Can APEC Bridge the Divide? A Game Theory Approach to US-China Cooperation

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Abstract

The escalating US-China rivalry threatens to impede economic integration within the Asia-Pacific Economic Cooperation (APEC) forum. This paper departs from the existing literature by analyzing specific actions of both countries that exemplify a focus on short-term gains. It argues that by understanding the dominance of short-run gains in current US-China actions, a framework that emphasizes long-term cooperation becomes particularly relevant. Employing game theory, the paper examines APEC's future prospects. The paper analyzes potential cooperation and conflict scenarios based on economic incentives and strategic considerations. While the current rivalry resembles a Prisoner's Dilemma, the paper explores alternative game structures, namely; Repeated Games and Supergames, that can incentivize cooperation on shared economic objectives. The analysis demonstrates that long-term benefits from cooperation can outweigh short-term temptations to defect, particularly if APEC institutions foster trust and transparency. Ultimately, the analysis highlights the critical role of a strengthened APEC in promoting a stable and cooperative equilibrium, thereby fostering long-term economic prosperity for the entire Asia-Pacific region.

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1. Introduction

The Asia-Pacific Economic Cooperation (APEC) was established in 1989 with an aim to foster regional economic integration and trade liberalization. It has played a significant role in reducing trade barriers, harmonizing business regulations, and addressing issues like environmental sustainability. However, the intensifying strategic competition between the United States and China presents a significant challenge to APEC's future. From a game theory perspective, the current US-China rivalry resembles a Prisoner's Dilemma scenario. In this classic game, individual actors, motivated by short-term gains, choose to defect, leading to a sub-optimal outcome for both parties. Applied to the US-China rivalry, unilateral trade barriers and technological decoupling may offer perceived short-term advantages but ultimately harm both economies. However, game theory offers alternative models for analyzing international cooperation. These models highlight how repeated interactions and the potential for future punishment can incentivize cooperation, even in situations with initial Prisoner's Dilemma characteristics. This paper contributes to the existing literature by analyzing specific actions of both countries that exemplify a focus on short-term gains. It argues that recognizing this "short-run trap" necessitates the introduction of a long-run Repeated Games framework to analyze cooperation dynamics within APEC amidst geopolitical tensions.

The organization of this paper is structured as follows. It begins by examining the historical underpinnings of distrust between the two major powers (Section 2). This section highlights both longstanding grievances and recent actions that prioritize short-term gains over long-term cooperation, thereby exacerbating existing tensions. Next, the development of relevant theoretical concept of the game theory is discussed in Section 3. Then, the paper employs a game-theoretic framework to analyze cooperation in APEC. Section 4 utilizes a Repeated Game model with incomplete information to capture the strategic interactions between the US and China. Building upon this foundation, Sections 5 and 6 extend the analysis to a Supergame setting, allowing for the incorporation of long-term considerations. The analysis yields crucial insights for navigating the complexities of regional economic cooperation and offer guidance for strengthening APEC as a platform for long-term economic prosperity in the Asia-Pacific region. Section 7 concludes, while Section 8 provides recommendations for future research.

2. Historical Roots of Distrust and The Contemporary US-China Relationship: A Critique of Unilateral Perspectives

A comprehensive understanding of the current US-China economic tensions necessitates a multidisciplinary approach that acknowledges the historical context and key developments of their relationship. The accumulation of distrust began in the 19th century through a series of unequal treaties imposed by Western powers, including the US, on the Qing dynasty. These treaties, perceived by China as infringements on its sovereignty, involved concessions like trade privileges and territorial control (Wang, 2018). Subsequent events, including US support for the losing Nationalist faction in the Chinese Civil War (1927-1949) and the Korean War

(1950-1953) where China fought US-led forces, further solidified China's view of the US as a geopolitical adversary. Moreover, US recognition of Taiwan and its policy of "strategic ambiguity" regarding its defense exacerbate Chinese suspicions. Additionally, the Tiananmen Square incident in 1989, where US condemnation was viewed by China as interference in its domestic affairs, deepened the strained relations. These past grievances, coupled with fundamental ideological differences between a democratic capitalist US and a communist one-party state China, creates a significant barrier to trust.

