 年發表《海底通訊電纜：技術概覽及國會議題》（*Undersea Telecommunication Cables: Technology Overview and Issues for Congress*）報告，亦討論了海纜設施遭中國等競爭對手惡意破壞的風險，建議行政

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[33] U.S. Department of Homeland Security and U.S. Office of the Director of National Intelligence, *Threats to Undersea Cable Communications* (Washington, D.C.: U.S. Department of Homeland Security and U.S. Office of the Director of National Intelligence, 2017), p. 22.

[34] The White House, *National Maritime Cybersecurity Plan* (Washington, D.C.: The White House, 2020), pp. 7-8.

[35] 請見：U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2020* (Washington, D.C.: U.S. Department of Defense, 2020), pp. 15-16; U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2021* (Washington, D.C.: U.S. Department of Defense, 2021), pp. 20-21; U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2022* (Washington, D.C.: U.S. Department of Defense, 2022), pp. 25-26; U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2023* (Washington, D.C.: U.S. Department of Defense, 2023), pp. 25-27.

部門加強防禦並嚴審跨國纜線工程申請。[36]該機構隔年發表的後續研究，則進一步說明海纜防護對國家安全及民生經濟的重要性，同時援引「北溪」（Nord Stream）管線爆炸事件，強調海底基礎設施遭受惡意攻擊的可能性確實存在。[37]

各項政策文件與研究成果顯示，在美中關係漸趨緊張的宏觀背景下，美國決策圈普遍視中國於海纜領域的發展態勢為安全挑戰，憂慮中國政府可能運用相關技術能力從事情報蒐集、破壞美國與盟友的纜線通訊，或透過參與國際海纜建設增進外交影響力。另一方面，近年國際間陸續出現中國船艦涉入海纜破壞事件的案例，例如我國離島海纜遭中國船隻損壞，以及波羅的海海纜疑遭中國商船刻意切斷等事件，均使相關疑慮更形具體。此類事件雖仍有釐清空間，但已和美國對中國海纜活動可能蘊含侵略意圖的研判相互映照。概言之，威脅感知與現實案例的對應，使海纜安全逐漸成為美國國安政策規劃中備受關切的重要議題。

綜合前述分析可知，對於美國而言，中國在海纜領域已逐步具備各項威脅構成要件。就總體實力而言，中國已擁有完整的海纜產業體系，並在全球市場中占有重要地位；就進攻實力而言，解放軍的海底戰力建構和纜線監聽及破壞技術研發，使其具備危害他國海底通訊安全的能力；就地理鄰近性而言，中國周邊海域匯聚印太主要海纜網絡，加以民用船舶高度流動且可轉化為攻擊平臺的特性，使地理距離難以作為防護；就侵略意圖而言，美國政策文件評估與近年爭議事件形塑的威脅感知，亦顯示華府當局已將中國的海纜相關動向視作安全挑戰。整體而言，依循「威脅平衡」理論分析架構，可察見中國在海纜領域對美國的威脅已然成形，促使美國政府採取平衡策略進行反制。

肆、美國對中海纜競爭的「威脅平衡」策略

面對中國在海纜領域逐漸成形的威脅態勢，美國政府近年與海纜相關的政策布局，亦映現回應威脅的連貫脈絡，一系列施政措施如強化海底防務能力、擴大與友盟國家間的技術和資源協調、阻撓中國企業對他國海纜建案的參與，以及積極介入國際海纜治理規範形塑進程。若

[36] Jill C. Gallagher, *Undersea Telecommunication Cables: Technology Overview and Issues for Congress* (Washington, D.C.: Congressional Research Service, 2022), pp. 13-21.
[37] Jill C. Gallagher, et al., *Protection of Undersea Telecommunication Cables: Issues for Congress* (Washington, D.C.: Congressional Research Service, 2023), pp. 6-8.

將相關作為置於「威脅平衡」理論視角之下觀察，可進一步辨識其中蘊含的「內部平衡」、「外部平衡」，以及其他新型平衡策略等特徵。對此，下文將分別檢視美國在對中海纜競爭中的各項平衡策略具體運作。

「內部平衡」策略意指國家經由自我完善、軍力擴建與調整部署等內部作為增強本國實力，俾有效回應外部安全威脅。美國政府的策略運用主要體現在「加強行政監管」和「建構海底攻防戰力」，設法消弭安全風險並維護本國通訊安全的相關努力之上。

在加強行政監管層面，自首任川普政府時期起，華府當局即對連結中國的海纜建設申請案採取謹慎看待、從嚴審查的立場。美國國務院（U.S. Department of State）隨後於 2020 年 8 月公布的擴大版「清潔網路計畫」（Clean Network Program）中，進一步將海纜納入監管範疇，凸顯其對國家安全的重要性。[38]舉例而言，由社群媒體「臉書」（Facebook）母公司「元宇宙平臺」（Meta Platforms）和搜尋引擎「谷歌」（Google）母公司「字母控股」（Alphabet）等大型科技企業共同參與的「太平洋光纖電纜」（Pacific Light Cable Network, PLCN）建設案，即因原始規劃將香港納入鋪設路徑，並意圖邀請中國企業共同投資，引發美國政府有關資安恐遭危害及關鍵技術外流等疑慮，最終在 2020 年時遭到司法部（U.S. Department of Justice）認定具有國安風險，從而未能獲得聯邦通訊委員會（Federal Communications Commission, FCC）完整核准。[39]拜登政府於 2021 年就任後，經確認該建案已修改排除中國企業投資，同時取消香港路徑，改為對連我國和菲律賓後，方予以批准。[40]此過程顯示美國正透過行政程序嚴審牽涉中國的海纜建案，促使企業機構配合國安需求調整工程規劃與投資結構。

除嚴格管控本國海纜建設申請，美國政府對於美洲地區的海纜建案

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[38] "The Clean Network," *U.S. Department of State*, August 5, 2020, https://2017-2021.state.gov/the-clean-network/.

[39] "Team Telecom Recommends that the FCC Deny Pacific Light Cable Network System's Hong Kong Undersea Cable Connection to the United States," *U.S. Department of Justice*, June 17, 2020, https://www.justice.gov/opa/pr/team-telecom-recommends-fcc-deny-pacific-light-cable-network-system-s-hong-kong-undersea.

[40] Charles Mok, "Geopolitics Reshaping the Internet in East Asia," *Friedrich Naumann Foundation for Freedom*, June 15, 2022, https://www.freiheit.org/taiwan/geopolitics-reshaping-internet-east-asia.

也保持密切關注。當智利政府於 2025 年時與「中國移動通信」（China Mobile Communications Group, CMCC）合作啟動名為「智利—中國快線」（Chile-China Express, CCE）的跨太平洋海纜建設項目時，華府當局便公開表達反對，強調此將對區域資安造成不利影響。[41]美國國務院隨後以「削弱區域安全」（Undermining Regional Security）名義，宣布撤銷智利交通和電信部正副部長及顧問簽證，禁止三人及其直系親屬入境美國，作為施壓該國擱置建案的手段。[42]

美國國會亦就對中海纜競爭表露高度關切，眾議院外交委員會（House Foreign Affairs Committee）2023 年 2 月時即通過了跨黨派議員共同提出的《海底電纜管控法案》（*Undersea Cable Control Act*），要求總統統合國務院和商務部，共同制定一套總體戰略，阻止中國等外國敵對勢力（Foreign Adversaries）取得海纜建設關鍵技術，建議行政部門儘速盤點須加以保護的技術及產品清單，建立嚴密的進出口管制政策與違規懲罰條款、加強和友盟國家間在供應能力及生產標準方面的協調，同時密切關注中國等對手的海纜工程動向。該項法案確認了海纜線路與周邊設施並非單純商業產品，而是關乎國安的敏感資產，更勾勒出一套相對完整的監管方案，明確指出中國即是外國敵對勢力，展現相抗衡的強烈意志。[43]

2024 年 10 月，另有八位跨黨派參議員聯名致函白宮，警示美國的對手持續開發攻擊海底關鍵基礎設施的能力，已構成重大國安威脅，敦促總統領導行政部門全面檢視海纜設施防護，擴大資源投入、制定整體戰略，和值得信賴的盟邦及夥伴國家緊密合作，共同因應來自中國和俄羅斯的挑戰。[44]「美中經濟暨安全審查委員會」（U.S.-China Economic and

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41 Francisca Orellana, "U.S. Accuses Chile of Risking Regional Sovereignty over China Project," *United Press International*, February 24, 2026, https://www.upi.com/Top_News/World-News/2026/02/24/latam-chile-china-underseas-fiber-optic-project-US-warning/6911771950977/.

42 "Visa Restrictions on Chilean Nationals Undermining Regional Security," *U.S. Department of State*, February 20, 2026, https://www.state.gov/releases/office-of-the-spokesperson/2026/02/visa-restrictions-on-chilean-nationals-undermining-regional-security.

43 "H.R.1189 - Undersea Cable Control Act," *U.S. Congress*, February 28, 2023, https://www.congress.gov/bill/118th-congress/house-bill/1189.

44 David Shepardson, "Senators Seek Biden Administration Review of Undersea Cable Vulnerabilities," *Reuters*, October 23, 2024, https://www.reuters.com/world/us/senators-want-biden-administration-review-undersea-cable-vulnerabilities-2024-10-21/.

Security Review Commission, USCC）在 2025 年度報告中，也警示中國正將破壞他國海纜系統作為脅迫手段，呼籲政府儘速整合跨部門資源，加強纜線安全巡防及提升緊急修復能力。[45]

在建構海底攻防戰力層面，美國智庫「戰略與預算評估中心」（Center for Strategic and Budgetary Assessments, CSBA）於 2015 年發表的報告《海底作戰的新時代》（*The Emerging Era in Undersea Warfare*）率先提出防務建設指導。該報告強調面對中國等對手意圖透過「反介入／區域拒止」（Anti-Access/Area Denial, A2/AD）戰術對抗美國，美軍有必要儘速加強海底戰力整備，掌握足以摧毀敵國海底基礎設施並防護自身設施的能力，相關建議其後逐漸反映於華府建軍規劃之中。[46]例如《2020 財年國防授權法案》（*National Defense Authorization Act for Fiscal Year 2020*）即納入設立「纜線安全船隊」（Cable Security Fleet, CSF）的方案，[47]該方案於 2021 年底啟動，由承包商「海底通訊」公司（SubCom LCC）在國防部監管下執行，指定「可靠號」（CS Dependable）和「決斷號」（CS Decisive）兩艘海纜鋪設暨維修船（Cable Repair/Laying Vessel），在戰時或緊急狀態下配合政府需求投入海纜線路維修作業。[48]

美國軍方同時重啟了冷戰時期的「海底整合監視系統」（Integrated Undersea Surveillance System, IUSS），並設置「戰區海底監視指揮部」（Theater Undersea Surveillance Command）以強化對海底空間的感知監控。[49]另一方面，海軍部門除為改造中的海狼級核潛艦（Seawolf-class Submarines）吉米卡特號（USS Jimmy Carter, SSN-23）增配海纜破壞裝

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45 U.S.-China Economic and Security Review Commission, *2025 Report to Congress: Executive Summary and Recommendations* (Washington, D.C.: S.-China Economic and Security Review Commission, 2025), p. 47.

46 Bryan Clark, *The Emerging Era in Undersea Warfare* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2015), pp. 15-17.

47 請見該法案第 3521 節有關「建立纜線安全艦隊」（Establishment of Cable Security Fleet）的說明：“National Defense Authorization Act for Fiscal Year 2020,” *U.S. Congress*, December 20, 2019, https://www.congress.gov/116/plaws/publ92/PLAW-116publ92.pdf。

48 Daniel F. Runde, Erin L. Murphy, and Thomas Bryja, “Safeguarding Subsea Cables: Protecting Cyber Infrastructure amid Great Power Competition,” *Center for Strategic and International Studies*, August 16, 2024, https://www.csis.org/analysis/safeguarding-subsea-cables-protecting-cyber-infrastructure-amid-great-power-competition.

49 Joe Brock, “U.S. Revives Cold War Submarine Spy Program to Counter China,” *Reuters*, September 21, 2023, https://www.reuters.com/investigates/special-report/usa-china-tech-surveillance/.

備，也持續擴大投資無人海底載具（Unmanned Undersea Vehicles, UUV），採購多艘「虎鯨」超大型無人海底航行器（Orca Extra Large Uncrewed Undersea Vehicle, Orca XLUUV）外。[50]另循「獅子魚計畫」（Lionfish Program）等管道與民間廠商合作開發軍用小型無人海底航行器，用於提升於全球各地海域防護海纜等關鍵基礎設施的能力。[51]

「外部平衡」策略建議國家遭逢安全威脅時，可和友好國家強化合作或締結同盟陣線，藉由資源整合共同平衡對手帶來的挑戰。面對中國近年藉由「帶路倡議」推廣，擴大介入全球各地海纜工程等趨向，美國政府正尋求和同樣關注其動向的友盟國家加強合作，協力阻遏中國勢力進一步擴展。

近年最具代表性的相關事例應屬美中環繞「東密克羅尼西亞海纜」（East Micronesia Cable）建案的角力。該案原係由世界銀行（The World Bank）在 2020 年時提出，旨在於太平洋島國地區（Pacific Islands Region）的密克羅尼西亞（Micronesia）次區域東側興建一套海纜系統，協助通訊能力匱乏的密克羅尼西亞聯邦、諾魯與吉里巴斯加強國際數位連結。[52]中國海纜企業「華海通信」參與該案競標過程中，提出約 7,260 萬的投標價格，和其他對手如「阿爾卡特海底網路」（Alcatel Submarine Networks, ASN）、「諾基亞」（Nokia）及「日本電氣」（NEC Corporation）報價相比低廉近 20%。這一情形引起美國政府警戒，憂慮若任中國企業介入中西太平洋海纜建設，將對區域資安構成危害，並向各島國政府強烈示警，世界銀行與相關島國在接納美國意見卻又無法排除

[50] Maya Carlin, "USS Jimmy Carter: The Navy's One of a Kind Stealth Seawolf-Class Submarine," *The National Interest*, July 29, 2024, https://nationalinterest.org/blog/buzz/uss-jimmy-carter-navys-one-kind-stealth-seawolf-class-submarine-208746.

[51] Robert Dougherty, "HII to Build 9 Lionfish Unmanned Vehicles for US Navy," *Defence Connect*, October 12, 2023, https://www.defenceconnect.com.au/naval/12954-hii-to-build-nine-lionfish-unmanned-vehicles-for-us-navy; H. I. Sutton, "Cable Attack: New Undersea Threat is Starting to Reshape Naval Wars," Naval News, February 28, 2024, https://www.navalnews.com/naval-news/2024/02/cable-attack-new-undersea-threat-is-starting-to-reshape-naval-wars/.

[52] "New Digital Project to Connect Federated States of Micronesia to Global Economic Opportunities," *World Bank Group*, March 29, 2020, https://www.worldbank.org/en/news/press-release/2020/03/29/new-digital-project-to-connect-federated-states-of-micronesia-to-global-economic-opportunities.

「華海通信」標案領先地位的情況下，最終決定直接撤銷全案。[53]美國隨後於 2021 年下旬邀集日本和澳洲聯合出資 9,500 萬美元承接該項工程，並獲相關島國公開支持，成功排拒了中國試圖參與當地海纜建設的嘗試。[54]

類似情形也出現在東南亞地區，當越南政府宣布預定於 2030 年前新建至少十條海纜，以解決現有海纜線路老化及故障頻仍等問題的施政目標時，美國政府也積極遊說河內當局，敦促其避免讓「華海通信」等中國企業參與工程，建議優先考慮由民主國家的海纜企業負責建造事宜，並暗示倘若中國介入該國纜線建造，將連動影響美國企業後續對越南的投資趨向。[55]

與此同時，美國和友邦彼此間的海纜事務合作也持續升級，諸如透過「四方安全對話」（Quadrilateral Security Dialogue, QUAD）啟動「海纜連結及韌性夥伴」計畫（Partnership for Cable Connectivity and Resilience）、於澳洲設立「海纜連結及韌性中心」（Cable Connectivity and Resilience Centre）協助印太國家提升海纜系統韌性，[56]以及和我國、日本、南韓共同籌建長達 1.25 萬公里的跨太平洋 E2A 海纜系統等事例，[57]都隱含美國政府整合國際資源設法制約中國的努力。智庫「大西洋理事會」（Atlantic Council）資深研究員布勞（Elisabeth Braw）指出，國際海纜體系正隨著美中競逐漸進「脫鉤」（Decoupling），世界各國未來的

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[53] Jonathan Barrett and Yew Lun Tian, “Exclusive Pacific Undersea Cable Project Sinks after U.S. Warns Against Chinese Bid,” *Reuters*, June 18, 2021, https://www.reuters.com/world/asia-pacific/exclusive-pacific-undersea-cable-project-sinks-after-us-warns-against-chinese-2021-06-18/.

[54] Mari Yamaguchi, “Japan, Australia, US to Fund Undersea Cable Connection in Micronesia to Counter China’s Influence,” *AP News*, June 7, 2023, https://apnews.com/article/micronesia-japan-australia-us-cable-china-155cd017a5a3045bf5078e5df25f17d9.

[55] Francesco Guarascio, Phuong Nguyen and Joe Brock, “Exclusive: Inside the US Push to Steer Vietnam's Subsea Cable Plans away from China,” *Reuters*, September 18, 2024, https://www.reuters.com/business/media-telecom/inside-us-push-steer-vietnams-subsea-cable-plans-away-china-2024-09-17/.

[56] Amy Remeikis, “Wong Announces New Digital Cable Centre to Limit China’s Influence in Indo-Pacific,” *The Guardian*, July 28, 2024, https://www.theguardian.com/australia-news/article/2024/jul/29/wong-announces-new-digital-cable-centre-to-limit-chinas-influence-in-indo-pacific.

[57] Telecom Review, “Undersea Infrastructure 2.0: Asia’s Next Wave of Submarine Investments,” January 30, 2026, https://www.telecomreviewasia.com/news/featured-articles/28230-undersea-infrastructure-2-0-asias-next-wave-of-submarine-investments/.

纜線工程規劃將不可避免地與地緣政治格局連動，被迫在美國與中國間選邊，一道牽動全球的「海底鐵幕」（Undersea Iron Curtain）正緩緩落下。[58]

除內外部平衡策略的操作外，威脅平衡理論晚近關於「去合法性」等新興策略構想的討論，似乎也在美國近期海纜事務相關施政中有所映現。部分研究注意到，面對造成安全威脅的他國，國家除可藉由內外部平衡策略應對，削弱對手外交政策與活動的合法性，也可能創造一定平衡效用。這一策略的執行雖未必能立竿見影地遏阻對手，但當其施政舉措為國際社會認知為不符合國際法規或道德標準，相關行動的成本、過程中可能面臨的阻礙，以及尋求他國協助的難度都將提升。[59]

美國政府在此方面的操作體現在尋求與友盟國家建立共識，主導國際海纜建設規範的制訂進程，並聯手限縮中國未來在此領域的活動空間。美國網路空間暨數位政策無任所大使菲克（Nathaniel C. Fick）於 2024 年 9 月邀請友好國家舉行海纜安全會議，共同發表〈有關在全球數位世界中海底電纜安全與韌性的聯合聲明〉（*Joint Statement on the Security and Resilience of Undersea Cables in a Globally Digitalized World*），並在隨後的第 79 屆聯合國大會中獲英國、日本、澳洲、加拿大、歐盟、芬蘭、法國、荷蘭、紐西蘭、葡萄牙、韓國、新加坡及多個太平洋島國認可。

這份聲明首先強調海纜設施在當代世界中的重要性，指出各國對海纜的高度依賴及國際規範的缺位形成了重大潛在安全風險，因此相關國家在美國邀請下共同簽署該聲明，宣示未來將整合海纜設施安全標準、建立一致的風險評估機制、強化各國纜線互通性、將透明度不足的供應商及其產品排除在供應鏈之外、建立更嚴謹的資訊傳輸監管框架，以及遵守《聯合國海洋法公約》（*United Nations Convention on the Law of the*

[58] Elisabeth Braw, “Decoupling Is Already Happening - Under the Sea,” *Foreign Policy*, May 24, 2023, https://foreignpolicy.com/2023/05/24/china-subsea-cables-internet-decoupling-biden/.

[59] Stephen M. Walt, *Taming American Power: The Global Response to U.S. Primacy* (New York: W. W. Norton, 2005), pp. 144-145.

Sea, UNCLOS）。[60]這份聲明雖然沒有公開點名中國，但對照美國政府過往在國際海纜建案中對中國廠商表達的安全疑慮、聲明中就海纜供應商透明度和風險管控的相關要求，以及對遵守《聯合國海洋法公約》的強調，實際上已構成一種透過規範與供應鏈機制形塑的排拒效果，為中國未來參與跨國海纜關鍵基礎設施建設的空間設置障礙，亦間接削弱其產業競爭力。

前述各項事例顯示，出於對海纜設施戰略價值與中國威脅的認知，美國政府在過去數年間已啟動相應的「威脅平衡」策略。無論是對內強化行政審查和海底戰力部署，對外聯合友邦阻遏中國企業取得海纜建案，或透過多邊聲明從法制度層面限制中國海纜產業發展等舉措，皆反映其積極回應對手挑戰、平衡威脅的政策取向。

伍、結語

進入二十一世紀以來，大國權力競逐再度成為國際政治的主軸線。過往以競合併存為標誌的美中關係，隨著美國重返印太與中國力求持續崛起的趨勢交會，彼此互動日益偏向競爭一側。綜觀近年美中兩國互動可見，雙方角力不僅涵蓋外交、經貿與軍事面向，更進一步滲入影響當代人類社會甚深的資訊科技領域。

為瞭解美國政府近年對中海纜競爭舉措的戰略意涵與連貫邏輯，本文嘗試援用國際關係學界的「威脅平衡」理論進行分析，一方面配合海纜線路的議題特質及空間特性，微調該理論提出的威脅構成要件指標，以求更精確地認識中國於海纜領域對美國構成的潛在威脅。另一方面，也利用該理論提出的「內部平衡」、「外部平衡」與其他新型平衡策略論述，理解美國政府晚近海纜事務施政作為中蘊藏的平衡策略意涵。

研究結果顯示，中國在海纜領域的發展趨向與該理論各項威脅構成

[60] "Multilateral Meeting on Security and Resilience of Undersea Cables during UN General Assembly High Level Week," *U.S. Department of State*, September 25, 2024, https://2021-2025.state.gov/multilateral-meeting-on-security-and-resilience-of-undersea-cables-during-un-general-assembly-high-level-week/; "Joint Statement on the Security and Resilience of Undersea Cables in a Globally Digitalized World," *U.S. Department of State*, September 26, 2024, https://2021-2025.state.gov/joint-statement-on-the-security-and-resilience-of-undersea-cables-in-a-globally-digitalized-world/.

