CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Political Studies

Department of Political Science

Bachelor's Thesis

2024 **Sebastian Oram**

CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Political Studies

Beyond Borders: A Game Theoretic Exploration of TSMC's Role in China-Taiwan Tensions

Bachelor's Thesis

Author of the Thesis: Sebastian Oram

Study programme: Politics, Philosophy and Economics

Supervisor: doc. Martin Riegl, Ph.D.

Year of the defence: 2024

Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.

In Prague on the 23rd of April 2024 Sebastian Oram

References

ORAM, Sebastian. Beyond Borders: A Game Theoretic Exploration of TSMC's Role in China-Taiwan Tensions. Praha, 2024. 40 s. Bachelor's thesis (Bc). Charles University, Faculty of Social Sciences, Institute of Political Studies. Supervisor doc. Martin Riegl, Ph.D.

Length of the Thesis:

105.758 characters including spaces

Abstract

This thesis undertakes a comprehensive analysis of the geopolitical tensions between China, Taiwan, and the United States, focusing on the pivotal role of Taiwan Semiconductor Manufacturing Company (TSMC) within the semiconductor industry. Employing a game-theoretic approach, it examines the historical context of China-Taiwan relations, the strategic importance of the Indo-Pacific region, and the market dynamics of the semiconductor industry. Through models such as the median voter theorem and strategic games like the prisoner's dilemma, it assesses the actors' preferences and strategic choices. The thesis culminates in an extensive form game to elucidate potential outcomes and the efficacy of TSMC's dominance in deterring a Chinese invasion, offering valuable insights into contemporary geopolitics and economic security.

Keywords

TSMC, deterrence, game theory, strategy, US, China, Taiwan, tensions, calculus.

Table of Contents

1. Introduction

1.1. Navigating the China-Taiwan Status Quo

Amidst the intricate web of geopolitical tensions and technological advancements shaping the 21st-century landscape, Taiwan emerges as a focal point of contention between China and the United States, underscored by its pivotal role in the global semiconductor industry.

The complex relationship between China and Taiwan has deep historical roots, shaped by conflicting territorial claims and divergent political ideologies. Following the Chinese Civil War (1945-49), the Republic of China (ROC) retreated to Taiwan in 1949, establishing itself as a separate entity from the People's Republic of China (PRC) on the mainland. Despite decades of separation, the PRC has maintained its stance that Taiwan is a renegade province and has asserted its right to reclaim it by force if necessary.

In the present day, Taiwan finds itself at the centre of a geopolitical tug-of-war, with the United States serving as its major unofficial protector. Taiwan's strategic significance stems not only from its geographic location but also from its pivotal role in the global semiconductor industry. At the heart of this industry is the Taiwan Semiconductor Manufacturing Company (TSMC), an institution of immense power and influence that has become synonymous with Taiwan's technological prowess.

TSMC's dominance in semiconductor manufacturing, particularly in the production of advanced microchips, has positioned Taiwan as a linchpin in the global supply chain for cutting-edge technology. With over 92% of the world's advanced chip manufacturing occurring on its shores, Taiwan has secured its status as an indispensable player in the realm of technology and defence (Buchholz, 2023).

The reliance of major American companies on TSMC's facilities underscores Taiwan's critical role in shaping the trajectory of global innovation. While outsourcing chip manufacturing to TSMC has proven lucrative for these companies, it has also exposed a vulnerability in the United States military-industrial complex. The majority of advanced chips powering America's most sophisticated military systems are produced in Taiwan, potentially placing critical technology within reach of America's biggest geopolitical adversaries.

The prospect of Beijing gaining control of Taiwan, and by extension, TSMC poses significant challenges for the United States' strategic interests. A Chinese takeover of TSMC would not

only disrupt global supply chains but also grant China unparalleled access to advanced semiconductor technology, tipping the scales in its favour in the realm of military innovation. In light of these dynamics, the relationship between China, Taiwan, and the United States is fraught with strategic implications that extend far beyond territorial disputes. As the battle for technological supremacy unfolds, Taiwan's position as a key player in the semiconductor Industry emerges as a focal point in the broader geopolitical landscape, shaping the contours of international relations and security in the 21st century.
Throughout the thesis, I shall try to answer the following research question.