The long history of distrust has fueled a continuously intensifying economic rivalry between the US and China. Previously characterized by underlying tensions, this dynamic has escalated into a full-fledged trade war since 2017. The Trump administration challenged China's trade practices, triggering retaliatory tariffs and a significant escalation. Several studies have quantified the economic costs of the trade war on the US economy. Moody's Analytics estimated the trade war had already cost nearly 300,000 jobs and reduced real GDP by 0.3% (Zandi et al., 2019). Similarly, a 2019 Bloomberg Economics report found a cost of around 0.7% to US GDP. This report further projected that the trade war would reach a total cost of USD 316 billion by the end of 2020 (Donnan & Pickert, 2019). While the US trade deficit with China did decline, this decrease was not reflected in the overall US trade balance. The unilateral tariffs imposed by the Trump administration may have redirected trade flows, leading to the observed increases in the US trade deficit with other economies like Europe, Mexico, Japan, South Korea, and Taiwan. (Hass & Denmark, 2020)

China also experienced economic strain, but not enough to yield to US demands for major reforms. A tentative agreement in 2020 aimed to boost Chinese purchases of US goods and improve intellectual property practices (Hass & Denmark, 2020). However, by December 2021, China had fallen short of its purchasing commitments. Overall, Bown (2021) highlights the severity of the tariff escalation, noting that between January 20, 2017 and January 20, 2021, average tariffs imposed by each country on the other's goods rose to approximately 20%, with these new measures covering over 50% of bilateral trade. The already tense relations were further strained by the Russia-Ukraine war in 2022, with the US imposing sanctions on Chinese companies. In response, China has implemented countermeasures to retaliate. These countermeasures include export controls on gallium and germanium, materials critical for the production of computer chips and other products. (Ma, 2024).

Despite ongoing geopolitical tensions, the economic relationship between the US and China remains deeply intertwined. Bilateral trade in goods surpassed USD 690 billion in 2022, with US exports reaching $154 billion and imports totaling USD 537 billion (Ma, 2024). Utilizing the Harmonized System (HS) classification codes and the International Trade Centre's Trade Map database (www.trademap.org), key US imports from China consist of electronics (HS 85), machinery (HS 84), and toys (HS 95). Conversely, US exports to China are primarily concentrated in agricultural products (HS 12) and pharmaceuticals (HS 30). This substantial trade relationship has undergone significant evolution since China's accession to the World Trade Organization (WTO) in 2001.

The economic interdependence extends beyond trade flows. There is a robust US business presence in China, with over 8,600 American companies operating there in 2023. Foreign direct investment (FDI) reflects this interconnectedness as well. In 2023, Chinese FDI into the United States surpassed USD 5.5 billion, while U.S. investment in China reached USD 2.47 billion (Ma, 2024). Given this multifaceted interdependence, short-sighted policies aimed at deflection and retaliation, with the expectation of immediate gains, are likely to inflict harm on both economies in the short and long term.

The economic relationship between the United States and China is not solely defined by trade disputes. Technological competition has emerged as another potential source of friction. Both nations restrict access to each other's tech sectors, hindering short-term competition and innovation. While this may bolster domestic industries, it sacrifices long-term collaborative gains. Territorial disputes in the South China Sea further exacerbate tensions. US military exercises challenge China's claims, prompting retaliatory actions that hinder cooperative resource management in the region.

This distrust permeates other areas, often prioritizing immediate political or economic concerns over long-term cooperation. Nationalistic rhetoric by leaders impedes trust-building, making cooperation on various issues more difficult. Visa restrictions for students and researchers limit educational and scientific exchange, hindering long-term collaboration in critical fields despite potential short-term security justifications. Similarly, focusing solely on blame in cybersecurity, where accusations of cyberattacks and intellectual property theft dominate, hinders the development of cooperative measures against cybercrime. Environmental issues present another arena where short-term economic concerns can overshadow long-term challenges like climate change mitigation, which necessitates international cooperation. Likewise, the increasingly competitive space race can lead to duplication of efforts and missed opportunities for collaborative scientific research and resource exploration. The following sections explore the potential for institutions like APEC, of which both the US and China are members, to serve as intermediaries and facilitate cooperation based on a long-term perspective.