要件相互對應，例如在總體實力部分，中國作為海纜建設後起國家，憑藉改革開放帶動的經濟和外交實力增長，成功發展出完整纜線產業體系及大型海纜企業，更以相對低廉的價格在國際市場上和美國、法國、日本等傳統海纜大國競奪標案，介入多項大型跨國纜線建設工程；在進攻實力部分，中國積極發展水下監聽、纜線切割等技術，其船舶亦被指控涉入多起國際海纜破壞事件。相關現象帶動了美國政府的侵略意圖感知，進而視中國在海纜領域的崛起為安全威脅。過往多年間，無論川普或拜登政府任內，華府當局均持續提升在海纜事務上的對中抗衡力道，相關舉措如對內強化行政管制與戰力建設，對外聯合盟邦限制中國取得海纜標案，或是透過統合各國共識，嘗試建構國際海纜安全標準和治理規範，循法制安排遏制中國勢力擴張等，分別體現了「威脅平衡」理論中的「內部平衡」、「外部平衡」及其他平衡策略的意涵。

就現況而言，美國對中國的平衡作為已取得一定成效，迫使中國先後退出多項國際海纜標案，但長期效用尚待後續觀察。畢竟中國相對低廉的海纜產品和建設服務對開發中國家甚具吸引力，依然是美日法等國家在市場中的強大競爭對手。另一方面，考量到國際海纜線路鋪設範圍遼闊致防護不易，即便美國已設法加強海底攻防及纜線監控能力，全面遏制中國船舶對世界各地海纜線路的破壞或監聽活動仍非易事。因此，美中之間的海纜競爭在可預見未來中將呈現動態且持續延伸的樣貌。

作為美國印太合作夥伴且長期面臨中國威脅的我國，面對中國在海纜領域的能力增長和運用相關技術打擊他國的威脅，我國正逐步強化對海纜設施的防護作為，包含透過法規修訂加重破壞纜線設施的處罰強度、規劃海纜遭破壞情境下的通訊備援方案，以及建立更完善的海纜巡防機制等。[61]此外，我國亦尋求於此一領域中擴大和美國及民主友邦間的合作。除獲邀參與美國、日本與澳洲等國家共同推動的太平洋島國地

[61] Jason Hsu, "Testimony before the U.S.-China Economic and Security Review Commission: Part of Your World: U.S.-China Competition Under the Sea," *U.S.-China Economic and Security Review Commission*, March 2, 2026, https://www.uscc.gov/sites/default/files/2026-03/Jason_Hsu_Testimony.pdf.

區海纜建案外，[62]美國國會也提出《臺灣海底電纜韌性倡議法案》（*Taiwan Undersea Cable Resilience Initiative Act*），要求軍方和國安單位共同協助我國提升海纜韌性暨防護水準，[63]如何把握此契機深化與民主友盟的戰略合作，全面強化國家資通訊安全，將是我國政府後續應積極探討的重要課題。

[62] "Reinvigorating the U.S.-Pacific Islands Partnership: U.S.-Pacific Islands Forum (PIF) Roundtable in Port Moresby, Papua New Guinea," *U.S. Department of State*, September 16, 2025, https://www.state.gov/releases/2025/09/reinvigorating-the-u-s-pacific-islands-partnership-u-s-pacific-islands-forum-pif-roundtable-in-port-moresby-papua-new-guinea/.

[63] "S.2222 - Taiwan Undersea Cable Resilience Initiative Act," *U.S. Congress*, July 9, 2025, https://www.congress.gov/bill/119th-congress/senate-bill/2222/titles.

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安全驅動市場秩序：美國關鍵礦產戰略與全球關鍵礦產供應鏈轉型

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摘　要

2025 年以來，中國以出口管制將關鍵礦產武器化，促使美國由「市場去風險化者」轉為「市場塑造者」。本文奠基於武器化相互依賴與去風險化文獻，提出「制度型去風險化」（institutional de-risking）作為分析概念，指涉戰略宣示、制度設計與金融動員三層構成之機制鏈：宣示提供授權、設計界定部署、動員填補安全溢價之成本缺口。本文以「美國政策工具是否內含系統性排除中國之設計邏輯」為主問題，研究發現美國正透過市場進入、差別關稅與海外投資建構「非中供應鏈」，而主動對齊之盟友反承擔最高之中國反制成本；此進程呈現「美方新建制度／中方工具升級」之不對稱演化。「制度型去風險化」能否維繫，取決於國會授權之政治穩定性、盟友承擔安全溢價之意願，以及中國反向定價策略之內生成本曲線。本文論證此政策架構之存在與內在邏輯，惟其是否足以重組全球礦產市場之底層秩序，仍屬進行中之歷史過程。

關鍵詞：關鍵礦產、美中競爭、稀土、供應鏈安全、安全溢價

Security-Driven Market Order: U.S. Critical Minerals Strategy and the Transformation of Global Critical Mineral Supply Chain

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Abstract

Since 2025, China's weaponization of critical minerals through export controls has shifted U.S. policy from a "market de-risker" to a "market shaper." Drawing on the literatures of weaponized interdependence and de-risking, this paper proposes "institutional de-risking" as an analytical concept, denoting a mechanism chain of three layers—strategic declaration, institutional design, and financial mobilization: declaration provides authorization, design defines deployment, and mobilization fills the cost gap of the security premium. Centered on whether U.S. policy instruments embed an internal logic of systematically excluding China, the study finds that the United States is constructing a "non-China supply chain" through the FORGE membership conditions, Clause 232 differential tariffs, and the Development Finance Corporation's overseas investments, while allies that actively align bear the highest costs of Chinese counter-measures. The process exhibits an asymmetric evolution: a "new institution" still under construction on the U.S. side versus a "tool upgrade" leveraging existing monopoly advantages on China's, which immediately leverages its existing midstream monopoly advantages. Whether institutional de-risking can be sustained depends on the political stability of congressional authorization, allies' willingness to share the security premium, and the cost curve endogenously shaped by China's counter-pricing strategy. This paper demonstrates the existence and internal logic of this architecture; whether it suffices to reorder the underlying foundations of the global mineral market remains

an ongoing historical process.

Keywords: *Critical Minerals, US-China Competition, Rare Earth Elements, Supply Chain Security, Security Premium*

壹、緒論

一、問題背景與研究動機

冷戰結束後三十年間，全球礦產市場的運作建立在一個隱含假設之上：資源應流向最低成本加工利用的地方。這個效率邏輯造就了中國在稀土元素（Rare Earth Elements, REEs）與關鍵礦產（Critical Minerals，以下簡稱 CM）供應鏈的結構性主導地位，非因中國擁有最多的礦石，而是因其以國家補貼、寬鬆的環境法規與系統性技術積累，將加工成本壓至他國廠商難以競爭的水準，俾逐一擠出競爭者。效率邏輯的成功運作，亦是其內在矛盾的起點。

2025 年以來，中國頻繁將 CM 作為地緣政治工具，對稀土及相關礦產實施出口管制，導致全球供應鏈出現結構性震盪。在此背景下，美國對 CM 政策發生根本性典範轉移：從鼓勵私人資本進行供應鏈多元化，轉向以國家力量主動介入市場定價、制度設計與金融動員。「關鍵礦產部長級會議」（Critical Minerals Ministerial，以下簡稱 CMM）、「資源地緣戰略參與論壇」（Forum on Resource Geostrategic Engagement，以下簡稱 FORGE）、價格下限構想與「金庫計畫」（Project Vault）戰略儲備計畫等動作，標誌美國已不再滿足於規則倡議者，而是以規則制定者之姿，試圖重組全球礦產市場的基礎秩序。此一轉變引發根本問題：美國的政策工具是否具有系統性排除中國的內在設計邏輯？而其制度介入又在何種程度上、以何種機制改變了礦產市場的運作條件？

二、研究缺口

現有文獻對美國 CM 政策的分析，多集中於兩個視角：一是供應鏈安全視角，著重識別對單一供應國的依賴風險，並提出多元化採購策略；[1]二是地緣政治競爭視角，將美中礦產博弈定位為大國競爭的延伸，強調

[1] 相關學者包含 Shiquan Dou and Deyi Xu, “The Security of Critical Mineral Supply Chains,” *Mineral Economics*, Vol. 36, No. 3, 2023, pp. 401-412; Ji Won Moon, Sean Y. Xun, Jaewon Chung, and Steven D. Textoris, “Assessment of Critical Minerals Supply Chain for the United States in Perspective of Trade Restriction by Foreign Countries,” *Resources Policy*, Vol. 110, November 2025, https://www.sciencedirect.com/science/article/pii/S0301420725002685; Jane Nakano, “The Geopolitics of Critical Minerals Supply Chains,” *Center for Strategic and International Studies*, March 11, 2021, https://www.csis.org/analysis/geopolitics-critical-minerals-supply-chains.

資源控制的戰略意義。[2]惟此二視角較少探討安全邏輯如何具體改變市場運作機制，[3]亦未充分分析美國如何透過制度設計將安全目標嵌入價格形成與資本配置過程。本文試圖填補此一缺口，並嘗試回答：當國家以制度設計取代市場競爭作為供應鏈重組的主要手段時，其政策邏輯、工具結構與地緣經濟影響為何。

本文以一個主問題為核心，並輔以兩個衍生觀察。主問題為：美國的政策工具是否具有系統性排除中國的內在設計邏輯，即當前美國的 CM 政策是一套經由制度設計實現的「非中供應鏈」建構工程，還是僅為一般意義上的供應鏈多元化？

此一主問題之下，本文進一步觀察兩個衍生面向。其一，礦產定價出現哪些安全化[4]的初步制度跡象，是否礦產價格的形成不再純粹是市場供需的結果，而開始嵌入安全考量？其二，美中制度競逐對資源國形成何種非對稱的選擇壓力——亦即，當美國與中國各自建構排他性的規則體系時，夾在兩者之間的資源豐富發展中國家面臨怎樣的結構性處境？

基於研究主張與論證能力對齊之方法論考量，本文將三個研究問題重組為「主問題＋衍生觀察」之層級結構：實證內容主要支撐主問題，衍生觀察則屬仍在發展之趨勢，留待後續研究深化。

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[2] 相關學者包含 Marc Schmid, “Rare Earths in the Trade Dispute Between the US and China: A Déjà Vu,” *Intereconomics*, Vol. 54, No. 6, 2019, pp. 378-384; Nimi A. Mancheri, Benjamin Sprecher, Glenn Bailey, Jianping Ge, and Arnold Tukker, “Effect of Chinese Policies on Rare Earth Supply Chain Resilience,” *Resources, Conservation and Recycling*, Vol. 142, 2019, pp. 101-112; Jiayi Zhou and André Månberger, *Critical Minerals and Great Power Competition: An Overview*, *SIPRI*, October 2024, https://www.sipri.org/publications/2024/research-reports/critical-minerals-and-great-power-competition-overview.

[3] 霍茲於 2014 年的核心論點甚至是「反駁」或「淡化」「國防與國家安全」的強烈擔憂。詳見 Eugene Gholz, “Rare Earth Elements and National Security,” *Council on Foreign Relations Energy Report*, October 2014, https://reurl.cc/4lkD6D, pp. 10-11, 13.

[4] 本文所稱「安全化」（securitization），係指安全考量被制度性嵌入價格形成與市場進入機制之制度層次現象，亦即安全邏輯透過具體規則、價格機制與融資安排，內化於市場運作條件之中。其與哥本哈根學派所指透過言說行為將議題從常態政治抬升至安全領域之言說過程，分屬不同分析層次。本文未採後者作為主要分析框架之理由，詳見第貳節。

三、研究方法與本文結構

本文採機制導向的政策過程分析（mechanism-oriented policy analysis），目標是重建美國 CM 政策由戰略宣示到制度實施的政策轉化鏈，分析各層級政策工具如何銜接為整合性的制度回應。本文論證旨在解析政策設計邏輯與中間機制，而非測量政策效果、進行統計因果推論，亦非嚴格過程追蹤（process tracing）意義下對競爭性假設的形式化排除。資料基礎為政策文件、機構報告與事件觀察。

本文結構如下：第貳節建立理論框架，從「武器化相互依賴」（Weaponized Interdependence）與「去風險化」（de-risking）文獻出發，提出「制度型去風險化」（institutional de-risking）作為分析概念。第參節梳理中國 CM 供應鏈的結構性主導地位及其出口管制演變，作為理解美國政策動機的結構性條件。第肆節為本文核心分析，依序檢視美國各項政策。第伍節評估其地緣經濟影響。第陸節提出結論並交代本文侷限。

貳、理論框架：從武器化相互依賴到制度型去風險化

前述研究缺口指向一個核心問題：當國家以制度設計取代市場競爭作為供應鏈重組的主要手段時，既有理論工具是否足以解釋此一現象？本節從武器化相互依賴與去風險化兩條當代國際政治經濟學的主軸出發，論證為何純粹的供應鏈安全文獻不足以分析美國當前的政策轉型，進而提出「制度型去風險化」作為本文的分析概念。另，本文未採哥本哈根學派的安全化（securitization）理論為主要框架：該學派分析安全「如何被論述建構」，本文則聚焦安全「如何被制度性嵌入市場機制」；後文「安全化」一詞即於此制度意義上使用（定義詳見註 4）。

一、武器化相互依賴框架及其在實體供應鏈的擴展

當代國際政治經濟學對國家如何以經濟工具行使強制權力已累積豐富理論，其中以法羅（Henry Farrell）與紐曼（Abraham Newman）之「武器化相互依賴」框架最具影響力。[5]該框架挑戰自由主義關於全球化導致權力分散的論述，主張全球經濟網絡呈現高度不對稱的「網路地貌」

[5] Henry Farrell and Abraham L. Newman, “Weaponized Interdependence: How Global Economic Networks Shape State Coercion,” *International Security*, Vol. 44, No. 1, Summer 2019, pp. 42-79.

（network topography）：少數國家憑藉對關鍵節點的有效管轄權，得將結構優勢轉化為強制能力，其機制有二：透過「全景監視效應」（panopticon effect）截取流經節點的資訊，[6]或透過「咽喉點效應」（chokepoint effect）切斷特定行為者對網絡的接取。法羅與紐曼在後續專著《Underground Empire》中，[7]進一步以 SWIFT 金融訊息系統與美元清算網絡等案例，闡述美國如何系統性武器化其網絡中心地位。

原始 2019 年論文之案例雖集中於資訊與金融網絡，惟法羅與紐曼已於後續研究將框架擴展至實體供應鏈與 CM 領域。在 2025 年的文章中，[8]他們具體指出：中國在稀土加工生態系中已取得「壟斷性掌控」（stranglehold），其權力來源並非礦藏壟斷，而是對開採與加工所需的經濟與技術生態系的支配；中國於 2020 年仿效美國模式建立出口管制法、於 2024 年新增兩用（Dual-use）物項規則，並禁止稀土加工設備出口，使其「將咽喉點轉化為實際槓桿的官僚機制」於短時間內成形。此一擴展為本文以該框架分析 CM 領域提供理論依據。

二、分析架構的選擇

或有論者質疑：本文既聚焦 CM 議題，何不逕採供應鏈安全文獻為分析工具？此類文獻將「依賴單一供應國」視為風險、以「降低脆弱性」為政策目標，聚焦供應多元化、庫存與替代材料等防禦性策略。[9]然而，2025 年以來的美國政策實踐已超越此範疇：其目標不僅在降低自身脆弱性，更在主動重組網絡結構以對抗對手（詳後述）。供應鏈安全文獻

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[6] 全景監視效應在礦產情境中以有限形式存在，在規模與深度上都遠不及金融與資訊網絡中的全景監視效應，因此本文將分析重心置於咽喉點效應，此一機制在礦產情境中的解釋力遠超前者。

[7] Henry Farrell and Abraham Newman, *Underground Empire: How America Weaponized the World Economy* (New York: Henry Holt and Company, 2023).

[8] Henry Farrell and Abraham Newman, "The Weaponized World Economy: Surviving the New Age of Economic Coercion," *Foreign Affairs*, Vol. 104, No. 5, September/October 2025, pp. 8-23.

[9] Shiquan Dou and Xu Deyi, "The Security of Critical Mineral Supply Chains," Mineral Economics, Vol. 36, No. 3, 2023, pp. 401-412; Jane Nakano, "The Geopolitics of Critical Minerals Supply Chains," *Center for Strategic and International Studies*, March 11, 2021, https://www.csis.org/analysis/geopolitics-critical-minerals-supply-chains; Ji Won Moon, Sean Y. Xun, Jaewon Chung, and Steven D. Textoris, "Assessment of Critical Minerals Supply Chain for the United States in Perspective of Trade Restriction by Foreign Countries," *Resources Policy*, Vol. 110, November 2025, 105726, https://www.sciencedirect.com/science/article/pii/S0301420725002685.

關注單一節點如何不被切斷，武器化相互依賴則關注網絡中心節點之所在、掌控者及其重新配置；當美國政策目標由前者轉向後者，分析框架亦須相應改變。

然現有武器化相互依賴文獻多集中於「強制方」如何發動經濟脅迫，對「被強制方」反制策略之理論探討仍屬有限。法羅與紐曼於論文結語指出，被鎖定或預期被鎖定的國家可能嘗試自我隔離於網絡之外、將網絡效應反向施加於對手，乃至「重塑網絡以最小化自身脆弱性或增加他人的脆弱性」；能否成功反制，取決於其自身之網絡位置與制度條件。[10] 布萊克威爾（Robert Blackwill）與哈里斯（Jennifer Harris）雖提供地緣經濟工具之類型清單，說明國家如何以經濟手段追求地緣政治目標，惟對「被強制方」如何透過制度建構系統性反制之微觀機制亦著墨有限。[11]本文所分析之美國 CM 戰略，正是上述「重塑網絡」反制策略之當代案例，其解析有助於填補既有文獻於「被強制方」制度建構之空缺。

三、去風險化作為理論橋樑

近期對「去風險化」（de-risking）的學術討論，正是回應此一空缺的重要嘗試。皮薩尼-費里（Jean Pisani-Ferry）等人將去風險化界定為「在相互依賴世界中維護經濟安全」的綜合政策架構；[12]法羅與紐曼則將其視為形塑新地緣政治格局的「新經濟安全國家」（new economic security state）的核心策略。在此基礎上，班德默（Sandra Bandemer）等人將去風險化進一步概念化為兩種政治策略的組合：[13]面對「入侵威脅」（threat of intrusion，即外部供應者可能植入後門或操控內部系統）者，傾向規制型回應；面對「排除威脅」（threat of exclusion，即可能被切斷關鍵資源取得）者，則傾向能力建構型回應。值得指出的是，此二分法即奠基於武器化相互依賴框架；亦即二者並非競爭理論，而是同一脈絡下分別

[10] Henry Farrell and Abraham L. Newman, “Weaponized Interdependence,” op. cit., p. 76.

[11] Robert D. Blackwill and Jennifer M. Harris, *War by Other Means: Geoeconomics and Statecraft* (Cambridge, MA: Belknap Press of Harvard University Press, 2016).

[12] Jean Pisani-Ferry, Beatrice Weder di Mauro, and Jeromin Zettelmeyer, “How to De-Risk: European Economic Security in a World of Interdependence,” *CEPR Policy Insight*, No. 129, 2024, https://cepr.org/publications/policy-insight-129-how-de-risk-european-economic-security-world-interdependence.

[13] Sandra Bandemer, Benjamin Daßler, Berthold Rittberger, Moritz Weiss, and Kathrin Will, “Politics of De-Risking: How the EU Confronts Vulnerabilities in Critical Digital Infrastructures,” *Journal of European Public Policy*, 2025, https://doi.org/10.1080/13501763.2025.2545305.

處理「攻擊面」與「防禦面」的概念延伸。就此而言，美國面對的是「排除威脅」，本文所分析的政策回應則屬「能力建構型去風險化」範疇。

四、概念落差與「制度型去風險化」的提出

然班德默等人所描述之「能力建構型去風險化」，係透過補貼、研發資金與國家援助豁免等傳統產業政策工具運作（如美歐晶片法案之半導體補貼）；美國 CM 戰略所部署之工具則遠超此範疇，其角色已由班德默之「市場促進者」（market facilitator），轉化為直接參與市場運作之「市場參與者」（market participant）。

本文據此提出「制度型去風險化」（institutional de-risking）作為分析概念。此處須先釐清「去風險」之兩種類別。第一種指商業投資風險：政策語彙中的「市場去風險化者」（market de-risker），指政府以貸款擔保、稅收抵免等方式替私人資本緩衝進入市場之商業風險，此即第伍節所稱美國所欲超越之舊角色。第二種指地緣經濟脆弱性風險：「制度型去風險化」所欲化解者，係被武器化之相互依賴對國家內生之脆弱性。二者之連結在於：美國政府退出緩衝商業風險之舊角色、轉而直接介入市場形成，此一轉變即「制度型去風險化」之具體政策模式；兩者雖共用「去風險」一詞，卻分屬不同意義層次，不宜混淆。

「制度型去風險化」定義可分解為三個要件。第一，在政策結構上，它涵蓋戰略宣示層的正當性建構、制度設計層的市場進入規則與規範界定、以及金融動員層的資本配置與價格干預，三者並非並列工具，而是一條由建構正當性到具體實施的完整制度架構。第二，在運作模式上，它將去風險化從個別政策行動轉化為持續性的制度安排，使政策回應具有跨時間的可預期性與不可逆性。第三，在國家角色上，它使國家從市場的促進者轉化為市場的參與者，直接介入價格形成、所有權配置與供應鏈重組。此概念奠基於班德默等人之能力建構型去風險化框架，更進一步刻劃國家由市場促進者轉為市場參與者之政策模式；其提出並非否定既有文獻之分類效度，而係為多層制度工具之深度介入現象，提供更精細之分析範疇。

「制度型去風險化」以國家深度介入市場為特徵，因而須與既有的「國家—市場」關係文獻對話。發展型國家（developmental state）強調官僚機構篩選戰略產業、推動技術追趕；創業型國家（entrepreneurial state）主張國家主動承擔創新風險、為新興產業創造市場；國家資本主

義（state capitalism）則聚焦國家以國有企業與主權基金將市場工具用於政治目的——三者共同指出國家可作為市場的形塑力量，此一前提亦為本文所承接。[14]本文與上述文獻之區別有三：介入對象上，前者指向本國產業能力之向內培育，本文則指向對外排除對手所掌握之網絡結構；驅動邏輯上，前者由產業升級或創新使命驅動，本文則以安全考量之制度性嵌入為核心；工具結構上，前者多以補貼、研發資金或國有持股等個別工具描述國家角色，本文則整合為填補「安全溢價」成本缺口之轉化機制鏈。尤須區分者，馬祖卡托（Mariana Mazzucato）所稱之市場塑造（market-shaping）係為創新使命創造新市場，性質為生產性；本文所稱美國由「市場去風險化者」轉向「市場塑造者」（market shaper），則係為地緣安全重組對手既有網絡的排除性塑造——二者共用語彙而旨趣相反，此即「制度型去風險化」有別於既有國家介入市場文獻之所在。

參、國際新局下的關鍵礦產競逐

全球化階段，歐美國家將大量製造產能外移至中國大陸；中國自發布《中國製造 2025》以來展現之戰略企圖，不僅確立其稀土主導權，更以此產業優勢作為地緣政治與經濟上制衡他國之籌碼。以下先述驅動關鍵礦產重要性之因素與中國供應鏈優勢，再分析中國 CM 禁令及其政策工具。

一、宏觀格局：驅動關鍵礦產之因素

近年稀土與 CM 因「全球能源轉型」、「新興科技與國防需求」及「地緣政治與供應鏈重構」三大結構性因素，需求快速增長，戰略地位急遽攀升。以下分述之。

首先，各國為達成《巴黎協議》（*Paris Agreement*）淨零排放目標所

[14] 相關著作詳見：Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925–1975* (Stanford, CA: Stanford University Press, 1982); Robert Wade, *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization* (Princeton, NJ: Princeton University Press, 1990); Alice H. Amsden, *Asia's Next Giant: South Korea and Late Industrialization* (New York: Oxford University Press, 1989); Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* (London: Anthem Press, 2013); Ian Bremmer, *The End of the Free Market: Who Wins the War Between States and Corporations?* (New York: Portfolio, 2010).

推動的能源轉型，是 CM 需求結構性增長的首要動力。潔淨能源技術屬於高度「礦產密集」（mineral-intensive）的產業：永磁馬達、離岸風機依賴釹、鐠等輕稀土，儲能電池則大量消耗鋰、鈷、鎳。[15]

其次，CM 是現代國防與高科技不可或缺的基礎材料，被視為 21 世紀的「科技金屬」。[16]稀土耐高溫與強磁的物理特質，是精準制導武器、雷達、匿蹤戰機等先進武器系統的核心組件，[17]因此中國對「科技金屬」供應鏈壟斷直接觸及西方國家的國防工業命脈。[18]

此外，生成式人工智慧（Generative AI）的爆發性發展，重塑了全球 CM 的需求結構。AI 晶片的物理穩定性與奈米級導線可靠性，仰賴一系列關鍵礦物——銅作為導線與散熱介質、銦作為熱介面材料、鉭與釕作為先進半導體導線製程中的阻障層與襯墊層。[19]隨資料中心規模與製程節點演進，相關礦物需求將持續成長。

最後，供應鏈脆弱性與大國博弈放大了 CM 的戰略價值。中國在加工與精煉端的壓倒性主導權，使歐美各國意識到過度依賴單一供應源的國家安全風險，並相繼推出「去風險化」（de-risking）與「友岸外包」（friend-shoring）等政策框架。就供需面而言，CM 長期供不應求之情況有限；其成為國際政治經濟核心問題之關鍵，不在供需失衡，而在生產過度集中於中國及其出口管制所引發之安全關切。

二、中國在全球礦產供應鏈中的結構優勢

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[15] International Energy Agency, “The Role of Critical Minerals in Clean Energy Transitions,” Revised version, March 2022, p. 45, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[16] David S. Abraham, *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age* (New Haven, CT: Yale University Press, 2015), p. 4.

[17] David S. Abraham, op. cit.; Sophia Kalantzakos, *China and the Geopolitics of Rare Earths* (New York: Oxford University Press, 2018), pp. 1, 62; Eugene Gholz, “Rare Earth Elements and National Security,” op. cit., pp. 1, 3.

[18] Jane Nakano, op. cit., pp. 13, 23-24.

[19] Lorenz Marscheider-Weidemann, et al., “Raw Materials for Emerging Technologies 2021,” *DERA Rohstoffinformationen*, August 2021, https://www.deutsche-rohstoffagentur.de/DERA/SharedDocs/Downloads/Rohstoffinformationen/rohstoffinformationen-50-en.pdf?__blob=publicationFile&v=3, pp. 127-129; Jean-Philippe Soulié, et al., “Selecting alternative metals for advanced interconnects.” *Journal of Applied Physics*, Vol. 136, No. 17, p. 171101-1-34.

不同於石油資源的地理分布相對分散，稀土及其加工鏈表現出極高程度的地理集中性。

（一）上游：豐富的礦石蘊藏量與進口量

中國在稀土上游兼具自有礦藏與進口管道。自有礦藏方面，中國稀土儲量約 4,400 萬噸，佔全球總量的 34%至 48%，居世界第一；[20]主要產地為內蒙古白雲鄂博礦區（含中國稀土工業儲量約 83.7%）與華南七省的離子吸附型重稀土礦床，後者因採用簡易電解質溶液浸出法，開採成本顯著低於加拿大、瑞典等地的硬岩型礦床。[21]進口管道方面，緬甸是中國最重要的境外重稀土供應國，2023 年向中國出口重稀土氧化物達 41,700 公噸，佔中國重稀土進口量近 98%。[22]

（二）中游：冶煉分離技術的決定性壟斷

中國的咽喉點（Chokepoint）優勢主要展現在中游冶煉環節。根據 IEA2025 年《全球關鍵礦產展望》，中國在 20 種關鍵能源礦產的精煉環節中，有 19 種位居全球首位，平均市佔率高達 70%（見表 1）。[23]此一優勢的形成路徑值得特別注意：在多數礦產中，中國的礦石產量並不突出（如鎳僅 3%、鈷僅 3%），但透過進口原礦並以低成本技術加工，其精煉量市佔卻大幅提升至全球領先地位。

在技術專利層面，中國持有全球稀土相關專利約 58%，特別在「稀

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[20] U.S. Geological Survey, *Mineral Commodity Summaries 2025* (Reston, VA: U.S. Geological Survey, 2025), p. 134；〈2025-2030 年中國稀土市場全景調查及投資戰略規劃報告〉，《新浪財經》，2025 年 10 月 14 日，https://finance.sina.com.cn/roll/2025-10-14/doc-inftwafi2018907.shtml。

[21] Xiaosheng Yang, et al., “China’s Rare Earth Ore Deposits and Beneficiation Techniques,” presented for 1st European Rare Earth Resources Conference, ERES2014 (Milos, Greece, September 4-7, 2014), http://www.eurare.org/docs/eres2014/firstSession/XiaoshengYang.pdf; “From Discovery to Dominance: 75 Years of Development in Inner Mongolia’s Rare Earth Industry,” *Go Inner Mongolia*, September 13, 2024, http://www.goinnermongolia.com.cn/2024-09/13/c_1021601.htm.

[22] “Fuelling the Future, Poisoning the Present: Myanmar’s Rare Earth Boom,” *Global Witness*, May 23, 2024, https://www.globalwitness.org/en/campaigns/natural-resource-governance/fuelling-the-future-poisoning-the-present-myanmars-rare-earth-boom/; Hunter Marston, “Myanmar’s Rare Earth Gold Rush Is Fool’s Gold,” *East Asia Forum*, October 4, 2025, https://eastasiaforum.org/2025/10/04/myanmars-rare-earth-gold-rush-is-fools-gold/.

[23] International Energy Agency, “Global Critical Minerals Outlook 2025,” *IEA*, June 2025, p. 252, https://www.iea.org/reports/global-critical-minerals-outlook-2025.

土冶煉技術」與「金屬合金鑄造技術」的專利數量最為顯著，顯示其優勢涵蓋產業鏈中高階環節；惟整體專利品質與技術延續性仍落後於美日兩國，顯示中國的中游壟斷主要建立在規模與成本優勢之上，而非技術領先。[24]

表 1、中國主要關鍵礦產之礦產量與精煉量市占

礦物	2024 年礦產量	2024 年礦產量全球占比	2024 年精煉量	2024 年精煉量全球占比	2040 年精煉量	2040 年精煉量全球占比
銅	1,815	8%	11,860	44.0%	15,688	50.4%
鋰	57	22%	170	70.2%	282	61.2%
鎳	134	3%	1,091	31.3%	1,480	33.4%
鈷	7	3%	196	78.4%	254	76.3%
石墨	1,580	86%	1,795	95.7%	3,811	84.9%
稀土	42	59%	74	91.4%	86	74.8%

說明：（1）各礦物的單位為千噸（kt）；（2）稀土僅涵蓋四種磁鐵稀土：釹（Nd）、鐠（Pr）、鏑（Dy）、鋱（Tb），不包括其他輕稀土與重稀土；（3）銅、鎳、鈷、石墨、稀土的精煉量單位為 IEA 報告中「Refining」數據；鋰的精煉量為 IEA 報告中「Chemicals」（鋰化合物）數據。

資料來源：IEA, “Global Critical Minerals Outlook 2025,” https://iea.blob.core.windows.net/assets/ef5e9b70-3374-4caa-ba9d-19c72253bfc4/Global Critical Minerals Outlook2025.pdf, pp. 294-304。

此一供應鏈體系的戰略節點不在境外礦山，而是中國境內外投資的加工設施。北京沿礦產價值鏈系統性累積附加價值，由工信部、自然資源部及國家發改委統籌規劃，並在重稀土分離領域具有高度集中優勢。[25]

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[24] Lei Zhou, Wen Xiao, and Na Yan, “International Comparative Research on the Relevance of Science and Technology and the Innovation Ability of the Rare Earth Industry — From the Perspective of Technology-Industry Mapping Based on Patent Information,” *Resources Policy*, Vol. 80, January 2023, https://www.sciencedirect.com/science/article/abs/pii/S0301420722007000.

[25] Lisa Depraiter, Stéphane Goutte, and Thomas Porcher, “Geopolitical Risk and the Global

（三）下游：永磁體製造的垂直整合

稀土產業的最高附加價值集中於下游功能材料製造，其中以釹鐵硼（NdFeB）燒結永磁體最具戰略意義，廣泛應用於電動車馬達、風力發電機與精密制導武器。中國目前生產全球 90%至 94%的燒結釹鐵硼永磁體。26在市場結構上，中國稀土產業形成以「北方稀土」與「中國稀土集團」為雙核心的「南北雙寡頭」（duopoly）結構，前者掌握全國 75%輕稀土開採配額，後者壟斷中重稀土供應；[27]此一集中化結構賦予龍頭企業議價能力，並使北京得以透過配額調控及影響全球市場價格。

綜上所述，中國對稀土供應鏈的主宰並非來自單一面向，而是上、中、下游的垂直整合，加上配額管制的多重疊加。這意味著，即便西方國家獲取境外礦場，只要精煉與磁材製造仍集中於中國，對稀土供應鏈的戰略依賴就難以實質改變。

三、中國關鍵礦產禁令

中國對 CM 的政策工具化可追溯至 2010 年釣魚台事件後對日本的非正式稀土禁運，[28]此後並透過 2011 年《促進稀土行業持續健康發展的若干意見》確立以出口配額、關稅與資格限制為核心的「環境保護與資

Supply of Rare Earth Permanent Magnets: Insights from China's Export Trends," *Energy Economics*, Vol. 146, 2025, p. 4; Tae-Yoon Kim, Shobhan Dhir, Amrita Dasgupta, and Alessio Scanziani, "With New Export Controls on Critical Minerals, Supply Concentration Risks Become Reality," *International Energy Agency*, October 23, 2025, https://www.iea.org/commentaries/with-new-export-controls-on-critical-minerals-supply-concentration-risks-become-reality; Rahul Pandey, "China's Rare Earth Leverage Is the Frontline of 21st Century Geopolitics," *The Diplomat*, October 10, 2025, https://thediplomat.com/2025/10/chinas-rare-earth-leverage-is-the-frontline-of-21st-century-geopolitics/; "Critical Dependence on Rare-Earth Minerals," *GQG Partners*, November 11, 2025, https://gqg.com/insights/critical-dependence-on-rare-earth-minerals/.

[26] Tae-Yoon Kim, et al., op. cit.

[27] 翁欣，〈新質生產力系列：供改逐步兌現，稀土永磁迎來高景氣〉，《中證鵬元資信評估股份有限公司》，2025 年 9 月 4 日，頁 5，https://www.cspengyuan.com/api/files/6960d45d42b27b2bdc799f06。

[28] 雖當時商務部並無正式禁令公告，而是是透過海關扣押貨船的非正式方式操作，且中方始終否認存在禁令。詳見〈分析：稀土成為中日關係新焦點〉，《BBC News 中文網》，2010 年 10 月 16 日，https://www.bbc.com/zhongwen/trad/world/2010/10/101016_china_japan_rare_earths。

源節約」監管體系。[29] 2012 年美、歐、日向 WTO 提起訴訟，中國於敗訴後取消稀土、鎢、鉬的出口配額制度。[30]此一階段促使美歐日意識到對中依賴風險，開始尋找替代礦源並開發稀土減量技術，但除日本外多數國家成效有限。[31]

自 2023 年起，中國進入出口管制法體系建立的時代，全面轉型為以《出口管制法》為核心的許可證管理體系，相較於 2010-2015 年以「環境保護、資源節約」為名之禁令，此一階段直接以「國家安全」為法理依據，標誌中國對外經貿管制邏輯的根本轉變。2023 年 12 月公告《中國禁止出口限制出口技術目錄》，禁止出口稀土提取、分離及合金生產技術；[32] 2024 年《稀土管理條例》以法規形式將技術管控與出口總量管制並列，標誌稀土智慧財產權系統性轉化為國家管控工具。[33] 2025 年中國連發三道禁令，將「中重稀土」、「稀有小金屬」（如鎢、鋇）以及「石墨／鋰電材料」納入出口管制。此階段管制具明確戰略選擇性：中國避開產量大、替代方案多之輕稀土，鎖定稀缺且具國防戰略

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[29] 〈國務院關於促進稀土行業持續健康發展的若干意見〉，《中華人民共和國生態環境部》，2011 年 5 月 23 日，https://www.mee.gov.cn/zcwj/gwywj/201811/t20181129_676509.shtml。

[30] 〈美日歐盟起訴稀土管控 中國業內稱訴訟前景樂觀〉，《中國新聞網》，2012 年 3 月 14 日，https://www.chinanews.com.cn/cj/2012/03-14/3741194.shtml；〈中國受稀土案敗訴影響 取消稀土出口配額〉，《人民網》，2015 年 1 月 6 日，http://politics.people.com.cn/BIG5/n/2015/0106/c70731-26331198.html；〈關於實施稀土、鎢、鉬資源稅從價計征改革的通知〉，《國家稅務總局上海市稅務局》，2015 年 5 月 20 日，https://shanghai.chinatax.gov.cn/zcfw/zcfgk/zys/201507/t417979.html。

[31] Tatsuya Terazawa, “How Japan Solved Its Rare Earth Minerals Dependency Issue,” *World Economic Forum*, October 13, 2023, https://www.weforum.org/stories/2023/10/japan-rare-earth-minerals.

[32] 〈中華人民共和國商務部 中華人民共和國科學技術部公告 2023 年第 57 號〉，《中華人民共和國商務部》，2023 年 12 月 21 日，https://fms.mofcom.gov.cn/zcfg/jsjckzcfg/art/2023/art_976221954467 40f897a578c784579bd8.html。管制分兩種，一種是禁止出口，一種是限制出口。禁止出口的有：稀土的提煉、加工、利用技術，包含 1、稀土萃取分離工藝技術限制出口；2、稀土金屬及合金材料的生產技術；3、釤鈷、釹鐵硼、鈰磁體製備技術、4、稀土硼酸氧鈣製備技術。限制出口包含大部分稀土相關技術，有：稀土採、選、冶煉技術（禁止類除外）及萃取劑合成配方、金屬材料的稀土改性添加技術、含稀土的鋁鋰合金製備技術、導電用稀土鋁導線的配方和製造工藝等。

[33] 〈稀土管理條例（中華人民共和國國務院令 第 785 號）〉，《中華人民共和國生態環境部》，2024 年 7 月 1 日，https://www.mee.gov.cn/zcwj/gwywj/202407/t20240701_1080564.shtml。

意義之中重稀土、半導體材料（鎵、鍺、銻、超硬材料）與電池材料，精準切斷高階晶片與國防產業鏈，導致相關礦產價格飆升（如銻價漲逾 200%），並直接衝擊日韓半導體與顯示器產業。

第三階段為對特定國家的定向管制，標誌中國從普遍性出口管制升級為地緣經濟工具。2024 年 12 月 3 日，中國首次對美國實施礦產定向禁令，包括禁止兩用物項對美國軍事用戶或軍事用途出口、原則上不許鎵、鍺、銻與超硬材料對美出口，並對石墨輸美實施更嚴格的最終用途審查；此舉一般被解讀為對前一日美國對中國半導體出口管制升級的直接反制。[34] 2025 年 10 月川習釜山會晤雖達成暫時性停火，但北京已將稀土配額轉向「國家安全」等級，不再發布詳細配額數據，並引入具域外效力（Extraterritorial reach）的法律條款，要求外國公司若使用中國技術或設備，即使在第三國生產亦須獲得許可。2026 年 1 至 2 月，中國對日本加強兩用物項出口管制並將三菱造船等 20 家日本實體列入管控名單，顯示定向管制之運用已不限於美國。

表 2、中國關鍵礦產出口管制事件

發布單位	時間	法案名稱／事件	受限制礦產／物項	對象國／範疇	主要影響
第一階段：出口配額管制時代（2010–2015）					
商務部	2010 年（非正式）	稀土出口配額削減約 40%（較 2009 年）釣魚島事件後對日稀土出口事實上中斷約 6 週（中方否認存在正式禁令）	稀土（全類）、鎢、鉬	全球　日本受衝擊最深	中國時供全球 97% 稀土，配額削減引發稀土價格數倍飆漲。此為首次以稀土為地緣政治工具之標誌性事件，促使美日歐加速多元化並於 2012 年聯手提起 WTO 訴訟。

[34] 〈商務部公告 2024 年第 46 號 關於加強相關兩用物項對美國出口管制的公告〉，《中華人民共和國商務部》，2024 年 12 月 3 日，https://www.mofcom.gov.cn/zwgk/zcfb/art/2024/art_3d5e990b43424e60828030f58a547b60.html；Amy Lv and Tony Munroe, “China Bans Export of Critical Minerals to US as Trade Tensions Escalate,” *Reuters*, December 3, 2024, https://www.reuters.com/markets/commodities/china-bans-exports-gallium-germanium-antimony-us-2024-12-03/.