3. Theoretical Concepts

The concept of Repeated Games, where players interact strategically over multiple periods, offers a structured approach for analyzing APEC's dynamic environment. Pioneering work by Axelrod (1984) highlights the importance of past interactions in fostering cooperation. However, uncertainties about past actions can complicate cooperation. Repeated games with incomplete information, where trust-building and reputation become crucial are shown in various studies (Andreoni & Miller, 1993; Fudenberg & Maskin, 1986; Kandori, 2002; Kreps & Wilson, 1982; Selten, 1978). Palfrey & Rosenthal (1994) further examines if discounted repeated interaction promotes cooperation in a public good setting with incomplete information. The experiment tests if repeated play can achieve equilibria with higher group benefits compared to a one-shot game. Results show increased cooperation due to repetition, with the effect depending on monitoring ability and environmental factors.

Incorporating infinitely repeated interactions, Axelrod's (1984) Supergame framework expands upon the repeated game paradigm. This indefinite time horizon is crucial for fostering cooperation. In one-shot games and even games with a known, finite number of repetitions, self-interested players are incentivized to defect due to the anticipation of future defection by others. Supergames, however, introduce a "shadow of the future", the recognition that current actions have lasting consequences (Gibbons, 1997; Osborne, 2003). This long-term perspective encourages players to consider the potential benefits of cooperation, as a positive reputation established through cooperation can yield significant rewards in future interactions. Supergames thus offer a framework for understanding the evolution of social norms and cooperation, where reputational effects incentivize players to prioritize long-term cooperation (Fudenberg & Tirole, 1991). Earlier works by Ahn et al. (2003) and Gachter & Herrmann (2009) investigated cooperation in social dilemmas. Laboratory experiments (e.g., Dal Bo Dal Bó & FréchetteFrechette, 2019; Rand & Nowak, 2013) further demonstrate that experience and the prospect of higher future rewards can significantly increase cooperation. Applying to international relations, Mosher (2015) emphasizes the role of discounted future payoffs and the speed of retaliation (which may be viewed equivalent to potential punishment) for defection in encouraging cooperation in repeated interactions.

The current body of literature analyzing US-China interactions in the context of APEC through the lens of game theory remain limited. This paper seeks to address the critical gap by providing comprehensive framework that illuminates the potential gains and losses associated with various strategic choices for both nations.

4. APEC as Repeated Games with Incomplete Information

The current dynamic between the US and China discussed in Section 2 often resembles a one-shot game. Both countries prioritize immediate wins, leading to actions like tit-for-tat tariffs or nationalistic rhetoric. This approach, much like the Prisoner's Dilemma, creates a situation where short-term gains lead to mutual losses in the long run. The concept of Repeated Games with incomplete information suggests that when actors interact repeatedly, they may consider the long-term consequences of their actions. In the context of APEC, continued economic interdependence between the United States (US) and China (CN) creates a situation of repeated interaction through trade, investment, and joint projects. Each interaction can be viewed as a "stage game" where players (US and CN) choose between the two strategies: Cooperation (C) and Defection (D). Cooperation prioritizes long-term mutual benefits. Defection prioritizes short-term gains by imposing trade barriers, restricting investment, or acting unilaterally.

Unlike a one-shot game, the repeated nature of interactions in APEC introduces several dynamics that incentivize cooperation. First, repeated interactions offer opportunities for open communication and fulfilling agreements, fostering trust (τ) between players. This trust increases the expected payoff from future cooperation (C, C(t-1)) in subsequent stage games (denoted by t) (Axelrod, 1984). Second, in repeated games

with incomplete information, players may not be entirely certain about the other player's future actions. However, the potential for retaliation (e.g., trade retaliation by the China in response to US trade barriers) creates a disincentive for defection (D). This can be modeled as a potential punishment cost (P) borne by the defector in future interactions (Osborne, 2003). Third, over time, repeated interactions within APEC can lead to the development of implicit norms of cooperation within the region. These norms establish expectations of behavior, making cooperation the default choice for players, even if the underlying information about future actions remains incomplete (Young, 2008).

To formalize cooperation in a repeated game, the decision to cooperate (C) for a player i, in a stage game (t) depends on the expected payoff compared to defection (D). The inequality in (1) provides a simplified representation.

$$U_i\big(C(t), a_j(t-1)\big) \cdot \pi\big(C(t-1)\big) + \big[U_i\big(C(t), D(t-1)\big) - P\big] \cdot (1 - \pi(C(t-1))) > U_i\big(D(t), a_j(t-1)\big) \text{ (1)}$$

where:

U_i represents the payoff function for player *i*, *i* = US, CN

$a_j(t-1)$ represents the action chosen by the other player in the previous stage game (t-1)

$\pi\big(C(t-1)\big)$ represents the player's belief about the other player cooperating (C) in the previous stage game (t-1). It essentially captures the concept of trust ($\boldsymbol{\tau}$). A higher value of $\pi\big(C(t-1)\big)$ indicates a stronger belief that the other player cooperated previously, which would incentivize cooperation in the current stage game.

The left-hand side of the inequality in (1) calculates the expected payoff for player i if they choose to cooperate (C) in the current stage game. It considers two scenarios based on the player's belief about the other player's past action, namely;

(1) The other player cooperated (C) previously $\pi\big(C(t-1)\big)$: This scenario is weighted by the player's belief $\pi\big(C(t-1)\big)$ and offers the highest expected payoff due to mutual benefits from cooperation.

(2) The other player defected (D) previously $(1 - \pi(C(t-1)))$: This scenario is weighted by the probability of the other player defecting and results in a lower payoff for player i even though they cooperated. However, it is still positive as they did not choose to defect themselves.

This inequality essentially states that the expected payoff from cooperation (considering the possibility of the other player defecting) must be greater than the payoff from immediate defection (D) net of the potential punishment cost (P). Trust ($\boldsymbol{\tau}$) can be incorporated by increasing the weight given to the scenario where the other player cooperates $\pi\big(C(t-1)\big)$.

5. Supergames with Infinite Time Horizon and Discounting

Building upon the insights gained from the repeated game analysis of APEC in Section 4, this section explores the concept of a Supergame to incorporate the crucial element of an indefinite time horizon and

discounted payoffs. Supergames, introduced by Axelrod (1984), involve a series of identical "stage games" played sequentially and indefinitely. In the context of APEC, these stage games represent ongoing economic interactions between member economies. Unlike finitely repeated games, Supergames acknowledge the actors' positive rate of time preference, meaning they discount the value of future payoffs relative to current ones (represented by a discount factor $0 < \delta < 1$). This introduces a long-term perspective into strategic decision-making, shifting the focus from short-term gains to the accumulation of benefits over an infinite horizon.

A Subgame Perfect Equilibrium (SPE) in a Supergame is achieved when players adopt strategies that constitute a Nash equilibrium in each individual stage game, played iteratively over the infinite time horizon. The payoffs for each player (U_i) consider both immediate and future benefits and costs associated with cooperation and defection. For APEC, this translates to US and CN (the primary actors) choosing actions in each interaction (eg., trade negotiations, joint projects) that represent a Nash equilibrium, considering the discounted value of future interactions. This represents a stable outcome where neither player benefits from unilaterally changing their strategy. In other words, a stable and cooperative outcome in the Supergame requires both players to prioritize building a positive reputation for cooperation, ensuring mutually beneficial outcomes in the long run. The knowledge of guaranteed future interactions incentivizes players to avoid risky defection, D (eg., trade barriers, unilateral actions) and prioritize cooperative actions, C (eg., trade facilitation, joint projects) that secure long-term economic benefits.

Unlike a one-shot game and repeated game, actors in a Supergame consider the indefinite nature of future interactions. The discounted payoff for player i from action combination $a_i(t)$ in the current stage game (t) and $a_j(t)$ by player j (the other country) is represented by $U_i\big(a_i(t), a_j(t) \cdot \delta^{(t-1)}\big)$. A higher discount factor δ signifies a greater emphasis on future benefits, while a lower δ reflects prioritizing short-term gains. A Subgame Perfect Equilibrium (SPE) in this Supergame requires both the US and CN to choose strategies that are their best response to the anticipated strategies of the other, considering the discounted value of future interactions. A cooperative SPE (C, C) is possible if the condition in (2) holds for both players.

$$U_i(C, C(t-1)) \cdot \delta^{(t-1)} > U_i\,(D, C(t-1)) \cdot \delta^{(t-1)} \qquad\qquad (2)$$

The inequality in (2) essentially states that the discounted long-term payoff from continued cooperation $(C, C(t-1))$ must outweigh the discounted payoff from defecting now $(D, C(t-1))$ and facing potential retaliation in future interactions.