發布單位	時間	法案名稱／事件	受限制礦產／物項	對象國/範疇	主要影響
商務部	2015-01	依 WTO 裁決取消稀土、鎢、鉬出口配額改為出口許可證管理制度	稀土、鎢、鉬	全球	以許可證取代配額，表面合規於 WTO。稀土價格大跌，美國最大稀土礦商 Molycorp 於 2015 年 6 月破產；中方藉低價擊垮境外競爭者、保留出口流向審查空間，此後稀土全球市佔維持 6 至 7 成以上。
第二階段：出口管制法體系時代（2023–）——物項普遍管制					
商務部 海關總署	2023-07-03	公告第 23 號對鎵、鍺相關物項實施出口管制	鎵（Ga）、鍺（Ge）	全球（非歧視）	中國供全球逾 90%鎵、近 70%鍺。2023 至 2024 年鎵出口量減近半，鎵價漲 53%、鍺價漲 64%，日韓半導體廠商受波及。
商務部 海關總署	2023-10-20	公告第 39 號優化調整石墨物項臨時出口管制措施	天然鱗片石墨、三高人造石墨	全球（非歧視）	中國佔全球石墨約 77%，日韓電池廠對球化石墨 100%依賴中國。管制初期美、印申請受阻，韓、德較快獲批，顯示差異性審批。
商務部 海關總署	2024-08-15（實施：09-15）	公告第 33 號對銻等物項及超硬材料實施出口管制	銻（Sb）超硬材料（金剛石）	全球（非歧視）	銻年內漲逾 212%。比利時鍺精煉商 Umicore 進口量先增後歸零，歐洲供應鏈受衝擊；超硬材料（CVD 設備）列管衝擊半導體封裝。
同上	2025-02-04	公告第 10 號對鎢、碲、鉍、鉬、銦相關物項實施出口管制	鎢（W）、碲（Te）鉍（Bi）、鉬（Mo）銦（In）	全球（非歧視）	管制 25 項。銦（ITO 靶材）衝擊日韓面板業；碲化鎘影響薄膜太陽能電池（如 First Solar）；鎢影響航太引擎與穿甲彈。
同上	2025-04-04	公告第 18 號	釤、釓、	全球（非	4 至 5 月稀土磁鐵對

發布單位	時間	法案名稱／事件	受限制礦產／物項	對象國/範疇	主要影響
		對部分中重稀土相關物項實施出口管制	鈰、鏑鑭、釤、釓（7 類中重稀土）	歧視）	韓出口崩跌 93%、對日 91%；5 月全球磁鐵出口約 6,000 萬美元，創 2015 年以來新低。歐日韓車業警告供應短缺、庫存恐數月告罄。公告迄今有效。
同上	2025-10-09	公告第 55–58 號、第 61–62 號，共 6 號。第 55 號：超硬材料新版；第 56 號：稀土設備；第 57 號：釤銪鉺銪鐿等 5 種中重稀土；第 58 號：鋰電池＋人造石墨負極；第 61 號：境外稀土物項（域外管轄） 第 62 號：稀土相關技術。	超硬材料（新版）稀土生產加工設備釤銪鉺銪鐿鋰電池 人造石墨負極材料稀土相關技術	全球（含域外管轄）	第 61 號首次對含中國原產稀土≥0.1%之境外製品行使域外管轄，波及全球供應鏈（含韓、歐）；第 58 號鋰電池管制為歷次最直接衝擊電動車產業者。第 70 號暫停令（2025-11-07）將 6 道公告暫停至 2026-11-10，背景為中美釜山會晤協議。
第三階段：對象國定向管制（2024–2026）					
商務部	2024-12-03	公告第 46 號（後經第 72 號調整）加強相關兩用物項對美國出口管制。	鎵、鍺、銻超硬材料、石墨	美國（定向）	首次對單一國家實施定向禁令：原則不予許可鎵鍺銻及超硬材料之對美軍事用途出口，石墨加強審查，為對美升級半導體管制之直接反制。第 72 號調整令（2025-11-09）暫停第 2 款至 2026-11-27。韓、歐同受普遍管制影響。
同上	2026-01-06	公告第 1 號關於加強兩用	全類兩用物項（逾	日本（定向）	禁止一切兩用物項對日本軍事用戶、軍

發布單位	時間	法案名稱／事件	受限制礦產／物項	對象國/範疇	主要影響
		物項對日本出口管制	1,000 種，含所有管制礦種）		事用途及提升日本軍事實力之最終用途出口；背景為日相高市早苗涉台言論。
同上	2026-02-24	公告第 11 號將三菱造船等 20 家日本實體列入管控名單	全類兩用物項	日本（特定實體）	三菱造船、三菱重工等 20 家日本軍工相關實體遭全面禁運兩用物項，另 20 家（含 SUBARU）列入關注名單受嚴格審查；為 2026 年第 1 號之配套措施。

資料來源：商務部公告 2023 年第 23 號；商務部海關總署公告 2023 年第 39 號；商務部海關總署公告 2024 年第 33 號；商務部公告 2025 年第 10 號；商務部海關總署公告 2025 年第 18 號；商務部公告 2024 年第 46 號；商務部公告 2026 年第 1 號；商務部公告 2026 年第 11 號。各公告出處詳見商務部、海關總署官網。

四、政策工具：配額管制、出口管控與「資訊不透明」的強制性

完整理解中國稀土供應鏈之主宰性，須進一步觀察其政策工具體系。傳統文獻多聚焦出口配額之「數量限制」，而忽略資訊管控本身之強制性，此乃中國 2024 年以來政策工具升級之核心特徵。

2024 年起，北京當局放棄了延續三十餘年的配額公開發布慣例，轉而改採不公開（non-disclosure）策略。伍德斯（Dwayne Woods）指出，隱藏配額本身即可成為強制性槓桿——外國政府與企業在資訊不對稱下被迫以最壞情景作為預防性假設，進而觸發超前備貨、緊急多元化採購乃至政府政策干預；即便中國並未實際減供，亦已達成以「不確定性」作為地緣政治工具的戰略效果。[35]

2025-2026 年初之市場波動，進一步展現中國利用壟斷地位進行「價格戰」之能力。自北京 2025 年 4 月實施出口管制以來，中國境外鎝

[35] Dwayne Woods, “The Power of Withholding: Rare Earth Quotas and Informational Statecraft in China,” *Journal of Chinese Political Science*, October 2025, https://doi.org/10.1007/s11366-025-09922-9.

（Dysprosium）、鋱（Terbium）價格已上漲約四至五倍，釔（Yttrium）更上漲約140倍且持續攀升；同期上海金屬市場（Shanghai Metals Market, SMM）之境內基準則相對平緩。此一背離顯示漲勢集中於受管制衝擊之非中供應層次，形成「內外有別」之定價結構。[36]

此一定價策略本質上是透過地緣經濟手段，迫使高科技下游製造業向中國本土轉移，以換取穩定的低價供應；其反面亦構成本文後續討論美國「安全溢價」政策的對照基礎，後述之美國價格下限機制與公共財政補貼，正是試圖在排除中國供應鏈的條件下，承擔此一安全溢價成本。

肆、美國關鍵礦產戰略架構

由於中國自 2025 年開始頻繁地以稀土作為地緣政治武器，自該年下半年起，川普政府對 CM 政策發生根本性的典範轉移。從國防授權法案中對「關鍵礦產清單」的定期更新，到以主權股權介入私人礦業公司的直接持股操作，再到 2026 年 2 月 4 日在國務院召開的 CMM 中正式宣告 FORGE 框架的誕生，美國政策已由規則倡議轉向規則制定。[37]本文提出美國 CM 戰略三層架構：一、戰略宣示層：「矽和平峰會」（Pax Silica）與算力國力論；二、制度設計層：FORGE 與部長級會議；三、金融動員層：Project Vault 與戰略投資。這三層並非並列的政策分類，而是構成一條具有內在轉化邏輯的機制鏈，其層層轉化之邏輯詳見本節第四小節。以下分述之。

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[36] 鏑之中國境內產業基準採上海金屬市場（Shanghai Metals Market, SMM）報價，2026 年上半年鏑氧化物約在每公斤 190 至 220 美元區間、鋱氧化物約在 800 至 900 美元區間，詳見上海金屬市場網頁，“Rare Earth Oxides,” *Shanghai Metals Market*, https://www.metal.com/Rare-Earth-Oxides。中國境外之權威報價則採價格報告機構（price reporting agency）Argus 之評估：據《路透社》報導，自 2025 年 4 月中國實施出口管制以來，中國境外鏑、鋱價格上漲約四至五倍、釔價格上漲約一百四十倍，同期釔、鏑、鋱之出口量仍較管制前低約五成。詳見 Lewis Jackson, Michael Martina and Laurie Chen, “Trump, Xi to Weigh Rare Earth Truce Extension, but China's Curbs Still Bite,” *Reuters*, May 13, 2026, https://www.reuters.com/business/aerospace-defense/trump-xi-weigh-rare-earth-truce-extension-chinas-curbs-still-bite-2026-05-13/。須說明者，SMM 中國境內產業基準與 Argus 之中國境外評估分屬不同市場層次，二者價差除反映出口管制外，亦部分反映市場類型差異與境外交易流動性。

[37] Hannah Northey and James Bikales, “White House Entices Allies with Critical Minerals Plan,” *Politico Pro*, February 5, 2026, https://subscriber.politicopro.com/article/eenews/2026/02/04/white-house-entices-allies-with-critical-minerals-plan-00764364.

一、戰略宣示層：「矽和平峰會」與算力國力論

2025 年 12 月 12 日，美國國務院在華盛頓舉辦首屆「矽和平峰會」，由經濟事務次卿赫爾伯格（Jacob Helberg）主持，邀集日、韓、新、澳、荷、英、以色列及阿拉伯聯合大公國等八國代表，共同簽署《矽和平宣言》（*Pax Silica Declaration*）。[38]「矽和平峰會」的合作範疇涵蓋「全球技術供應鏈的戰略性堆疊」（full technology stack），包括軟體應用、前沿基礎模型、算力與半導體、先進製造、物流運輸、礦產精煉與加工及能源等層次。此後成員持續擴增，至 2026 年年中已達 24 國。[39]

峰會後，赫爾伯格向美國國務院總部及全體駐外使館下達指令，要求落實峰會討論成果，具體包括識別旗艦基礎建設計畫並協調盟友的經濟安全實踐，[40]此一行政動員規模顯示其具體政策意圖遠超過一般宣示性倡議。同月，國務院宣告成立規模 2.5 億美元的「Pax Silica 基金」，以美國政府資金為基礎，吸引軟銀（SoftBank）、新加坡淡馬錫（Temasek）及阿布達比穆巴達拉（Mubadala）等主權財富基金作為創始成員，目標擴大至 4 兆美元規模的自願性投資聯合體。

Pax Silica 之基本假設為：人工智慧領域之領先地位將決定經濟、安全與軍事力量；其關鍵在將礦產、能源、算力與 AI 霸權等原屬不同政策領域之議題，整合為統一之戰略敘事，並以垂直整合邏輯重建美國國力。因此，在 Pax Silica 官方網頁上，赫爾伯格明白宣示：「若 20 世紀以石油與鋼鐵為動力，21 世紀則以算力及支撐算力的礦物資源為動力。」[41]此一宣示也清楚表明「算力即國力」戰略重心。

然如前述，於中國壟斷稀土供應之背景下，與友盟合作成為美國政

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[38] 「Pax Silica」之命名取自拉丁文 pax（和平、穩定與長期繁榮）與 silica（二氧化矽，矽的前驅物）。美國國務院官方說明援引「Pax Americana」與「Pax Romana」作為語源參照，揭示此一倡議試圖為 AI 時代的技術秩序，確立具有廣泛共識與歷史厚度的命名框架。台灣以「非正式簽署方」（non-signatory participant）身份出席峰會討論，並以《美台經濟安全合作聯合聲明》形式認同宣言原則。U.S. Department of State, "Pax Silica Summit," December 12, 2025, https://www.state.gov/releases/office-of-the-spokesperson/2025/12/pax-silica-initiative.

[39] "Outcomes of the Second Pax Silica Summit," *U.S. Department of State*, June 26, 2026, https://www.state.gov/releases/office-of-the-spokesperson/2026/06/outcomes-of-the-second-pax-silica-summit.

[40] U.S. Department of State, "Pax Silica Summit," op. cit.

[41] Ibid.

策之必然。在川普政府貿易政策一貫偏好雙邊框架——從退出 TPP、重談 USMCA 到以 232 條款、單邊關稅作為主要施壓工具——Pax Silica 以多邊宣言形式組建科技供應鏈聯盟，在川普第二任政策光譜中具有相對的異質性。赫爾伯格在 2026 年 3 月的「山丘與矽谷論壇」（Hill and Valley Forum）早餐會亦指出，Pax Silica 基金的戰略目標是確保「礦產、港口、工廠及支撐全球晶片供應鏈的能源資產」在盟友控制之下。[42] 因此，Pax Silica 並非單純的供應鏈安全倡議，而是一套以「算力即國力」為核心命題的戰略論述體系，並且在此框架下被整合為以美國為核心、盟友共享的集體戰略利益。

二、制度設計層：「資源地緣戰略參與論壇」與部長級會議

國務卿盧比奧（Marco Rubio）在首屆 CMM 上宣布成立 FORGE，取代拜登政府於 2022 年建立的「礦產安全夥伴關係」（Minerals Security Partnership）。該次部長級會議共有 54 個國家及歐盟委員會的代表出席，其中包括 43 位外交部長或對等層級官員。FORGE 由南韓擔任輪值主席至 2026 年 6 月。同日，美國另與阿根廷、庫克群島、厄瓜多、幾內亞、摩洛哥、巴拉圭、秘魯、菲律賓、阿拉伯聯合大公國、英國及烏茲別克等 11 國簽署雙邊礦產框架或諒解備忘錄，累計加上過去五個月已簽的 10 份，合計 21 份雙邊協議；另有 17 國談判已完成但尚未正式簽署。[43]

有別於傳統多邊協調機制，FORGE 在制度上屬「複數邊聯盟」（plurilateral coalition），其目標是在志同道合的成員國之間，建立一套具有可執行規則的 CM 優惠貿易與投資區。換言之，FORGE 不追求普遍性成員資格，而是以共同接受特定規則作為加入集團前提。惟這套框架目前仍存在明顯的不確定性。以美國與剛果民主共和國（Democratic

[42] Luke James, “Trump Administration Targets $4 Trillion Pax Silica Investment Fund for Semiconductors — The US Will Start with a $250 Million Investment for Global Consortium,” *Tom's Hardware*, March 24, 2026, https://www.tomshardware.com/tech-industry/semiconductors/trump-administration-targets-4-trillion-pax-silica-investment-fund-for-semiconductors.

[43] Office of the Spokesperson, “2026 Critical Minerals Ministerial,” *U.S. Department of State*, February 4, 2026, https://www.state.gov/releases/office-of-the-spokesperson/2026/02/2026-critical-minerals-ministerial；汪哲仁，〈關鍵礦產部長級會議 —— 美國戰略礦產框架最後一塊拼圖〉，《國防安全即時評析》，第 953 期，2026 年 2 月 10 日，https:// indsr.org.tw/focus?uid=11&pid=3053&typeid=27。

Republic of the Congo）簽署的協議為例，因違反剛果憲法中關於資源主權的規定，以及涉及資源交換的條約須經國會批准的要求，而遭到反對。[44]可見，在透明度與國內問責機制不足的情況下，即便協議已簽署，到最後是否會加入 FORGE 亦未定。

FORGE 與部長會議提出價格下限（Price Floor）機制。2026 年 2 月 3 日，美國分別與歐盟、日本及墨西哥宣布「行動計畫」，探索開發「邊境調整價格下限」（border-adjusted price floors），並研究納入具約束力的複數邊貿易協議之可能性；備選工具包括「標準基礎市場、差價補貼或承購協議」。美墨行動計畫預計在 60 天內（即 2026 年 4 月初前）落實，可能採用「最低進口價格」（Minimum Import Price）形式。[45]在前期先例上，五角大廈已在 2025 年 7 月與 MP Materials 的交易中設定每公斤 110 美元的釹鐠氧化物（NdPr）價格下限：市場價低於此水準時政府補差額，市場價高於此水準時政府分享 30%的上行收益。

然而，價格下限目前有三個核心問題尚待確認：參考價格的設定基礎為何、於哪些礦種實施，以及最終有哪些國家同意實施價格下限。[46]另一制度相關工具，係美國傾向以可調整關稅（Adjustable Tariffs）吸引盟友加入。可調整關稅的法律基礎源自 2025 年 4 月 22 日商務部依《1962 年貿易擴張法》第 232 條款啟動「加工關鍵礦產及其衍生品」（Processed Critical Minerals and Their Derivative Products, PCMDPs）國家安全調查。該調查認定美國國防工業基礎、16 個關鍵基礎設施部門及軍事作戰能力皆仰賴 PCMDPs，惟國內加工產能嚴重不足，有損國家安全。2026 年 1 月 14 日，川普簽署《第 11001 號總統公告》（Proclamation 11001），指示商務部與美國貿易代表（USTR）在 180 天內（至 2026 年 7 月 13 日）就 PCMDPs 進口問題與貿易夥伴談判協議；談判目標包括「考慮對關鍵礦產貿易設置價格下限及其他貿易限制措施」，若談判未果，則不排除

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44 "US Critical Minerals Ministerial Raises New Prospects — and Questions — for Developing Producers," *Natural Resource Governance Institute*, February 16, 2026, https://resourcegovernance.org/articles/us-critical-minerals-ministerial-raises-new-prospects-and-questions-developing-producers.

45 Pillsbury Winthrop Shaw Pittman, "The Trump Administration Launches Plurilateral Initiative and a Strategic Reserve to Secure Critical Minerals Supply Chains," *Pillsbury Insights*, February 17, 2026, https://www.pillsburylaw.com/en/news-and-insights/critical-minerals-forge-project-vault.html.

46 Ibid.

在未來實施更嚴格進口限制。[47] 232 條款屬行政授權而非立法關稅，毋須國會立法即可執行，調整幅度、適用範圍與豁免條件均由行政部門單方決定，賦予總統極高之裁量空間，因而成為推動盟友加入 FORGE 之工具。

三、金融動員層：Project Vault 與戰略投資

（一）公私合資模式：「金庫計畫」與戰略儲備

2026 年 2 月 2 日，川普政府宣布建立「美國戰略關鍵礦產儲備」（U.S. Strategic Critical Minerals Reserve）與「金庫計畫」。該計畫核心是對需求面保障提供國內金融工程。[48]

在資本結構方面，「金庫計畫」採公私合資架構，資金來源由兩部分構成：美國進出口銀行（Export-Import Bank of the United States, EXIM）提供 100 億美元貸款，以及來自私人部門的 20 億美元。EXIM 將運用法定職權，向獨立第三方實體「金庫公司」（VaultCo）提供貸款，由其執行「金庫計畫」交易。由 Hartree Partners LP、Traxys North America LLC 及 Mercuria Americas 供應礦源，來源並不限於美國。[49]

在參與機制方面，企業需滿足兩項條件：第一，提交所需礦產的種類與數量清單，並承諾以固定價格在日後購入其申請儲備的數量；第二，預先支付儲存費用及 EXIM 貸款給 VaultCo 的利息。此機制使企業得以

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[47] "Adjusting Imports of Processed Critical Minerals and Their Derivative Products into the United States," *The White House*, January 14, 2026, https://www.whitehouse.gov/presidential-actions/2026/01/adjusting-imports-of-processed-critical-minerals-and-their-derivative-products-into-the-united-states/.

[48] Hannah Northey, "Trump's Mineral Stockpile Takes Shape," *Politico Pro*, February 26, 2026, https://subscriber.politicopro.com/article/eenews/2026/02/26/trumps-mineral-stockpile-takes-shape-00800148.

[49] Pillsbury Winthrop Shaw Pittman, op. cit.; Zahava Urecki, "Project Vault and FORGE: The Administration's Latest Moves to Secure Critical Minerals," *Bipartisan Policy Center*, February 13, 2026, https://bipartisanpolicy.org/article/project-vault-and-forge-the-administrations-latest-moves-to-secure-critical-minerals/; 有關金庫計畫融資結構，即 EXIM 提供100億美元直接貸款，結合近20億美元私人資本的部分，請參閱 "EXIM Approves Project Vault Loan to Launch America's Strategic Critical Minerals Reserve," *Export-Import Bank of the United States*, February 2, 2026, https://www.exim.gov/news/project-vault; "Week in Review: Project Vault and the U.S. Strategic Critical Mineral Reserve," *Export-Import Bank of the United States,* February 6, 2026, https://www.exim.gov/news/week-review-project-vault-and-strategic-critical-mineral-reserve.

對沖長期價格風險，將未來採購成本鎖定於可預期區間。企業除在正常情況下依補庫機制提取外，亦可在特定市場條件，如出口管制生效或市場供應受到嚴重約束時，動用儲備。

（二）債務與股權工具並行

川普政府於 CM 領域最顯著之政策創新，係將直接股權投資納為產業政策工具，有別於貸款、補助等傳統工具。相關投資案例如下表所示。

表 3、美國政府關鍵礦產股權投資案例

公司	礦種／產業	股份比例	投資規模	投資方	時間	背景與政策意涵
MP Materials	稀土/永久磁鐵	**15%**	未公開	美國政府	2025 年 7 月	成為最大單一股東；降低對中國盛和資源（Shenghe）依賴；Mountain Pass 礦山整套擴建，並包含股權、價格下限及包銷協議（DoD）。
Lithium Americas	鋰	5%	能源部貸款 23 億	同上	2025 年 10 月	政府同時持有控股母公司 Lithium Americas 和礦山計畫 Thacker Pass 各 5%。Thacker Pass 因未達首次撥款條件，政府以同意延遲還款換取免費 5%股份；引發股份稀釋爭議。
Trilogy Metals	銅鋅/金銀	**10%**	約 3,560 萬	同上	2025 年 10 月	阿拉斯加 Upper Kobuk 計畫仍在早期許可階段。伴隨安布勒工業公路（211 英里）批准，顯示長期戰略布局意圖。

公司	礦種／產業	股份比例	投資規模	投資方	時間	背景與政策意涵
USA Rare Earth	稀土/磁鐵製造	**10%**	$16 億（債務＋股權組合）	商務部	2026 年 1 月	（CHIPS 辦公室）非約束性意向書階段；支持國內稀土礦山及磁鐵製造設施，與半導體供應鏈連結。
Korea Zinc（韓國鋅業）	多金屬冶煉	合資企業	$74 億	國防部	2025 年 12 月	合資比例未公開。田納西州多金屬冶煉廠；建立美國境內大規模下游產能；獲美國主要機構投資者融資。
Atlantic Alumina	氧化鋁/鎵	優先股	$1.5 億優先股	國防部	2026 年 1 月	優先股比例未公開，另 3 億美元來自其他管道。確保美國唯一氧化鋁精煉廠持續運營；建立首個大規模國內初級鎵生產。

資料來源：Kevin Brunelli & Tom Moerenhout, “Q&A: How the US Is Using Equity Stakes to Support Domestic Critical Minerals Development,” *Center on Global Energy Policy*, October 27, 2025, https://www.energypolicy.columbia.edu/qa-how-the-us-is-using-equity-stakes-to-support-domestic-critical-minerals-development/; FTI Consulting, “The New U.S. Government Critical Minerals Playbook,” February 13, 2026. https://www.fticonsulting.com/insights/articles/lender-market-maker-us-critical-minerals-playbook。

除股權之外，川普政府也大幅擴張信貸規模，分為兩個階段：2025 年 7 月《一個偉大美麗法案》（*One Big Beautiful Bill Act*, OBBBA）簽署前的制度建立期，以及簽署後的大規模部署期。OBBBA 撥款 15 億美元給國防部戰略資本辦公室（Office of Strategic Capital, OSC），作為信用補貼（credit subsidy），透過槓桿操作可創造出 2,000 億美元貸款授權，其中 1,000 億美元專款用於 CM 生產及相關產業。2025 年 8 月，OSC 向 MP Materials 發放 1.5 億美元貸款，支持其在 Mountain