Nevertheless, there remain challenges to cooperation in the Supergame. For example, a low discount factor δ for either US or CN can incentivize defection, as the long-term benefits of cooperation are discounted heavily. This can be exacerbated by political pressures or short-term economic gains associated with defection. Moreover, future US-China relations and the global economic landscape are uncertain. This uncertainty can make players more likely to prioritize short-term gains through defection, disrupting

cooperation. Through APEC facilitation, open communication, adherence to agreements, and fostering trust τ can increase the value of future cooperation $U_i(C, C(t-1)) \cdot \delta^{(t-1)} \cdot \tau(t-1)$, making cooperation more likely. Moreover, while not explicitly punitive, APEC can create a potential for retaliation (e.g., trade diversion) against defectors, further discouraging actions that break the cooperative equilibrium. To capture these challenges in more detail, Supergame may be further extended to incorporate other factors such as rivalry, trust and stochastic effect. This is discussed in Section 6.

6. Extended Supergame: Incorporating Rivalry, Trust and Stochastic Effects

The rivalry between the US and China can be explicitly modeled by introducing two additional factors into the payoff function. The first factor, Strategic Competition (S), captures the potential benefits associated with gaining a strategic advantage over the other player through defection (e.g., dominance in regional trade). The second factor, Reputation Effects (R), which can be positive (through consistent cooperation), leading to desirable consequences in the future or negative (through repeated defection), leading to undesirable consequences. By incorporating these rivalry factors, the SPE condition for cooperation is illustrated in (3).

$$(U_i(C, C(t-1)) \cdot \delta^{(t-1)} \cdot \tau(t-1) + R(C)) > (U_i(D, C(t-1)) \cdot \delta^{(t-1)} + S(D)) \tag{3}$$

Further extending the model into a refined Supergame with discounting and Dynamic Nash Equilibrium (DNE), incorporates the complexities of short-term interests, future uncertainties, and the role of APEC in fostering cooperation. The two additional factors may be introduced. The first factor, Short-Term Payoff (S) associated with defection (D) captures the immediate political or economic gains a player might seek. This payoff diminishes over time as the negative consequences of disrupting long-term cooperation become apparent. This decay can be modeled with a factor $\emptyset$ ($0 < \emptyset < 1$), representing the depreciation rate of the short-term gain. Another factor, a stochastic element (ε) captures the uncertainty surrounding future US-China relations. This uncertainty can take various forms, such as the probability of a political event or economic shock. The DNE conditions for cooperation (C) incorporating these additional factors can be represented in (4).

$$U_i(C, D(t-1)) \cdot \delta^{(t-1)} + \emptyset^{(t-1)} \cdot S < U_i\left(C, C(t-1)\right) \cdot \delta^{(t-1)} \cdot \tau(t-1) + \varepsilon(t) \tag{4}$$

The left-hand side of the inequality in (4) represents the discounted payoff from defecting now $U_i(C, D(t-1))$ and receiving the short-term gain (S) that depreciates over time $\emptyset^{(t-1)}$. The right-hand side represents the discounted payoff from continued cooperation $U_i\left(C, C(t-1)\right)$ adjusted by the level of trust $\tau(t-1)$ accumulated through past interactions in APEC. This trust factor increases the value of future cooperation. The uncertainty term $\varepsilon(t)$ captures the potential benefits or losses due to unforeseen events.

A stronger APEC, through its role as a platform for dialogue, can influence the DNE conditions in several ways. First, through open communication, successful conflict resolution within APEC and fulfilling

agreements can increase the level of trust $\tau(t)$ over time. This raises the threshold discount rate δ^* and uncertainty level $\varepsilon^*(t)$ required for defection to be a best response, promoting cooperation. Second, by fostering a more predictable and stable environment for economic interactions, APEC can potentially reduce the impact of future uncertainties $\varepsilon(t)$ on decision-making. This can be achieved through mechanisms like promoting transparency, establishing clear guidelines for trade and investment, and fostering regional security cooperation.