Pass 重稀土分離工程，形成從礦山到磁鐵的完整產業鏈。該協議同時包含 4 億美元優先股投資、每公斤 110 美元的 NdPr 氧化物價格下限，以及與未來磁鐵產能連動的 30%上行收益分配條款。[50]

OBBBA 對信貸工具的最深層影響，不僅在於規模擴張，更在於政策工具的重新定向。以能源部「能源主導融資計畫」（Energy Dominance Financing, EDF）[51]為例，該計畫原是拜登政府的「去碳化工具」，OBBBA 於 2025 年 7 月 4 日刪除減少空汙排放的前提，並由能源部於同年 10 月 28 日發布修訂後臨時最終規則。[52]新 EDF 將「能源基礎設施」的定義大幅拓寬，明確涵蓋 CM 從礦藏識別、採掘、加工、運輸直至精煉的完整價值鏈，並授權能源部長在 2028 年 9 月 30 日前擔保最高 2,500 億美元

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[50] "Office of Strategic Capital Announces First Loan Through DoD Agreement With MP Materials to Secure Critical Materials Supply Chain," *U.S. Department of Defense*, August 10, 2025, https://www.defense.gov/News/Releases/Release/Article/4270722/office-of-strategic-capital-announces-first-loan-through-dod-agreement-with-mp/; Brownstein Hyatt Farber Schreck, "U.S. Expands Critical Minerals Financing and Bilateral Partnerships Under Trump," *Brownstein Hyatt Farber Schreck*, November 10, 2025, https://www.bhfs.com/insight/u-s-expands-critical-minerals-financing-and-bilateral-partnerships-under-trump/. OSC 授權槓桿結構（10 億美元信貸補貼支撐至多 1,000 億美元通用雙用途融資，另 5 億美元支撐額外 1,000 億美元關鍵礦產融資，合計 15 億美元創造約 2,000 億美元授權）之依據為《單一大而美法案》（*One Big Beautiful Bill Act*, P.L. 119-21）第 20005(b)條。參見 Ankura, "The One Big Beautiful Bill: Impacts to Federal Grant, Loan, and Tax Credit Opportunities," December 17, 2025, https://ankura.com/insights/the-one-big-beautiful-bill-impacts-to-federal-grant-loan-and-tax-credit-opportunities；及 Nossaman, "The OBBB Act: Enhancing U.S. National Security & Defense Capabilities," July 15, 2025, https://www.nossaman.com/newsroom-insights-the-obbb-act-enhancing-u-s-national-security-and-defense-capabilities。OSC 通用授權所涵蓋之 31 項技術類別（如半導體、量子計算），係依《2024 財政年度國防授權法》（P.L. 118-31）第 903 條所定。參見 U.S. Department of Defense, Office of Strategic Capital, "Investment Strategy for the Office of Strategic Capital," Fiscal Year 2025, January 2, 2025, https://media.defense.gov/2025/Jan/02/2003623435/-1/-1/1/FY25-INVESTMENT-STRATEGY-FOR-OFFICE-OF-STRATEGIC-CAPITAL.PDF；並見 Federal Register, "Notice of Funding Availability—Covered Technology Categories—Equipment Financing," September 27, 2024, https://www.federalregister.gov/documents/2024/09/27/2024-22229/notice-of-funding-availability-covered-technology-categories-equipment-financing。

[51] EDF 的前身是《通貨膨脹削減法案》（IRA，2022 年）在《能源政策法》第 1706 條款下建立的「能源基礎設施再投資計畫」（EIR），其原本的核心條件是：申請計畫必須能夠減少溫室氣體排放或空氣污染物。

[52] U.S. Department of Energy, "Energy Dominance Financing Amendments," 90 Fed. Reg. 48705, October 28, 2025, https://www.federalregister.gov/documents/2025/10/28/2025-19675/energy-dominance-financing-amendments.

本金的貸款，並另撥 10 億美元信貸補貼（credit subsidy）承擔擔保的預期違約成本，估計可實際支撐約 2,000 億美元的專案融資。[53]

（三）主權基金與礦產併購

美國國際開發金融公司（Development Finance Corporation, DFC）於川普二期政府之礦產戰略中居中樞角色。2025 年 12 月，DFC 的最大或有負債上限從約 600 億美元提升至 2,050 億美元，且擴大了投資範圍，從原先的低收入與中低收入國家，延伸至上中收入國家，前提是相關計畫支持美國國家安全與經濟競爭力。[54]DFC 已確認海外投資如表 4。

表 4、DFC 關鍵礦產海外投資代表性案例

專案	地點	工具	規模	結構特徵與政策意涵
Phalaborwa 稀土計畫	南非	股權投資	$5,000 萬	透過 TechMet 旗下 Rainbow Rare Earths 執行；DFC 同時持有 TechMet 股權，為其最大股東之一，形成基金-計畫雙層投資結構。
Serra Verde 稀土礦（Pela Ema 礦區）	巴西	債務融資	$5.65 億	針對稀土礦山的直接債務融資，支持美國下游稀土供應鏈多元化；巴西為南半球稀土儲量最大國之一。開始為 $4.65 億, 最終$5.65 億，含 DFC 股權購買選擇權。
Lobito 走廊基礎設施	安哥拉、尚比亞、	基礎設施融資	$5.53 億	支持銅等 CM 沿走廊出口的鐵路與物流基礎設施；為美

[53] Holland & Knight, "How the One Big Beautiful Bill Act Reshapes DOE Loan Programs," *Holland & Knight*, August 15, 2025, https://www.hklaw.com/en/insights/publications/2025/08/how-the-one-big-beautiful-bill-act-reshapes-doe-loan-programs.

[54] 有關美國國際開發金融公司或有負債上限提升至 2,050 億美元，係依 2025 年 12 月簽署之《2026 財政年度國防授權法》所含《2025 年 DFC 現代化與再授權法》（P.L. 119-60, Division H, Title LXXXVII）。參見 U.S. International Development Finance Corporation, "DFC Secures Expanded Authorities with FY26 NDAA Signed into Law," December 18, 2025, https://www.dfc.gov/media/press-releases/dfc-secures-expanded-authorities-fy26-ndaa-signed-law；並見 Congressional Research Service, "U.S. International Development Finance Corporation (DFC)," IF11436, https://www.congress.gov/crs-product/IF11436。

專案	地點	工具	規模	結構特徵與政策意涵
	DRC			國在撒哈拉以南非洲礦產物流布局的關鍵節點。【時間在本論文研究期間之前，列為背景資訊】
Orion 關鍵礦產聯合基金	多國（全球）	基金投資人（股權）	啟動規模$18 億，目標$50 億	由 Orion Resources Partners 與阿布達比 ADQ 共同組建，DFC 作為基金投資人參與；Columbia CGEP 指出，透過專業金融機構可降低投資決策政治化風險，避免「選擇贏家」的直接股權投資問題。
Mercuria–Gécamines–DFC 三方合作	DRC	商業合作（DFC 支持）	未公開	Mercuria 在 DFC 資金支持下，藉 Gécamines 持有的少數股份與合約行銷權，將中國多數控股礦山所產銅重新導向美國下游買家。此模式不涉及礦山所有權，乃透過下游採購控制物質流向——FTI 稱之為「controlling physical flows of commodities」，為對抗中國之側翼路徑。

資料來源：Kevin Brunelli and Tom Moerenhout, op. cit.; FTI Consulting, “The New U.S. Government Critical Minerals Playbook,” February 13, 2026, https://www.fticonsulting.com/insights/articles/lender-market-maker-us-critical-minerals-playbook; “US Backs Brazil Rare-Earth Mine With $465 Million Funding,” Bloomberg Law, November 7, 2025, https://news.bloomberglaw.com/environment-and-energy/us-backs-brazilian-rare-earth-project-with-465-million-funding。

這些案例揭示 DFC 在全球南方的投資組合，是依不同政治與產業條件下，選擇從供應鏈的不同節點介入，而非採用單一策略。

第一種為通道控制型，以 Lobito 走廊為代表。DFC 投資安哥拉、尚比亞、DRC 三國之鐵路與物流基礎設施，介入點非礦山所有權而係出

口通道；掌握走廊即可決定礦產之流向與裝運港口，自物流節點影響供應鏈上游之物質移動條件。

第二種為股權布局型，以南非 Phalaborwa 稀土計畫為代表。DFC 以持有 TechMet 股份進而控制 Rainbow Rare Earths 之雙層結構，自礦山開發階段即於生產端取得影響力；透過專業金融機構之中介，亦可降低政府直接「選擇贏家」（picking winners）之決策政治化風險。

第三種為供應錨定型，以巴西 Serra Verde 為代表。該公司由美英投資基金持有，惟其稀土產出主要買家曾為持有十年期供應合約之中國客戶。DFC 提供最終達 5.65 億美金之債務融資，實質條件為將部分產出轉向西方市場，Serra Verde 因此已將對中合約縮短至 2026 年底到期。此模式改變者非所有權或流通路徑，而係生產商之締約對象——以美國國家信用背書之低成本融資，換取供應方向之重新承諾。

第四種為流通截流型，以 Mercuria—Gécamines—DFC 三方模式為代表。DRC 銅礦山多由中國企業控股，美國無力取得所有權；惟剛果國有礦業公司 Gécamines 依契約握有部分中國控股礦山產出之行銷權。Mercuria 於 DFC 資金支持下取得對應之採購授權，將原流向中國買家之銅礦截留轉售美國下游製造商——所有權結構未變，改變者係商品離開礦山後之實體流向，自流通環節之法律接縫介入。

從這四種模式可知，美方介入的不一定是所有權，也可以是出口通道、融資依賴、或合約行銷權。

四、三層機制的邏輯轉化鏈

前述三層分析展示了美國 CM 戰略的具體政策內容。本節進一步論證三層之間的因果機制——戰略宣示如何使制度設計得以可能？制度設計又如何觸發金融動員？這兩個問題的答案更直接關係到本文核心命題的成立。

（一）第一個轉化：戰略宣示如何使制度設計得以可能？

戰略宣示層的功能在於將礦產供應、半導體製造、AI 領導地位與盟友協調等原屬不同政策領域的議題，整合為單一的安全敘事框架，構成

制度設計突破常態政治阻力之前提。常態阻力有三。首先是法理阻力。若無「礦產即國家安全」之論述支撐，232 條款的國家安全調查難以在 WTO 安全例外條款下成立；其次是多邊規範阻力。FORGE 框架對中國之系統性排除，若無「算力即國力、礦產即算力基礎」的戰略邏輯，將被視為違反 WTO 非歧視原則之貿易保護主義。最後是預算審查阻力，若無「對抗中國礦產武器化」框架，DFC 負債上限提高及投資範圍擴張至上中收入國家，以及 OBBBA 透過 OSC 信用補貼擴張，難以通過國會審查。

就此而言，戰略宣示層為制度設計層提供雙重授權：法律授權奠基於 232 條款、《國際緊急經濟權力法》(International Emergency Economic Powers Act, IEEPA) 等安全例外條款；政治授權則來自盟友與國會對「安全優先」作為例外原則的接受。缺乏此一整合，個別動作難以累積為系統性安排。

（二）第二個轉化：制度設計如何觸發金融動員？

制度設計層之核心功能，在於界定合格供應鏈之市場進入資格、交易價格與不合作代價。FORGE 框架以政治可信度為篩選邏輯，界定盟友供應圈之合格成員；價格下限機制設定提供美國與盟友持續經營的利潤空間；232 條款關稅則決定不合作者之市場成本。三者構成完整之「規則—價格—代價」結構。

此結構內生地產生金融動員之需求。FORGE 所欲建構之合格供應商，於中國長期傾銷定價下難以商業可行：如前節所述，鎳之中國國內價格僅西方市場價之約 21%，意味任何符合 FORGE 篩選邏輯之非中供應商，成本必然高於中國定價。若無公共財政承擔此「安全溢價」，合格供應商將遭低價擊垮，制度設計亦形同具文。

因此，金融動員層並非「額外加上」，而係制度設計之邏輯延伸。Project Vault 以固定價格採購承諾提供需求面保證；OBBBA 透過 OSC 信用補貼擴張，以支持產能建設；EDF 重定向後之 2,500 億美元擔保額度，涵蓋從礦藏至精煉之完整價值鏈；DFC 上限提高並擴張至上中收入國家，使盟友供應圈之境外節點獲得低成本融資。四者部署方向，由制度設計層所界定之「誰、以何種條件、需要多少財政支持」決定。

此邏輯解釋一個重要現象：西方政府投入巨額補貼卻未能建立替代供應鏈，[55]關鍵在於缺乏制度設計層之篩選邏輯與價格機制為前提。無合格供應商之界定，補貼難以聚焦；無價格下限機制，公共支出無以對沖中國市場價格波動。川普二期政策之創新，並非投入更多公共資金，而在於先建立制度框架，再使金融工具沿框架部署。

前述兩個轉化機制之因果關係及其層間傳遞條件，可整理如圖 1 所示；三者環環相扣，缺一不可。

「制度型去風險化」作為「被武器化方」對咽喉點威脅的系統性反制，要求一套同時具備正當性建構、規則界定與資本動員能力的制度安排。三者的共同效果，是將供應鏈安全從個別政策行動升級為持續性的制度安排，使美國從市場去風險化者轉型為市場塑造者。

伍、市場典範轉移與地緣經濟影響

從美中在 CM 的戰略新布局，可以發現三個特點：國家力量重返市場、安全溢價的共同承擔、供應鏈區塊化的不對稱性。

一、國家重返市場：從市場去風險化到市場塑造

美國此 CM 政策轉變，標誌政府於市場中角色之戰略重置：由為私人企業與市場緩衝商業風險之「市場去風險化者」（market de-risker），轉為主動介入市場形成之「市場塑造者」（market shaper）。過去，西方

[55] 過去西方政府的補貼之所以難以建立替代供應鏈，最具代表性的案例是 2010 年 IPO 後一度被視為美國稀土復興指標的 Molycorp 公司——其於 2015 年 6 月聲請破產保護，旗下 Mountain Pass 礦山最終於 2017 年以 2,050 萬美元出售予含中國盛和資源 10%持股的 MP Mine Operations LLC 投資集團；理論層次的市場結構分析詳見 Eugene Gholz and Llewelyn Hughes, “Market Structure and Economic Sanctions: The 2010 Rare Earth Elements Episode as a Pathway Case of Market Adjustment,” *Review of International Political Economy*, Vol. 28, No. 3, 2021, pp. 611-634.

圖 1、制度型去風險化的三層機制邏輯轉化鏈

說明：實線箭頭表示因果賦能關係；灰底圓角標籤表示層間傳遞之機制條件；綠框表示各層之機制產出，三層累積驅動國家角色由防禦性去風險化轉為主動塑造市場。

資料來源：作者自行繪製。

政府之市場介入以貸款擔保、稅收抵免等工具降低私人投資風險為主；2025 年以來之美國政策已跨越此界線：政府直接持股、設定官方採購價格下限、以財政承擔市場溢價，並要求盟友接受共同規則為加入前提。

當中國以國家力量系統性壓低精煉成本、排擠境外競爭者，西方私人資本已無法於無政府介入之條件下維持商業可行性。就此而言，美國政府之介入並非背離自由市場原則，而係對中國先行扭曲市場之反制：

以國家力量回應國家力量。

對此一立場，學界亦有相反觀點。霍茲（Eugene Gholz）曾論證稀土供應風險遭誇大，指出 2010 年中國對日禁運未達預期效果，主因在於非中供應之成長空間、出口管制之執行困難與市場之即時調整能力。[56]霍茲與休斯（Llewelyn Hughes）以替代材料、技術創新與庫存調整分散衝擊，論證禁運之經濟成本遭高估。[57]兩者呼應哈希克（James Hasik）對美國政府過度介入稀土供應鏈的疑慮。[58]

然而，這些論證建立在當時市場結構假設之上，當時中國的出口管制係針對所有買家之普遍性管制，該前提於 2023 年後已實質改變。市場能否自行消化衝擊，取決於中國是否持續將礦產政治化：霍茲之市場調整論以「武器化屬偶發、有限度」為前提，但既有實證顯示中國之政治化係持續且系統升級。據此，本文認為「以國家力量回應國家力量」雖成本高昂，於當前條件下仍具合理性，其可持續性則有待下文風險評估。

二、美國與盟友共同承擔安全溢價：可持續性的三個變數

然此一反制邏輯面臨無法迴避之成本問題。如鏑之中、西價差存在大幅溢價。就此而言，「非中供應鏈」之建構須正視一項現實：更安全之供應，於短期內必然更昂貴。

此溢價終須由某方承擔。美國目前之選擇，係由公共財政承擔大部分：以價格下限補足差額、以 Project Vault 固定採購價鎖定礦產國企業收益、以 DFC 海外投資降低礦產開發國之政治風險溢酬。惟此模式之長期可持續性，取決於三個關鍵變數之配合，以下分述之。

（一）國會授權的政治穩定性

第一個變數是美國國會對相關預算授權的政治穩定性。本輪政策動員的金融基礎主要由三項立法工具支撐：OBBBA 透過 OSC 信用補貼擴張；EDF 擔保額度；DFC 或有負債上限提高。表面上，這些授權規模足

[56] Eugene Gholz, “Rare Earth Elements and National Security,” op. cit., pp. 10-13.
[57] Eugene Gholz and Llewelyn Hughes, op. cit..
[58] James Hasik, “Maybe Not So Rare After All,” *Atlantic Council*, July 31, 2017, https://www.atlanticcouncil.org/content-series/defense-industrialist/maybe-not-so-rare-after-all/.

以支應替代供應鏈的初期建設成本。然而，這些授權的政治穩定性存在三個風險點：第一，政權更迭：OBBBA 之續期、補充撥款與年度撥款安排，仍視未來各屆國會是否持續授權；第二，國會結構變化：2026 年期中選舉若改變參眾兩院多數黨格局，相關預算優先順位可能調整；第三，支出競爭壓力：CM 政策須與其他預算專案競爭有限的財政空間，若美國財政赤字持續擴大，公共支出的政治可接受度將下降。當前可觀的授權規模並不等同於長期可持續的財政承擔能力。

（二）盟友的承擔意願

第二個變數是 FORGE 框架下盟友共同承擔安全溢價之意願。值得注意者，盟友於中國定向管制下已承受不成比例之衝擊，據路透社引中國海關數據，2025 年 4 月管制以來，日本鏑進口量僅及管制前之百分之四、德國未獲配給，製造商磁材成本亦較管制前高出約 1.5 至 3 倍。[59]FORGE 之設計意圖，係使盟友透過 PCMDPs 進口談判機制於本國承擔部分溢價成本，以降低美國單方之財政壓力。然而，目前 21 份已簽署之雙邊礦產協議中，除美墨外，多數仍停留於原則性合作層次，未明確界定盟友之承擔義務。盟友國內政治對「支付更高礦產成本」之接受度常受其通膨、生活成本與產業競爭力等因素影響。在加入 FORGE 之過渡成本歸屬未明確之際，盟友之實際承擔意願實為關鍵考驗。

（三）中國的反向定價策略

第三個變數，為中國之反向定價策略。安全溢價並非靜態成本，係隨中國定價策略動態變化。若中國持續以傾銷應對 FORGE 之建立，美國之差額補貼壓力將持續擴大。更具戰略意涵者，在於中國掌握主動，如部分礦種維持高溢價以獲短期收益，部分礦種則壓低價格以擊垮非中供應商。就此而言，美國財政之承擔規模非由美國單方決定，部分由中國之策略選擇所形塑。安全溢價之成本動態，因此具對手反應（adversary response）之內生性——此為傳統產業政策補貼分析較少觸及之維度。

三變數中任一之不利變化，均可能侵蝕整體政策的可持續性。這並不意味著美方政策必然失敗，而是「以國家力量回應國家力量」的政策選擇是一個進行中的歷史過程，其結果取決於上述三個變數的長期演

[59] Lewis Jackson, Michael Martina and Laurie Chen, “Trump, Xi to Weigh Rare Earth Truce Extension, but China’s Curbs Still Bite,” op. cit.

化，而非政策設計本身的內在合理性。本文的方法論定位——機制導向的政策過程分析——正是為了識別這套機制的設計邏輯與中間機制，而非預測其終局結果。

三、不同類型行為者的策略回應

制度型去風險化在全球展開，並不僅是美中兩個主要行為者的博弈，而是涉及多種類型行為者的策略互動。本節分析三類具有代表性的行為者——資源國、製造業國、跨國企業——在美中制度競逐下的回應策略，以呈現本文核心分析框架的外溢影響。以下所建構屬闡釋性類型學（illustrative typology），目的在呈現行為者回應策略之變異幅度，而非對因果假設進行嚴格比較檢驗；案例依「策略差異最大化」原則於各類行為者內部選取。

（一）資源國：選邊壓力下的差異化回應

礦產資源豐富之發展中國家，係 FORGE 框架與中國礦業外交雙重競逐之主要場域，以下三案例展現不同回應策略。DRC 採取「兩面下注」：一方面與美國簽署礦產合作備忘錄以吸引 DFC 融資，另一方面維持與中國礦業企業之長期合作（中國掌握其鈷礦近 80%產能）。惟此策略受限於憲政與外部協議間之張力。巴西則展現「轉向重整」策略：Serra Verde 稀土公司於 DFC 融資吸引下縮短對中合約以重定向供應，成為非中稀土供應鏈之候選節點。印尼則延續「中國軌道」：中國資本已掌握其鎳冶煉產能 90%以上，加入 FORGE 將涉龐大之存量資產調整成本，預期仍以中國合作為主軸。

資源國之選邊非「政治偏好」所致，而受制於三結構性因素：既有外資存量、本國法規框架，以及 FORGE 融資條件之相對吸引力。因此，FORGE 盟友供應圈之擴張將呈選擇性而非普遍性，DRC、巴西等有空間納入，印尼則因結構鎖入難以納入。

（二）製造業國：依賴結構下的不對稱選擇

製造業國之策略回應，主要受其產業結構對中國中游加工依賴度之制約。日本展現「主動接軌」美方策略：作為 Pax Silica 簽約方積極配合 FORGE，並對澳洲等地之非中供應商大量投資。然而，主動對齊者之反制成本亦最為直接——日本隨即成為中國定向反制之首要對象。南韓則展現「被動依附」策略：其產業結構深度依賴中國中游加工，以電

池所需之球化石墨（spherical graphite，對中依賴近 100%）與永磁體製造為代表。2025 年 4 至 5 月稀土磁鐵對韓出口崩跌 93%，迫使其加入 FORGE 以分散供應風險，同時承擔過渡期之調整成本。就此而言，南韓之選擇並非「主動對齊」，而係「被動依附」：若無中國之定向衝擊，其未必於短期內接受 FORGE 之篩選邏輯。

（三）跨國企業：誘因與強制之間的策略平衡

跨國企業作為供應鏈重組之主體，其策略回應反映「政策誘因組合」與「股東權益侵害」間之張力。MP Materials 為「主動配合」之典型：於 15%股權、OSC 貸款、價格下限與包銷之政策組合下，由中國盛和資源之合作轉向美國非中供應鏈建構，商業可行性亦得維持。Lithium Americas 則展現誘因模式之侷限：以延遲還款換取 5%免費股份，引發稀釋爭議——誘因與強制之界線於實務中仍易滋生分歧。

下游製造商（如電動車、半導體業者）則展現「被動回應」策略：於美國價格下限與安全溢價政策下，須於「接受更高合格供應商成本」與「承擔中國定向反制風險」間作出選擇。值得注意者，此非單純商業考量——FORGE 之政治可信度篩選邏輯，將「使用何種礦產來源」由商業決策升級為政治站位。就此而言，跨國企業已非中立之市場主體，而係制度型去風險化下之政治結構性行為者。

四、供應鏈區塊化的不對稱演化

本節進一步將分析層次提升至全球供應鏈治理結構：美中礦產博弈所推動之供應鏈轉型，是否形成穩定之兩套區塊，及其治理意涵。

全球供應鏈走向區塊化進程具明顯之不對稱性。美國主導之 FORGE 體系試圖建立以政治可信度為篩選之「盟友供應圈」，經三層機制逐步落實；中國之應對則為既有主導地位上之工具升級，無須新制度：其反制係疊加於既有中游壟斷與 2020 年《出口管制法》體系所預置之許可審批機制之上，邊際動用僅需一紙公告即告生效，故制度建置成本趨近於零、即時性亦高。此不對稱可自三維度觀察。在時間上，FORGE 推行需數年乃至數十年，中國之工具運用具即時性；成本上，FORGE 需持續公共財政承擔，中國之咽喉點維持成本相對較低；在反制上，FORGE 對中國僅為「拒絕加入」之被動排除，中國對 FORGE 盟友之反制則具「主動衝擊」性質。就此而言，「制度型去風險化」之成本主要由發起方承擔，中國之反制成本則較低且具即時性。

於此不對稱結構下，全球供應鏈治理之未來演化呈現三種可能形態。「完整區塊化」指兩套體系各自封閉、礦產商品嚴格按盟友關係劃分；惟其實現條件嚴苛，須可觀且持續之公共財政承擔、盟友共同分攤安全溢價，且中國之咽喉點逐步被替代，於當前條件下更接近政策意圖而非可預期之演化結果。「混合區塊」指盟友既加入 FORGE，又保留與中國之有限合作關係，實證上已可見初步跡象。「分層區塊」則指核心戰略物項（如重稀土、磁鐵）採區塊化管理，一般商品維持相對開放市場——此於 2025-2026 年之政策實踐中亦可見雛形（如 232 條款關稅、Project Vault 採購承諾均限於特定戰略物項）。最終演化取決於前述可持續性三變數之長期走向，目前難以斷言。

陸、結語

本文以「美國政策工具是否具系統性排除中國之內在設計邏輯」為主問題，輔以礦產定價安全化跡象、美中制度競逐對資源國之非對稱壓力兩項衍生觀察，透過戰略宣示、制度設計與金融動員三層框架，檢視美國 CM 政策之轉型邏輯。就此而言，此系列政策實踐可概念化為「制度型去風險化」——當被武器化方之政策回應整合為涵蓋三層之完整制度架構，使國家由市場促進者轉為市場參與者時，去風險化即由個別政策行動轉化為持續性之制度安排。

就主問題而言，美國透過 FORGE 之市場進入條件、232 條款關稅之差別待遇與 DFC 海外投資之供應導流機制，建構以政治可信度為篩選標準之「非中供應鏈」；其介入節點涵蓋股權、出口通道、融資依賴至流通截流，具系統性排除中國之內在設計邏輯。第一項衍生觀察上，礦產定價已呈安全化之初步跡象——價格下限、固定採購承諾與政府承擔之溢價差距，均顯示價格形成已嵌入安全考量，惟此安全化尚屬制度跡象層次，未證明已重組整體市場之價格形成基礎。第二項衍生觀察上，全球供應鏈之區塊化進程呈顯著不對稱：美方體系為「新建制度」需逐步落實，中國體系則以「工具升級」即時運用中游壟斷優勢，兩者於時間、成本與反制能力三維度呈非對稱。真正承受選擇壓力者非美中兩國，而係夾於兩套規則體系之間、被迫作出非對稱選擇之資源豐富發展中國家。

理論貢獻可概括為三點。其一，承續法羅與紐曼所預見之「反制方重塑網絡」議題，將美國 CM 戰略定位為武器化相互依賴下被武器化

方之制度建構案例，填補既有文獻聚焦強制方之研究空缺。其二，奠基於班德默等人之「能力建構型去風險化」，提出「制度型去風險化」，刻畫國家介入由市場促進性升級為市場參與性之政策模式；此概念化亦與霍茲與休斯之市場調整論形成對話——該論以「中國武器化屬偶發、有限度」為前提，惟 2023 年以降之出口管制體系成形與定向管制升級顯示此前提已不成立，以制度設計取代市場競爭之政策路徑因而具理論必要性。其三，透過解析價格下限、戰略儲備與主權股權投資等工具之運作，揭示「安全溢價」並非抽象概念，而係可透過制度設計量化、分攤與轉移之政策變數，為去風險化文獻提供工具層次之微觀機制描述。

本文侷限同時界定其主張之合理範圍。第一，FORGE 與 Project Vault 均處啟動初期，本文分析立於設計邏輯層次而非執行成果層次；「制度型去風險化」能否維繫為穩定制度安排，至少取決於三變數之同向配合：美國國會授權之政治穩定性、盟友承擔安全溢價之意願，以及中國反向定價策略所內生之成本曲線。就此而言，本文論證政策架構之存在與內在邏輯，惟其是否足以重組全球礦產市場之底層秩序，仍有待觀察。第二，本文聚焦美國政策端，對中國反制策略之演化著墨有限。第三，資源國於兩套體系間之實際決策涉及國內政治、既有合約義務與憲政框架等複雜因素，本文僅自結構層面分析，未深入個案。

未來研究可沿以下方向展開：其一，追蹤 FORGE 之實際執行，檢驗「制度型去風險化」是否由美國個案演化為盟友共享之制度形態；其二，比較美中兩套規則體系對特定資源國之實際影響；其三，探討安全溢價之長期可持續性，包括美國國會授權之政治動態與中國反向定價策略對美國財政動員之回饋效應；其四，比較不同被武器化方（如歐盟、日本、南韓）之制度回應路徑，檢驗「制度型去風險化」是否呈現多種國別形態。

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The Laos-China Railway and Lessons for the Vietnam North - South High-Speed Railway Project

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Abstract

The study aims to assess the successes and drawbacks of the Laos-China railway, drawing lessons for Vietnam in constructing its North - South high-speed railway. It adopts a qualitative approach, analyzing secondary sources to examine the construction of the Laos-China railway and the current state of Vietnam's railway system. The findings indicate that the railway has brought multiple benefits to Laos, such as reducing commuting time, boosting trade, creating job opportunities for Lao residents, and strengthening regional connectivity, thereby enhancing Laos's role in Southeast Asia's economic network. However, Laos also faces significant challenges, including a substantial increase in public debt, a growing dependence on Chinese investment and technology, and adverse environmental impacts associated

with large-scale infrastructure projects. The study recommends that Vietnam should proceed cautiously in accepting foreign support, focus on infrastructure development in key areas, and thoroughly assess the social and environmental impacts of the North - South high-speed railway project to ensure sustainable and independent development.

Keywords: *Railway, China - Laos, Laos-China railway, Vietnam North - South Railway*

寮中鐵路及其對越南南北高速鐵路項目的啟示

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摘　要

本研究旨在評估中寮鐵路的成效與弊端，並為越南建設南北高速鐵路提供經驗借鑑。本研究採用質性研究方法，透過分析次級資料，探討中寮鐵路的建設歷程以及越南鐵路系統的現狀。研究結果顯示，該鐵路給寮國帶來了諸多效益，例如縮短通勤時間、促進貿易發展、為寮國居民創造就業機會，並加強區域聯通性，從而提升了寮國在東南亞經濟網絡中的角色。然而，寮國也面臨著重大挑戰，包括公共債務大幅增加、對中國投資與技術的依賴日益加深，以及與大規模基礎設施項目相關的負面環境影響。本研究建議，越南在接受外國援助時應審慎行事，集中力量推進關鍵地區的基礎設施建設，並全面評估南北高速鐵路項目的社會與環境影響，以確保實現可持續且自主的發展。

關鍵詞：鐵路、中寮、中寮鐵路、越南南北鐵路

I. Introduction

In the context of deepening globalization and international economic integration, large-scale infrastructure development has emerged as a critical driver for regional connectivity, trade expansion, and long-term economic growth. Among current prominent trans-border infrastructure initiatives, the Belt and Road Initiative (BRI), launched by China in 2013, is recognized as one of the most extensive and influential projects. It aims to strengthen economic connectivity between China and global regions through strategic investments in transport, energy, and infrastructure systems.

The Laos-China railway (LCR) is a part of BRI. This railway connects Vientiane, the capital of Laos, with Kunming in China's Yunnan province. It facilitates the transportation of goods and passengers both within Laos and across the border, reducing travel time and transport costs. The project is not only important for Laos's economic development but also has significant impacts on the Southeast Asian region, including Vietnam. As Vietnam is going to implement the North - South high-speed railway project, a mega-venture requiring immense capital investment that will highly likely necessitate the participation of foreign partners for funding, technology, and construction expertise, studying the experience of the LCR is of paramount importance in providing policy lessons.

Although Vietnam and Laos exhibit certain differences in geographical conditions, population size, and levels of economic development, both nations are developing countries in Southeast Asia and confront shared challenges when executing strategic infrastructure projects, particularly regarding massive capital mobilization, debt sustainability management, technology transfer assurance, and the maintenance of strategic autonomy in relations with external partners. Therefore, this study conceptualizes the LCR as a reference case to simultaneously analyze the opportunities and risks inherent in large-scale infrastructure projects involving foreign

capital and technology. By evaluating both the achievements and challenges posed by the LCR project, the study aims to derive policy implications that can assist Vietnam in implementing the North - South high-speed railway project in an efficient and financially sustainable manner, while minimizing adverse socio-environmental impacts and ensuring long-term strategic autonomy.

II. Theoretical Framework

Many developing countries confront a substantial infrastructure gap, whereas domestic financial resources, technological capabilities, and implementation capacities remain limited. Consequently, external financial sources, including Official Development Assistance (ODA), concessional loans, and foreign investments, play a critical role in supporting the construction of large-scale infrastructure projects.

Hubbard & Duggan argue that foreign aid and external debt foster development only when they help recipient nations enhance their domestic competitiveness and productive capacity; conversely, the inefficient utilization of such funds can lead to a debt spiral and prolonged dependency.[1] Against the backdrop of the BRI implementation, international literature has formed divergent perspectives regarding the impacts of Chinese-provided infrastructure loans. Hurley et al. contend that large-scale borrowing by nations with limited financial capacity can exacerbate risks to debt sustainability, while creating potential economic dependency and constraining the policy-making space of recipient states. From this perspective, the concept of debt diplomacy (or debt-trap diplomacy) is utilized to explain the nexus between infrastructure financing and strategic influence.

However, Brautigam argues that there is insufficient empirical

[1] Hubbard, R. G., & Duggan, *W. The aid trap: hard truths about ending poverty* (New York: Columbia University Press, 2009).

evidence to conclude that China deliberately utilizes BRI loans to seize the strategic assets of borrowing nations.[2] A growing body of recent literature suggests that debt risks associated with BRI projects cannot be explained solely by the strategic intent of the lender; rather, they must be situated within a broader context. This includes the recipient country's governance capacity, the economic feasibility of the projects, financial management mechanisms, and fluctuations in the global economic environment.

The expansion of Chinese-funded transport routes, economic corridors, and logistics networks can catalyze a process of increasingly China-centric integration. Within this framework, flows of trade, investment, finance, and technology tend to align more closely with the Chinese economy, potentially fostering relationships of asymmetric interdependence between China and participating nations. However, this integration does not automatically imply an inevitable loss of strategic autonomy for participating states. In practice, developing nations often face the dilemma of balancing the leverage of capital, technology, and connectivity opportunities from major powers against the preservation of their independent developmental decision-making. As a result, strategic autonomy is conceptualized as a nation's capacity to pursue its developmental objectives and national interests while maintaining control over strategic decisions, critical infrastructure assets, and key technological sectors.[3]

In addition to financial and geopolitical debates, environmental sustainability has emerged as a crucial research direction for large-scale infrastructure projects, particularly mega-railway ventures (Chester & Horvath, 2009). Although railway systems are generally considered a lower-

[2] Deborah Brautigam, "A Critical Look at Chinese 'Debt-trap Diplomacy': The Rise of a Meme," *Area Development and Policy*, Vol. 5, No. 1, 2020, pp. 1-14.
[3] Alfred Gerstl, *Hedging strategies in Southeast Asia: ASEAN, Malaysia, the Philippines, and Vietnam and their relations with China* (London: Routledge, 2022).

carbon mode of transport compared to road and air travel, the construction process of new rail lines can exert significant impacts on ecosystems, biodiversity, land use, and the livelihoods of local communities. Consequently, Hriday (2023) suggests that the evaluation of railway projects should adopt a life-cycle perspective, balancing long-term economic benefits and operational emission reduction efficiency against the adverse socio-environmental impacts arising during the construction phase.

Thereby, the assessment of the LCR extends beyond analyzing its contributions to regional connectivity, trade, and economic development; it also necessitates an examination of issues regarding debt sustainability, reliance on external capital and technology, as well as long-term socio-environmental consequences. This analytical framework is applied to evaluate the LCR as a case study, aiming to derive implications for the development of Vietnam's North - South high-speed railway.

III. The China - Laos railway

A. Overview of the China - Laos Railway

The LCR is a key part of the BRI, China's strategic initiative to connect Asia, Europe, and Africa through a wide network of transportation and infrastructure. This railway not only brings major benefits to China but also helps Laos, a landlocked country, expand its connection with the outside world.

The railway has a total length of 1,035 kilometers, with 422 kilometers running through Laos. It stretches from the capital Vientiane to Boten, a town near the Chinese border, which is linked to the Chinese railway network in

Yunnan province.[4] (Figure 1)

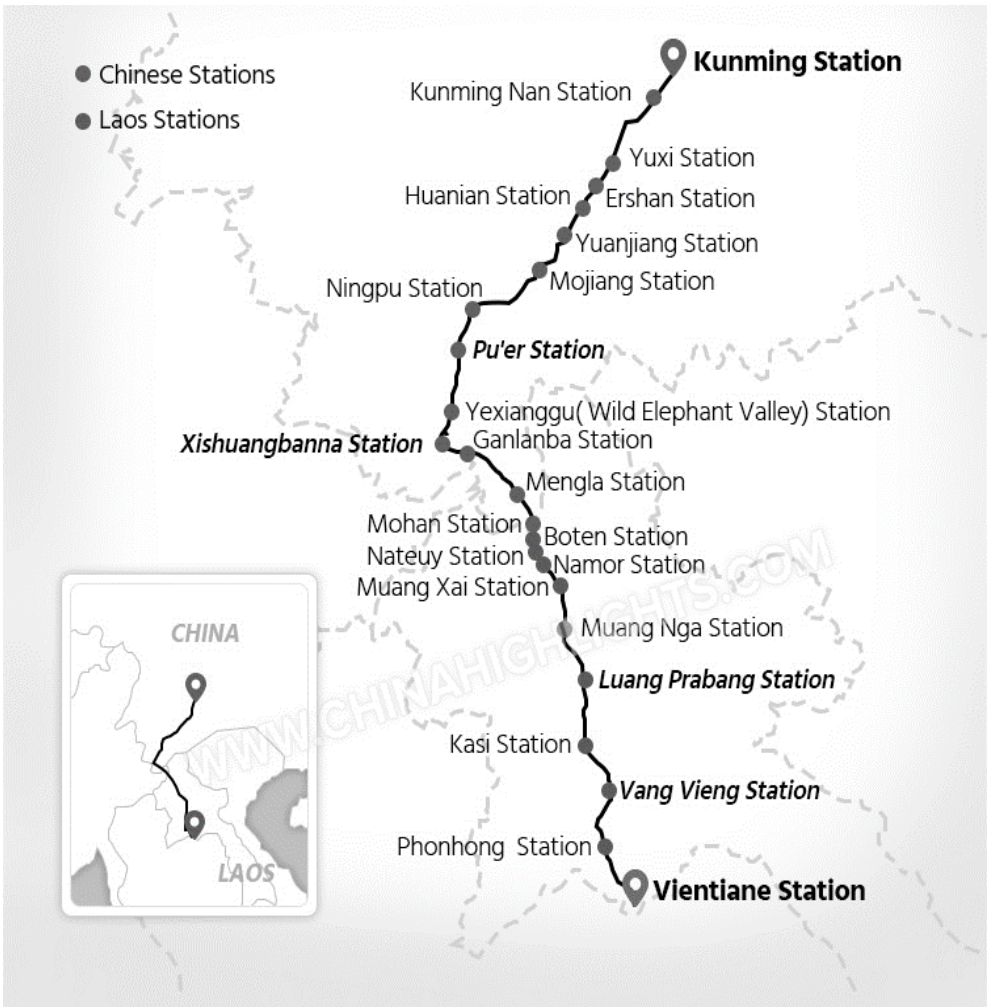

Figure 1: The China - Laos Railway

Source: "The Numbers of China-Laos Railway Trips Exceeded 16 Millions," *China Train Booking,* 2023, https://www.chinatrainbooking.com/news/lao-

The railway comprises a total of 24 stations, with the blue section representing the line within Laotian territory and the red part indicating the

[4] "China-Laos Railway Starts Operation", *Xinhuanet*, December 3, 2021, http://www.news.cn/english/2021-12/03/c_1310350441.htm.

line within Chinese territory, with Boten Station serving as the cross-border transfer point.

The railway uses a standard gauge of 1,435 mm and is built according to China's GB Grade 1 standards[5]. It operates EMU (Electric Multiple Unit) trains manufactured by China.[6] These trains can run at a maximum speed of 160 km/h for passenger transport and 120 km/h for freight transport, carrying loads of 2,000 to 3,000 tons per trip.[7]

Most of the railway passes through Laos's rugged mountainous terrain, which includes high mountains and deep valleys. As a result, many bridges and tunnels had to be constructed to ensure smooth travel at high speeds. Bridges and tunnels comprise 62% of the entire route, including 198 km of tunnels and 62 km of river and viaduct bridges,[8] specifically, 75 tunnels and 167 bridges.[9]

According to data from the Environmental Systems Research Institute, Inc. (ESRI) in 2022, the land along the China - Laos railway consists of 75.68% forest land, 9.12% grassland, 6.81% built-up areas, and 6.43%

[5] The GB (Guobiao) Standards are mandatory for all products sold or used in the Chinese market. They are issued by the Standardization Administration of China (SAC) and the National Committee of China for ISO and IEC. GB Grade 1 is part of the GB standards system, developed to ensure product quality and safety across various industries.

[6] Hafida Fahmiasari, "Analysis of the China-Lao PDR Railway Opportunities and Challenges of Mekong Logistics," *Mekong Institute*, 2023, https://mekonginstitute.org/wp-content/uploads/2023/08/B3-Analysis-of-the-China-Lao-PDR-Railway-Opportunities-and-Challenges-of-Mekong-Logistics.pdf.

[7] "Hoàn thành hầm chui xuyên biên giới, dự án đường sắt Lào-Trung Quốc," *Tạp chí Lào-Việt*, September 14, 2020, https://tapchilaoviet.org/tin-bai-noi-bat/hoan-thanh-ham-chui-xuyen-bien-gioi-du-an-duong-sat-lao-trung-quoc-20926.html.

[8] Ibid.

[9] "China-Laos Railway Starts Operation", *Xinhuanet*, December 3, 2021, http://www.news.cn/english/2021-12/03/c_1310350441.htm.

agricultural land.[10] (Figure 2)

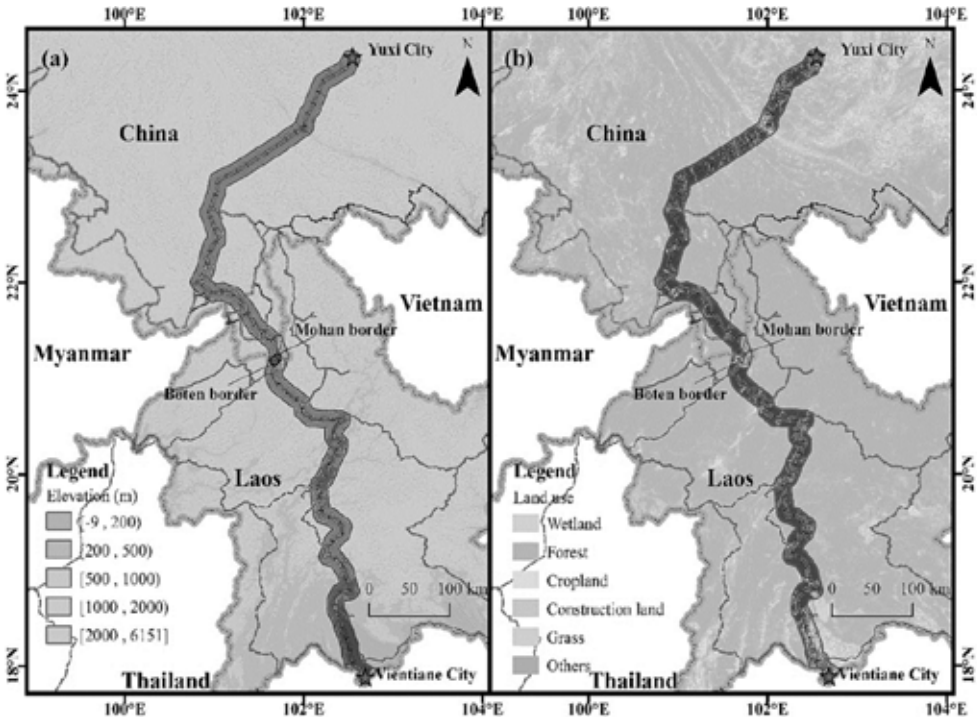

Figure 2：Land Use Types along the China - Laos Railway

Source: Xiao, C., Wang, Y., Yan, M., & Jeffrey Chiwuikem Chiaka, "Impact of Cross-border Transportation Corridors on Changes of Land Use and Landscape Pattern: A Case Study of the China-Laos Railway," *Landscape and Urban Planning*, Vol. 241, January 2024, p. 104924, https://doi.org/10.1016/j.landurbplan.2023.104924.