7. Conclusions and Policy Implications

This paper identifies the limitations of current US-China interactions, prioritizing short-term gains at the expense of cooperation on global challenges. It proposes a framework based on the game theory concept, emphasizing long-term cooperation within the APEC region. APEC's characteristics demonstrably align with this framework. First, it is a long-standing institution dedicated to fostering regional economic cooperation, ensuring repeated interactions. Second, APEC's initiatives prioritize long-term economic integration and shared prosperity, reflecting the Supergame's emphasis on sustained cooperation. Third, APEC can serve as a platform for the US and China to establish a reputation for cooperation, attracting other members and incentivizing cooperative behavior – a key aspect of Supergames.

While tensions persist, US and China remain crucial trading partners. Trade facilitation would benefit both countries, especially in agriculture (US exports soybeans, corn, and cotton to China) and manufacturing (both are major players in electronics and chemicals). Improved trade facilitation between US and China would also offer significant benefits for economies within the APEC region. Streamlined customs procedures, harmonized regulations, and simplified paperwork could expedite business transactions, leading to lower consumer prices and boosting exports from APEC countries, particularly for products with reduced trade barriers. Additionally, this would enhance regional supply chain efficiency, reducing lead times and inventory costs for APEC businesses. Increased trade activity could also create new jobs in sectors that benefit from exports to these major economies. In the long-term, increased FDI, facilitated by smoother investment flows, would fuel infrastructure development and economic growth in APEC economies. Closer US-China economic ties would also lead to technology spill-over, fostering innovation and new industries within the region.

Policymakers play a crucial role in strengthening regional architecture. Establishing clear trade rules, investment guidelines, and robust dispute settlement mechanisms would solidify economic ties. Streamlined customs procedures, harmonized regulations, and simplified paperwork can expedite business transactions, potentially leading to lower consumer prices and increased exports from APEC countries.

Businesses can significantly improve regional connectivity by advocating for policies that promote smooth trade flows and investment opportunities within APEC. Encouraging collaboration between US and Chinese firms, particularly in research and development (R&D), holds promise for fostering regional innovation.

Exploring opportunities for regional sourcing through integrated operations can lead to greater efficiency and cost savings.

Civil society actors have a crucial role in raising public awareness about the potential benefits of deeper US-China economic cooperation and regional integration. Maximizing regional economic gains hinges on a broader strategy of APEC integration. Economic studies quantifying the long-term benefits of deeper US-China cooperation within APEC can incentivize member states towards a more integrated economy. Disseminating these studies and fostering regular dialogues can solidify a collaborative environment. Educational campaigns and cultural exchange programs can break down stereotypes and create a more favorable environment for cooperation. Finally, by monitoring ongoing trade negotiations, civil society can advocate for policies that promote regional stability and economic prosperity.

A stable and predictable regional economic environment, fostered by open communication, clear rules, and cultural exchanges, would benefit APEC economies in the long run. However, achieving these benefits requires sustained commitment from all parties: governments, businesses, and civil society. This collective effort, guided by a Supergame framework, can pave the way for a more prosperous and cooperative future for the Asia-Pacific region.

8. Recommendations for Future Research

Future studies can enhance the model by incorporating time-varying discount rates $\delta(t)$ that reflect the evolving economic landscape and past interactions. Alternatively, introducing explicit signals of cooperation or defection within the model can illuminate how reputations are built and influence strategic choices across APEC member economies. Furthermore, by expanding the framework to encompass potential coalitions between other APEC members, a more comprehensive understanding of how regional dynamics and collective action can shape US-China competition and foster broader cooperation within APEC can be achieved.

This paper lays a conceptual groundwork for future research, demonstrating the utility of a game-theoretic approach in analyzing the economic incentives and strategic considerations that underpin cooperation and conflict scenarios within APEC. While game theory offers a valuable framework for analyzing strategic interactions, its application is not without limitations. Its core assumptions of rational actors and perfect information can obscure the influence of domestic politics, ideology, and historical grievances on decision-making. Additionally, the multifaceted nature of the relationship, encompassing economic, security, and ideological dimensions, challenges the ability of a single game theory model to fully capture its complexities. These limitations notwithstanding, game theory retains its value as a tool for analyzing specific aspects of the US-China relationship. Its application remains particularly insightful when examining economic competition or potential avenues for cooperation. However, a comprehensive understanding necessitates

employing game theory in conjunction with other theoretical frameworks to capture the full complexity of this dynamic.

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