The main contractors responsible for the project include Sinohydro Group, China Power Construction Group, China Railway No. 5 Engineering Group, China Railway No. 2 Engineering Group, and China Railway No. 8 Engineering Group. All of these are state-owned enterprises managed by the

[10] Xiao, C., Wang, Y., Yan, M., & Jeffrey Chiwuikem Chiaka, "Impact of cross-border transportation corridors on changes of land use and landscape pattern: A case study of the China-Laos railway," *Landscape and Urban Planning*, Vol. 241, January 2024, p. 104924. https://doi.org/10.1016/j.landurbplan.2023.104924.

State-owned Assets Supervision and Administration Commission (SASAC) under the Chinese government. In addition, the Laos - China Railway Co., Ltd. (LCRC) is a joint venture formed by three of the above-mentioned Chinese state-owned companies, holding a 70% share. A state-owned enterprise from Laos also participates in the project, holding the remaining 30% share.[11] The project is being developed under a Build – Operate - Transfer (BOT) agreement. During the 50 - year concession period, the China - Laos Railway Co., Ltd. is responsible for maintenance costs and other project-related risks before handing it over to the Lao government.[12]

After China and Laos signed an intergovernmental railway cooperation agreement in 2015, the project officially broke ground in December 2016. After nearly five years of construction, the railway was completed at the end of 2021 and officially began operations in December 2021.[13] Specifically:

2015: The Chinese and Lao governments signed an intergovernmental railway cooperation agreement, marking the official start of the project implementation phase;

2016: Construction began in Luang Prabang, northern Laos, for the Lao section of the railway;

2017: The first tunnel on the railway line was completed in Vientiane province, with a length of 301 meters;

2018: The first T-shaped concrete beam of the railway was erected in

[11] "China Eximbank provides $480 million loan for China-Laos Railway Project," *Aiddata*, 2024, https://china.aiddata.org/projects/33726/.
[12] "Laos-China Railway project to be profitable after 23 years," *Laotian Times*, December 27, 2021, https://laotiantimes.com/2021/12/27/laos-china-railway-project-to-be-profitable-after-23-years/.
[13] "China-Laos Railway, a flagship project under BRI," *Xinhuanet*, December 3, 2021, http://www.news.cn/english/2021-12/03/c_1310349912.htm.

Vientiane, marking an important milestone as construction moved from foundation work to the upper structure;

2019: Work began on the railway's power supply system in Vientiane;

2020: Despite the COVID-19 pandemic, construction continued, extending the line from Vientiane to the transport hub of Luang Prabang in northern Laos, with annual construction targets met;

2021: The railway was completed on schedule and officially opened on December 3, 2021.[14]

Regarding construction cost, the China - Laos railway is one of the largest infrastructure projects Laos has ever undertaken, with a total investment of about USD 5.9 billion,[15] equivalent to more than one-third of the country's gross domestic product (GDP). (Figure 3)

[14] "China-Laos Railway, a flagship project under BRI," *Xinhuanet*, December 3, 2021, http://www.news.cn/english/2021-12/03/c_1310349912.htm.

[15] Jitsiree Thongnoi, "China-Laos Railway Brings Higher Mobility, Employment as Profit Concerns Linger," *The China Global South Project*, May 8, 2024, https://chinaglobalsouth.com/analysis/china-laos-railway-brings-higher-mobility-employment-as-profit-concerns-linger/, accessed on 21/09/2024.

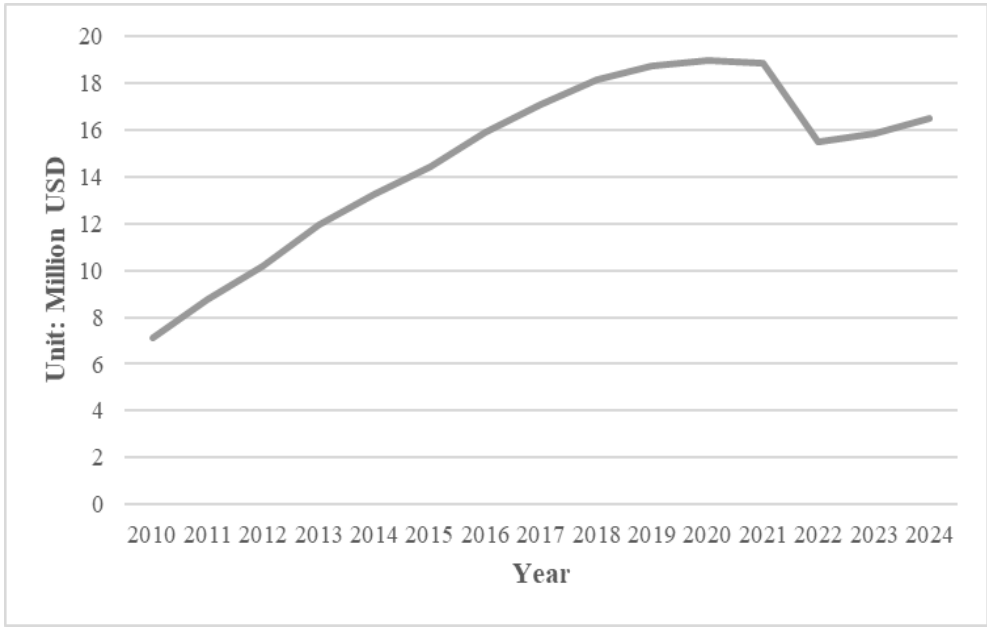

Figure 3：Laos's GDP from 2010 to 2023

Source: The graph compiled by the author based on data from the World Bank, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=LA.

Out of the nearly USD 5.9 billion in construction investment, 60% (around USD 3.54 billion) was financed through loans, while 40% (about USD 2.36 billion) came from government contributions by both China and Laos. Specifically, in June 2019, the Laos - China Railway Company (LCRC) secured a debt financing of USD 3.54 billion (about 22.45 billion RMB) from the Export - Import Bank of China (China Eximbank).[16] The Lao government and the Chinese government contributed USD 730 million and USD 1.63 billion in equity capital to the project, respectively.[17]

The USD 3.54 billion loan was backed by an equity commitment, asset

[16] Debt financing refers to the use of borrowed funds or credit by companies or governments to cover their expenditures. These expenditures are typically tied to the issuance of short-term or long-term bonds.

[17] "China Eximbank Provides $480 Million Loan for China-Laos Railway Project," op. cit.

mortgages, and a concession agreement. To provide its USD 730 million share in equity, the Lao government borrowed USD 480 million from China Eximbank at an interest rate of 2.3%, with a loan term of 25 years and a 5-year grace period. The government also agreed to provide the remaining USD 250 million from its own budget, paid in annual installments. The Lao government did not issue a sovereign guarantee for this loan. Instead, it pledged future revenue from one bauxite mine and three potash mines in Laos as collateral. In addition, before this loan agreement was signed, an intergovernmental framework agreement between Laos and China had already been signed on November 13, 2015.[18]

B. Benefits and Challenges of the China - Laos Railway

(A) Benefits of the Railway for Laos

First, the LCR has significantly reduced travel time. With a maximum speed of 160 km/h, the journey from Vientiane to Boten has been shortened from 15 hours to just 4 hours[19,] and the trip from Vientiane to Luang Prabang now takes only 2 hours[20]. Notably, the travel time between Kunming and Vientiane has been reduced from several days to just 10.5 hours.[21]

Second, the railway has boosted passenger and freight transportation between Laos and China. In 2023, the LCR in Laos transported over 4 million tons of goods, an increase of more than 83% compared to the same period in 2022, averaging about 11,204 tons per day. Of this total, 615,000 tons were shipped from China to Laos, while 3.474 million tons were exported from

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[18] Ibid.

[19] Tom Wilms, "Right on Track or off the Rails," *European Institute for Asian Studie*s, Policy Brief, No. 4, 2021, https://eias.org/wp-content/uploads/2021/12/The-Laos-China-Railway.pdf.

[20] "China-Laos Railway Fuels Tourism Boom in Laos," *Xinhuanet*, February 24, 2024, https://english.news.cn/20240224/73dfb3f3f5df4cc0a685198c713e1b24/c.html.

[21] "China-Laos railway to run cross-border passenger trains starting Thursday," *Vientiane Times*, 2023, https://www.vientianetimes.org.la/freeContent/FreeConten72_chinalaos23.php.

Laos to China. As of June 19, 2024, the total freight volume reached 2.63 million tons, up 32% from the same time in 2023, averaging 15,393 tons per day, with a peak of 22,217 tons in a single day.[22] Approximately 2,900 different product types have been transported along this route,[23] including fruits, grains, frozen seafood, electronic and mechanical parts, minerals, and new energy vehicles[24]. Statistical data indicate that Laos' export turnover to the Chinese market reached US$4.56 billion in 2024, recording a robust growth of 21.4 percent compared to the previous year; within this figure, agricultural exports alone surged by 20 percent year-on-year in 2023.[25]

In terms of passenger transport, nearly 2.6 million passenger trips were made in 2023, an increase of almost 86% compared to 2022, averaging 7,106 passengers per day.[26] In 2023, international passenger trains carried 111,000 travelers. The number of daily train services has also increased significantly on both sides: from 35 to 51 in China and from 4 to 12 in Laos. Daily passenger volume rose from 20,000 to 103,000 in China, and from 720 to 12,808 in Laos.[27] As of June 19, 2024, a total of 1.69 million passengers had traveled on the LCR line, an increase of 41.3% compared to the same period

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[22] Niem Chheng, "Laos-China Railway Revolutionises Travel and Boosts Socio-economic Growth," *The Star*, July 4, 2024, https://www.thestar.com.my/aseanplus/aseanplus-news/2024/07/04/laos-china-railway-revolutionises-travel-and-boosts-socio-economic-growth.

[23] "Lượng hàng hóa vận chuyển qua tuyến đường sắt Trung Quốc – Lào đạt 10 triệu tấn," *Tạp chí Lào - Việt*, September 18, 2024, https://tapchilaoviet.org/tin-ngay/luong-hang-hoa-van-chuyen-qua-tuyen-duong-sat-trung-quoc-lao-dat-10-trieu-tan-71206.html.

[24] "China-Laos Cross-Border Railway: Goods Handled for Over 8 Million Tonnes," *Agenzia Nova*, April 23, 2024, www.agenzianova.com/en/news/China-Laos-cross-border-railway-handled-goods-for-over-8-million-tons/.

[25] ASEAN Briefing, "Leveraging the Laos-China Railway for Trade," June 19, 2026, https://www.aseanbriefing.com/news/leveraging-the-laos-china-railway-for-trade/.

[26] Niem Chheng, "Laos-China Railway Revolutionises Travel and Boosts Socio-economic Growth," op, cit.

[27] "China-Laos Railway Transports More than 30 Million Passenger Trips," *Global Times*, March 14, 2024, www.globaltimes.cn/page/202403/1308838.shtml.

in 2023, averaging 9,864 passengers per day.[28]

Third, the improved convenience and reduced travel time have helped Laos boost domestic tourism and attract more international tourists. In the first nine months of 2023, Laos welcomed over 2.4 million foreign visitors, an increase of 285% compared to the same period in 2022. Among them, nearly 1 million came from Thailand, over 600,000 from Vietnam, and nearly 480,000 from China.[29] Monthly passenger numbers have risen significantly from just over 600,000 at the start of operations to more than 1.1 million.[30] By early 2025, the tourism sector recorded over 48.6 million passenger trips.[31] This growth has also created opportunities for related sectors such as hospitality, restaurants, and retail services.

Fourth, the railway has created job opportunities for the Lao population. In 2020, the construction of the China - Laos railway created 32,000 jobs for Lao workers. Since June 2020, the Laos - China Railway Company has recruited and trained Lao interns through nine separate training programs. More than 800 Lao staff, over 90% of those trained, have been assigned to specific roles, and Lao nationals make up 60% of the company's workforce.[32] In 2022, the railway had generated a total of over 110,000 jobs in Laos since it began operations.[33] Additionally, more than 3,500 Lao workers are employed in areas such as freight transport, logistics, security, cleaning, and

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[28] Niem Chheng, "Laos-China Railway Revolutionises Travel and Boosts Socio-economic Growth," op, cit.

[29] "China-Laos Railway brings booming tourism, business opportunities," *Global Times*, November 30, 2023, https://www.globaltimes.cn/page/202311/1302788.shtml.

[30] "China-Laos Railway Boosts Local Tourism, Employment," *Xinhuanet*, December 6, 2023, https://english.news.cn/20231206/9a1646de0e5a4f89bed299720daeecea/c.html.

[31] "Leveraging the Laos-China Railway for Trade," *ASEAN Briefing*, June 19, 2026, https://www.aseanbriefing.com/news/leveraging-the-laos-china-railway-for-trade/.

[32] Yang Han, "Tracks of Change Lead to Prosperity," *China Daily*, July 15, 2024, https://www.chinadaily.com.cn/a/202407/15/WS669454afa31095c51c50df6c_2.html.

[33] Xinhuanet, "China-Laos Railway promotes friendship, provides development opportunities," December 2, 2022, https://english.news.cn/20221202/63c5a49394fb4acc806d768d50a25540/c.html.

other related fields.[34] Furthermore, as sectors like logistics, urban transportation, trade, tourism, and other industries grow, the LCR has indirectly created over 100,000 job opportunities,[35] helping to reduce the country's unemployment rate.

Fifth, the railway has strengthened Laos' regional connectivity. Laos has become a key transit point for exports from Thailand to China. Thailand has increased its export of agricultural products, especially durian, to China via the LCR.[36] The shipping time from Map Ta Phut in Rayong Province, Thailand, to Guangzhou, China, has been shortened to just 5-6 days, helping to preserve the freshness of the produce compared to transport by road or water.[37] In the first five months of 2023, Thailand's agricultural exports to China via the China - Laos railway increased by 365%, thanks to faster transportation and the support of free trade agreements.[38] In 2025, trade activities at the Mohan border checkpoint (Yunnan, China) recorded robust growth, with the import volume of Thai durian and other tropical fruits increasing by 25% year-on-year, driven by the LCR.[39]

(B) Challenges for Laos

1. Domestic Challenges

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[34] "China-Laos Railway Demonstrates Huge Value after First Year of Operation," *Global Times*, December 2, 2022, https://www.globaltimes.cn/page/202212/1280993.shtml.

[35] "Resolving Global Dilemma: China's High-level Opening-up," *China International Import Expo*, July 16, 2024, https://www.ciie.org/zbh/en/news/exhibition/insights/20240716/45005.html.

[36] Apornrath Phoonphongphiphat, "Thailand's Rail Network to Link to Laos-China High-Speed Train," *Nikkei Asia*, June 16, 2024, https://asia.nikkei.com/Business/Transportation/Thailand-s-rail-network-to-link-to-Laos-China-high-speed-train.

[37] "First Transport Train to China via Laos Is a Boon for Thai Farmers," *Nationthailand*, April 19, 2023, www.nationthailand.com/business/corporate/40026793.

[38] Xinhua News Agency, "Thai Durian Shipments to China Surge as China-Laos Railway Boosts Trade," *Bangkok Post*, August 16, 2023, www.bangkokpost.com/business/general/2630505/thai-durian-shipments-to-china-surge-as-china-laos-railway-boosts-trade.

[39] "2025 Annual Report," *China Railway Engineering Corporation*, April 23, 2026, https://www.crecg.com/zgztywz/articleFileDir/2026-04/23/da6876460ba14af4873eade3c9ed2403.pdf.

First, a large number of unexploded ordnances (UXOs) left over from the Vietnam War have posed significant obstacles to the construction of the railway. During the war, the United States secretly expanded the battlefield into Laos to cut off the Ho Chi Minh trail, conducting 580,000 bombing missions between 1964 and 1973. This resulted in an estimated 270 million bombs dropped, with a total weight of 2 million tons, averaging eight bombs per minute over nine years. Approximately 80 million of these bombs (about 30%) failed to detonate.[40] Clearing these UXOs has not only made construction more difficult but also delayed the project's progress. The affected areas remain dangerous for both construction workers and local residents.

Second, public debt and financial risks have become a growing burden for Laos. After the railway was built, Laos' external debt rose by USD 507 million in 2022 and increased by another USD 950 million in 2023. In total, Laos' public and publicly guaranteed debt (including domestic and external debt) reached USD 13.8 billion in 2023, equivalent to 108% of the country's GDP. Of this, USD 10.5 billion was external debt, nearly half of which (48% or USD 5.09 billion) was owed to China.[41] The International Monetary Fund (IMF) has estimated that Laos' debt could reach as high as 123% of its GDP, about three times the normal level.[42] In 2024, although Laos' public debt decreased to 94.7 percent of GDP,[43] this remains an alarming figure for an agriculture-dependent developing country like Laos. Moreover, the loan from

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[40] "China-Laos Railway thrives despite Challenges," *The Diplomat Insight*, January 12, 2022, https://thediplomaticinsight.com/china-laos-railway-thrives-despite-challenges/.

[41] Marwaan Macan-Markar, "Laos Central Bank Shake-up Reveals Forex Crisis, China Dependence," *Nikkei Asia*, July 14, 2024, https://asia.nikkei.com/Economy/Laos-central-bank-shake-up-reveals-forex-crisis-China-dependence.

[42] RFA Lao and Taejun Kang for RFA, "Laos: Belt and Road Poster Child – or Problem Child?" *BenarNews*, September 29, 2023, https://www.benarnews.org/english/news/thai/belt-road-raises-laos-external-debt-09292023105722.html.

[43] International Monetary Fund, "Laos: General Government Gross Debt," *IMF DataMapper (World Economic Outlook Database)*, 2026, https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/LAO?zoom=LAO&highlight=LAO.

the Export-Import Bank of China, with a relatively high interest rate (2.3% per year) and strict conditions, poses long-term financial risks, especially if Laos is unable to generate sufficient revenue to repay the debt. If the railway fails to operate efficiently and revenues fall short of expectations, Laos may face debt repayment difficulties, increased pressure on the national budget, and a heightened risk of falling into a debt trap. The government must therefore balance project operation with responsible public spending.

Third, Laos' small economy and limited population size also challenge the railway's efficiency. With a population of just over 7 million,[44] domestic demand for transportation and freight is not large enough to guarantee sustainable profitability for the project. Although the railway is expected to promote trade and logistics, Laos must attract more transit goods from neighboring countries and more international tourists, especially from Thailand, to fully leverage the railway's potential.

Fourth, the operation of the LCR requires a highly skilled workforce, which poses a challenge for Laos in terms of human resource development. The railway uses modern technology, which demands qualified personnel for effective management, operation, and maintenance. Therefore, Laos must actively develop its own training programs to produce human resources that meet the technical requirements of the railway.

Fifth, the project has had negative impacts on the environment and local communities. The railway passes through mountainous and tropical forest areas, meaning that construction required digging through mountains and clearing forests to build tunnels and bridges. This has caused environmental degradation in some parts of Laos. In addition, the construction of a high-speed railway required large-scale land clearance, which disrupted the lives of people living along the route and created difficulties in resettling displaced

[44] "Laos Population," *World Bank Organisation*, 2026, https://data.worldbank.org/indicator/SP.POP.TOTL?locations=LA.

communities.

2. External Challenges

First, the fact that Laos holds only 30% of the joint venture's shares while China holds 70% reflects an imbalance of control. This may lead to Laos having limited influence in important decisions regarding the operation and management of the railway, raising concerns over the country's lack of full control over one of its strategic infrastructure assets. Deeper integration into the regional economic network driven by China offers Laos numerous opportunities for economic development and enhances its connectivity status within the region. However, this intensifying integration into a China-led infrastructural and economic framework also raises questions regarding long-term strategic dependency. Due to the substantial disparity in economic scale and technological capability between the two nations, increased connectivity could foster a state of asymmetric interdependence. Within this dynamic, while both Laos and China benefit from economic cooperation, China potentially retains a significant advantage as the primary supplier of capital, technology, and key consumer markets. This dependency manifests in financial dimensions and also persists through the operation and maintenance of the railway system, technology transfer, and reliance on technical standards established by China.

Second, fluctuations in international markets may affect the railway's operational efficiency. The railway was built to help Laos connect with the region and expand access to the Chinese market. However, unpredictable global events, such as economic downturns or major disruptions like the COVID-19 pandemic, can lead to decreased demand for travel, freight transport, and imports in China, which in turn reduces the railway's utilization and lowers project revenues.

Third, while the LCR has improved Laos' infrastructure and made it easier to connect with China, it has also increased the country's dependence

on China. Since China plays a leading role in financing, designing, supplying technology, and constructing the railway, Laos risks becoming dependent on China not only financially but also politically. With rising public debt, if Laos fails to repay loans on time, it may be forced to make concessions, such as allowing China to exploit natural resources or granting it long-term rights to operate the railway. Although the Lao government did not issue a sovereign guarantee for the loan, it pledged revenue from one bauxite mine and three potash mines as collateral for the loan from China's Export-Import Bank.[45]

Fourth, despite its goal of becoming a regional transport hub, the China - Laos railway faces competition from other transport routes. Road and sea transport corridors through Thailand, Myanmar, and Vietnam could serve as alternatives if the LCR is not competitive in terms of cost or travel time.

Moreover, Laos has not yet fully tapped into the logistics potential of the ASEAN region due to limited connectivity. The railway must be better integrated with other regional transport networks to improve connectivity and optimize supply chains. If Laos relies solely on one railway line without sufficient transit hubs and supporting infrastructure, the project's profitability is unlikely to meet expectations.

IV. Vietnam's Railway System

A. Current Limitations of Vietnam's Railway System

First, most of Vietnam's railway infrastructure was built during the French colonial period and has hardly been upgraded since. As a result, the quality of tracks, bridges, and stations has severely deteriorated. While many countries around the world have already adopted fourth-generation magnetic rail technology, Vietnam still relies on outdated diesel-powered locomotives, considered second-generation technology, just one step ahead of steam

[45] "China Eximbank Provides $480 Million Loan for China-Laos Railway Project," op cit.

engines.[46]

Second, the speed of Vietnam's trains remains relatively low, ranging from 20 km/h to 100 km/h. On average, freight trains operate at 50-60 km/h, and passenger trains at 80-90 km/h.[47] These speeds are equivalent to or even slower than traveling by car, leading to long travel times between destinations. As a result, trains are a less attractive option for passengers, and the economic efficiency of train services remains low.

Third, despite efforts to improve the system, the railway sector struggles to attract private investment and lacks a long-term development strategy. This has led to accumulated losses and inefficient operations. Financial difficulties also limit the ability to maintain and expand infrastructure. Many upgrade and renovation projects have been delayed or left unimplemented due to a lack of funding.

Fourth, Vietnam's railway sector faces significant challenges in meeting the country's "Net Zero" carbon emissions target by 2050, as committed by the Prime Minister at COP26[48]. Most railway lines still rely on diesel locomotives, which emit high levels of greenhouse gases. Transitioning to more sustainable transportation options is essential. Continuing to use diesel engines not only harms the environment and hinders emissions reduction goals but also reduces Vietnam's ability to access international financing and partnerships for sustainable development.

Due to these limitations, Vietnam urgently needs a high-speed railway system powered by clean energy in order to catch up with global trends and

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[46] Tổng cục thống kê, "Đường sắt Việt Nam qua một số chỉ tiêu thống kê," *Dữ liệu và Số liệu Thống kê*, June 2023, https://www.gso.gov.vn/du-lieu-va-so-lieu-thong-ke/2023/06/duong-sat-viet-nam-qua-mot-so-chi-tieu-thong-ke/.

[47] Ibid.

[48] Minh Quang, "Cam kết của Việt Nam tại COP26 và NDC cập nhật," *Bộ Tài nguyên và Môi trường*, November 9, 2023, https://www.monre.gov.vn/Pages/cam-ket-cua-viet-nam-tai-cop26-va-ndc-cap-nhat.aspx.

regain the railway sector's former competitive advantages.

B. The North - South high-speed railway project

Vietnam has set a goal to build the North - South high-speed railway to connect the two ends of the country. This is one of the nation's strategic infrastructure projects aimed at: (i) reducing pressure on the existing road and air transport networks; (ii) promoting regional economic growth and enabling sustainable development for provinces and cities along the North - South axis; and (iii) aligning Vietnam with regional and global trends in modern infrastructure development.

The high-speed railway is planned to have a design speed of 350 km/h, use standard gauge tracks (1,435 mm), and be fully electrified.[49] The total length is expected to be about 1,541 km, passing through 20 provinces and cities. Of the route, 60% will be on bridges, 10% in tunnels, and 30% on embankments. It will start from Ngoc Hoi Station (Hanoi) and end at Thu Thiem Station (Ho Chi Minh City). The entire line will have 23 passenger stations and 5 freight stations at key hubs connected to Hanoi, Ho Chi Minh City, and major seaports, with the capability to carry freight when needed. The high-speed rail will reduce travel time from Hanoi to Ho Chi Minh City to just 5.5 hours. Travel time between Hanoi and key cities like Vinh, Da Nang, and Nha Trang will be shortened to approximately 1.3 hours, 2.7 hours, and 4.3 hours, respectively, much faster than existing trains or passenger cars. Some short-haul routes may even be faster than air travel when waiting time is taken into account.[50] The project is planned to be constructed in three phases: the Hanoi - Vinh segment and the Vinh - Nha Trang segment are

[49] Sputnik Việt Nam, "Đường sắt cao tốc Bắc – Nam mất hơn 33 năm hoàn vốn, vì sao Việt Nam vẫn làm?" *Sputnik News*, October 20, 2024, https://kevesko.vn/20241020/duong-sat-cao-toc-bac--nam-mat-hon-33-nam-hoan-von-vi-sao-viet-nam-van-lam-32468541.html.

[50] VTV Digital, "Phương án dự kiến của Đường sắt tốc độ cao Bắc – Nam," *Thời sự VTV*, September 23, 2024, https://vtv.vn/kinh-te/phuong-an-du-kien-cua-duong-sat-toc-do-cao-bac-nam-20240923122526326.htm.

scheduled to start in 2027, while the Nha Trang - Ho Chi Minh City segment is expected to begin in 2028. The goal is to basically complete the entire project by 2035.[51]

Although the North - South high-speed railway project has been discussed since 2010, it has not yet been implemented due to several key reasons:

First, the construction cost is very high and requires substantial funding. Preliminary estimates put the total cost at about USD 67.34 billion (approximately VND 1,713 trillion), equivalent to USD 43.7 million per kilometer.[52] This accounts for nearly 30% of Vietnam's average GDP from 2010 to 2023, and about 16% of the country's GDP in 2023. While USD 43.7 million per kilometer is around the global average for high-speed rail, the total length of 1,541 km presents a major financial challenge for Vietnam.

Second, managing and operating a complex project like a high-speed railway is a significant challenge for Vietnam. Effective capital management, construction supervision, and safety assurance require a highly skilled and experienced workforce, something that remains limited in Vietnam.

Third, the project will affect land use in the areas it passes through, so careful consideration is needed for land clearance compensation and the resettlement of displaced residents.

V. Recommendations for the Vietnam North - South High-Speed Railway Project

The experience of the LCR demonstrates that the ultimate challenge for

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[51] Ngọc An, "Thủ tướng: Làm đường sắt tốc độ cao Bắc - Nam theo hướng tuyến ngắn nhất, tốc độ 350km/h," *Tuổi Trẻ Online*, July 11, 2024, https://tuoitre.vn/thu-tuong-lam-duong-sat-toc-do-cao-bac-nam-theo-huong-tuyen-ngan-nhat-toc-do-350-km-h-20240711120058O1.htm.

[52] Tuần Phùng, "Đường sắt tốc độ cao Bắc - Nam tốc độ 350km/h đang nghiên cứu thế nào?" *Tuổi Trẻ Online*, September 25, 2024, https://tuoitre.vn/duong-sat-toc-do-cao-bac-nam-toc-do-350km-h-dang-nghien-cuu-the-nao-20240925123452867.htm.

developing nations when executing large-scale infrastructure projects is balancing the leverage of external resources with the preservation of long-term strategic autonomy. For Vietnam, this is of paramount importance as the North - South high-speed railway project demands massive capital investment, cutting-edge technology, and extensive operational expertise. It serves as a practical case study from which Vietnam can draw important lessons in developing the North - South high-speed railway, one of the country's largest infrastructure projects.

A. Exercise Caution When Receiving External Support

The LCR project significantly increased Laos's public debt due to its heavy reliance on a large loan from China, which accounted for 70% of the total investment. This has exposed Laos to financial risks and increased dependence on China.

To avoid falling into a similar situation, Vietnam should carefully evaluate its financing model for the North - South high-speed railway. With an estimated cost of around USD 67.34 billion, this is a substantial investment that requires the Vietnamese government to reallocate public spending and seek external financial support during the implementation phase.

In terms of funding, Vietnam can take advantage of ODA from countries such as Japan, South Korea, and the European Union; concessional loans from international organizations like the World Bank, the Asian Development Bank (ADB), the Asian Infrastructure Investment Bank (AIIB); and initiatives like the Global Gateway. Vietnam should diversify its sources of funding to reduce financial risks and ensure independence in project management, avoiding over-reliance on any single country. Regardless of the chosen partner, Vietnam should play an active role in negotiating terms such as interest rates, repayment periods, and lending conditions to ensure transparency and alignment with national interests, while minimizing financial and public debt risks.

Regarding contractors, several domestic companies now have the capacity to undertake large-scale projects. Therefore, Vietnam can encourage local enterprises to participate in the investment, construction, and operation of the North - South high-speed railway. This would not only reduce dependence on foreign contractors but also strengthen the capabilities of Vietnamese firms.

In terms of technology, Vietnam can consider receiving support from countries with extensive experience in high-speed railway development, such as Japan, France, China, and South Korea, in the form of technology transfer and training of Vietnamese personnel to serve the project.

Furthermore, in high-tech sectors such as high-speed rail, prolonged reliance on foreign experts during the system's design, operation, maintenance, and upgrading phases can constrain the recipient nation's technological autonomy. Therefore, Vietnam needs to intensify investments in training domestic engineers, technical experts, and managers, while demanding knowledge and technology transfer from foreign partners. This approach plays a critical role in building endogenous capacity and minimizing long-term technological dependency.

B. Prioritize High-Speed Railway Development in Areas with High Demand and Strong Connections to Key Economic Zones

Choosing the right areas for infrastructure development is crucial for operational efficiency. The LCR connects the Chinese border to Vientiane, following a key economic corridor to optimize connectivity between Laos and China. For Vietnam, the top priority should be linking major cities such as Hanoi, Vinh, Hue, Nha Trang, Da Nang, and Ho Chi Minh City, areas with high transport and tourism demand and strong economic growth potential.

Additionally, it is crucial to establish connecting routes between the high-speed railway and key industrial zones. These zones play a vital role in production and the supply chain, with significant demand for cargo

transportation. Efficient transportation links will create strong economic momentum and strengthen the national logistics network. Moreover, the potential for international connectivity should be considered, enabling Vietnam to integrate into regional transport systems, enhance trade advantages, and boost national competitiveness.

C. Carefully Assess Environmental and Social Impacts

One of the biggest challenges of large-scale infrastructure projects is their negative impact on the environment and society, such as deforestation, soil erosion, and population displacement. The LCR led to a significant loss of forest land and drew criticism for insufficient environmental impact assessments. The project also disrupted the lives of local communities due to poorly handled resettlement issues.

In Vietnam, past environmental and social impact assessments have often been superficial, failing to account for long-term impacts on the environment, society, and economy. With a large portion of the proposed railway passing through forests and mountainous terrain, the North - South high-speed railway must be developed with caution to avoid repeating Laos's mistakes. Before construction begins, Vietnam needs to conduct a thorough environmental and social impact assessment to ensure the project does not cause serious damage. Construction and management plans should align with international standards and Vietnam's sustainable development commitments. This is especially important given the European Union's plan to impose environmental taxes on polluting imports starting in 2026 and Vietnam's commitment to achieving net-zero emissions by 2050. If the North - South railway fails to meet environmental standards, Vietnam may face increased export costs to the EU and reduced access to international financing and cooperation on sustainable development. Therefore, Vietnam should prepare plans to cut emissions during the construction and operation phases, such as promoting green and sustainable infrastructure development.

Furthermore, land clearance is a major challenge in national infrastructure projects, particularly regarding land compensation. Preliminary estimates show the project will require about 10,827 hectares of land and the resettlement of approximately 120,836 people.[53] Construction will thus face significant challenges in site clearance and impact communities along the route, including resettlement, loss of farmland, and livelihoods. As a result, solutions such as land clearance, resettlement support, and vocational training must be integrated early in the project planning phase.

VI. Conclusion

The China - Laos Railway represents one of the most significant infrastructure projects in Southeast Asia in recent years, illustrating both the opportunities and challenges that developing countries face in implementing large-scale transportation projects. The project has substantially improved Laos' connectivity with China and the broader region by reducing travel and transportation time, facilitating trade and tourism, creating employment opportunities, and strengthening the country's position within regional logistics networks. At the same time, it has revealed several challenges, including mounting public debt, potential dependence on external financing and technology, governance constraints, and adverse environmental and social impacts.

For Vietnam, where the existing railway system continues to suffer from outdated infrastructure, limited technological capacity, and insufficient transport efficiency, the North-South High-Speed Railway constitutes a strategic investment for enhancing national competitiveness, promoting economic growth, and modernizing the country's transport system. Nevertheless, given its enormous financial scale, long implementation period,

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[53] Sputnik Việt Nam, "Đường sắt cao tốc Bắc – Nam mất hơn 33 năm hoàn vốn, vì sao Việt Nam vẫn làm?" *Sputnik News*, October 20, 2024, https://kevesko.vn/20241020/duong-sat-cao-toc-bac--nam-mat-hon-33-nam-hoan-von-vi-sao-viet-nam-van-lam-32468541.html.

and wide-ranging socio-economic implications, the project requires thorough preparation based on comprehensive assessments of economic viability, financing mechanisms, technological capability, human resource development, and environmental and social sustainability.

Drawing lessons from the China-Laos Railway, Vietnam should adopt a prudent, proactive, and sustainable development approach. This includes diversifying financial resources and international partners, safeguarding national autonomy in project management and operation, prioritizing transport corridors with strong demand, and integrating rigorous environmental and social impact assessments from the earliest stages of project planning. Only by balancing economic growth objectives with financial sustainability, economic sovereignty, and sustainable development can the North-South High-Speed Railway become a transformative driver of Vietnam's industrialization and modernization while strengthening the country's regional connectivity and integration into global value chains.

This study also suggests that the success of cross-border infrastructure projects depends not only on investment scale or technological sophistication but also on institutional capacity, financing structures, governance arrangements, and the ability of recipient countries to effectively operate and maximize project benefits after completion.

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戰略與評估

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一、 分節標題：文章之大小標題，
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六、 專書

（一）中文書籍：作者姓名，《書名》（出版地：出版者，年），頁 x-x。（初版無需註明版別）

（二）英文書籍：Author's full name, *Complete title of the book*（Place of publication: Publisher, Year）, p. x or pp. x-x.

（三）如引用全書時，可註明該書起迄頁數或省略頁數。

範例

陳鴻瑜，《南海諸島之發現、開發與國際衝突》，（臺北：國立編譯館，1997 年），頁 3。

Kenneth N. Waltz, *Man, the State, and War: A Theoretical Analysis* （New York: Columbia University Press, 1959）, p. 2.

七、 專書譯著

（一）中文：Author（s）' full name 著，譯者姓名譯，《書名》（書名原文）（出版地：出版者，出版年），頁 x 或頁 x-x。（初版無需註明版別）

（二）英文：Author（s）' full name, *Complete Title of the Book,* trans. Translator（s）' full Name（Place of publication: Publisher, year of publication）, Volume number （if any）, p. x or pp. x-x.

範例

布里辛斯基（Zbigniew Brzezinski）著，林添貴譯，《大棋盤-全球戰略大思考》（台北：立緒出版社，1999 年），頁 67。

Jhumpa Lahiri, *In Other Words*, trans. Ann Goldstein （New York: Alfred A. Knopf, 2016）, p. 146.

八、 期刊譯著

（一）中文：Author's full name 著，譯者姓名譯，《篇名》（篇名原文），《刊物名稱》，第 x 卷第 x 期，年月，頁 x 或頁 x-x。

（二）英文：Author's full name, "*Title of the Article,"* trans. Translator（s）' full Name, *Title of the Journal*, Vol. x, No. x, Month Year, p. x or pp. x-x.

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Kelvin Fong 著，王玉麟譯，《亞太區域潛艦概況》〈Submarines in the Asia-Pacific〉，《國防譯粹》，第 33 卷第 7 期，2006 年，頁 89-95。

九、 專書論文或書籍專章

（一）中文：作者姓名，〈篇名〉，編者（群）姓名，《書名》（出版地：出版者，出版年），頁 x 或頁 x-x。（初版無需註明版別）

（二）英文：Author's full name, "Chapter Title," in Editor/Editors' full Name（s）, ed（s）., *Complete Title of the Book*,（Place of publication: Publisher, Year of publication）, p. x or pp. x-x.

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十、 學術性期刊論文

（請依個別刊物實際出刊項目，完整臚列）

（一）中文：作者姓名，〈篇名〉，《刊物名稱》（出版地），第 x 卷 x 期，年月，頁 x 或頁 x-x。（臺灣出版之期刊無需註明出版地，但若與其他地區出版期刊名稱相同者，仍需註明出版地，以利識別）

（二）英文：Author's full name,"Title of the article,"*Name of Periodical*, Vol. x, No. x, Month Year, p.x or pp. x-x.

範例

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十一、學位論文

（一）中文：作者姓名，《學位論文名稱》，學校院或系所博士或碩士論文（畢業年份），頁 x 或頁 x-x。

（二）英文：Author's full name,"Complete Title of Dissertation/ Thesis,"（Ph.D. Dissertation/Master's Thesis, Name of the Department, Name of the Degree-granting University, year of graduation）, p.x or pp. x-x.

範例

馬振坤，《從克勞塞維茲戰爭理論剖析中共三次對外戰爭》，國立臺灣大學政治學研究所所博士（2002），頁 1。

Stacia L. Stinnett, "*The Spratly Island Dispute: An Analysis,*" （Master's Thesis, Florida Atlantic University, 2000）, p.1

十二、研討會論文

（一）中文：作者姓名，〈篇名〉，發表於○○○○研討會（地點：主辦單位，舉辦年月日），頁 x 或頁 x-x。

（二）外文：Author's full name,"Paper Title,"presented for Complete Title of the Conference （Place of conference: Conference organizer, Date of conference in month day, year）, p. x or pp. x-x.

範例

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十三、官方文件

（請依個別刊物實際出刊項目，完整臚列）

（一）中文：官署機構，〈文件名稱〉（行政命令類）或《文件名稱》（法律類），卷期（案號），日期，頁 x 或頁 x-x。

（二）外文：Author's Full Name, "Title of the Article," Date, Section or Page Numbers.

範例

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十四、報刊、非學術性雜誌

（若為社論、短評、通訊稿或作者匿名，則可不列作者欄）

（一）中文報紙：作者姓名，〈篇名〉，《報紙名稱》（出版地），年月日，版 x。（一般性新聞報導可省略作者和篇名，臺灣出版之報紙無須註明出版地。）

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（四）英文雜誌：Author's full name, "Title of the Article," *Title of the Magazine*, Date, Page x or pp.x-x.

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十五、網際網路資料

（一）請依照個別線上網站實際資訊，詳細臚列。

（二）引用網路版報紙的一般報導，無須註明版次，但須附上網址，其餘體例不變。

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稱》(法律類)，卷期(案號)，日期，頁 x 或頁 x-x，《網站名稱》，網址。

4. 報導：作者姓名，〈篇名〉，《媒體名稱》，日期，網址。

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（六）外文：

1. 專書：Author（s）' full name, *Complete title of the book* （Place of publication: Publisher, Year）, p. x or pp. x-x, URL.
2. 論文：Author（s）' full name,"Title of the article,"*Name of the Periodical*, Vol. x, No. x, Date, p.x or pp.x-x, URL.
3. 官方文件：Author's Full Name, "Title of the Article," Date, Section or Page Numbers, URL.
4. 報導：Author's full name,"Title of the article,"*Name of the Media*, Month Day, Year, URL.

範例

Robert D. Blackwill, *Trump's Foreign Policies Are Better Than They Seem* （New York: Council on Foreign Relations Press, 2019）, p. 1, Council on Foreign Relations, https://cfrd8-files.cfr.org/sites/default/files/report_pdf/CSR%2084_Blackwill_Trump_0.pdf.

Ralph A. Cossa, "Regional Overview: CVID, WMD, and Elections

Galore," *Comparative Connections: A Quarterly E-Journal on East Asian Bilateral Relations*, Vol. 6, No. 1, April 2004, p.1, Pacific Forum, http://cc.pacforum.org/2004/04/cvid-wmd-elections-galore.

White House, "National Security Strategy of the United States of America," December 18, 2017, p. 1, White House, https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

Colin Clark, "Mattis' Defense Strategy Raises China To Top Threat: Allies Feature Prominently," *BreakingDefense*, January 18, 2018, https://breakingdefense.com/2018/01/ mattis-military-strategy-raises-china-to-top-threat-allies-feature-prominently.

十六、第二次引註之格式

首次引註須註明完整之資料來源(如前述各案例),第二次以後之引註可採以下任一格式:

(一)作者姓名,《書刊名稱》或〈篇名〉,或特別註明之「簡稱」,頁 x-x。

(二)如全文中僅引該作者單一作品,可簡略為——作者,前引書(或前引文),頁 x 或頁 x-x。

(三)某一註解再次被引述,簡略為——同註 x,頁 x 或 x-x。

(四)英文資料第二次引註原則相同:op. cit., p.x or pp.x-x(前引書,頁 x 或頁 x-x。)

(五)Ibid. p.x or pp.x-x.(同前註,頁 x 或頁 x-x。)

十七、文末之參考文獻

(一)參考文獻原則上與第一次引述的註釋體例格式相同,惟書籍、研討會論文及博碩士論文無須註明頁數。

(二)所有文獻依前述註釋類別排列,並依中文、英文、其他語文先後排序。

(三)中文著作依作者姓氏筆畫排序,英文著作依作者姓氏字母排序。

(四)將書籍專章列為參考書目時,依專章作者排序。

(五)翻譯作品依翻譯語文類別,中文譯作按譯者姓氏筆畫排序,英文譯作按原作者姓氏字母排列。

(六)同一作者有多篇著作被引用時,按出版時間先後排序。

(七)每一書目均採第一行凸排 2 字元。