‘To what extent does TSMC's dominance in the semiconductor industry shape the bargaining power of Taiwan in its geopolitical position to China and the rest of the world, and how is this reflected in game theoretic models?’

To answer this research question it is important to understand that TSMC acts more as an incentive or a reason for countries to be interested in Taiwan, among others, instead of being an actor that influences the outcome itself. Accompanying my research question, are two hypotheses that I would like to examine, they both ask an important question about the effects of a resolution of the Taiwan Strait problem and to what extent these might be true, through different lenses. The first hypothesis I wanted to answer is closely related to the school of thought known as Realism, which views world politics as a competition and a state of constant conflictual nature. "In game theoretic models of the China-Taiwan dynamics, the presence of credible commitments from external actors, such as the United States, to defend Taiwan will influence the strategic calculus of China, potentially leading to outcomes characterised by a balance of power and deterrence." The hypothesis emphasises power dynamics, deterrence strategies and the influence of external actors, which all fall under the scope of realism. The second hypothesis relates more to the traditionally opposite school of thought to realism known as liberalism. "Game-theoretic analysis of cooperative strategies will demonstrate the potential for economic interdependence to act as a stabilising factor in China-Taiwan relations, contributing to outcomes characterised by cooperation and mutual gains." This hypothesis on the other hand emphasises the potential for economic interdependence to foster cooperation and mutual gains between China, Taiwan and by extension the US.

It is crucial to recognise that Realism and Liberalism are both schools of thought that encompass a broad spectrum of theoretical frameworks. Ascribing one hypothesis to realism and another to liberalism provides a general orientation rather than a precise categorisation. Just as game theory simplifies reality through models, associating my hypotheses with the two schools of thought serves as a reference to determine different perspectives, albeit in a loose manner.

To begin, I will provide a thorough examination of the historical context of the Cross-Strait relations and the prevailing status quo in the region. Subsequently, I will delve into the critical role of TSMC in the modern world, exploring its intricate supply chain and its relation to the United States, recognising its pivotal role in shaping outcomes in the Taiwan Strait. Building upon this groundwork, I will employ various game-theoretic models to dissect the strategic calculus of the involved parties. Starting with the median voter theorem, I will elucidate the preferences of key actors and their implications for strategic decision-making. Moving on to classic two-by-two games like the Prisoner's Dilemma and the Game of Chicken, I will explore the potential actions and their repercussions for the US and China. In the final phase of the thesis, I will introduce an extensive form game that integrates insights from the previous models, offering a comprehensive overview of potential scenarios and their associated payoffs. By synthesising these analyses, I aim to address the central question of how TSMC's dominance, coupled with the strategic interests of other countries, can influence Taiwan's ability to deter a potential Chinese invasion.

1.2. Literature Review

The literature review process is a crucial part of the thesis, reviewing fields such as geopolitics and game theory was a task at times very complicated due to the vastly differing nature of the two disciplines. One being based more on understanding foreign policies through which to analyse or even predict international political behaviour and the other being more closely related to applied mathematics rather than politics in its core. It was only after reviewing several articles, journals and academic works that I realised that these two disciplines, however divergent they may be, are in fact extremely complementary, hence my

decision to combine them. The literature review can be divided into three distinct sections, in the first section I concentrated on gathering as much information as possible on the Cross-Strait dispute through a geopolitical and historical context, in the second section I researched game theory and game theoretic applications and their usefulness in international relations and in the third and final section, I gathered information on TSMC and its pivotal role in maintaining US interest in the region along with existing works on the topic.

Bush, R.C. (2019), provides a good initial analysis of an overview of the historical context of China and Taiwan, he covers important topics that help the reader understand the complex implications that the two territories are intertwined in. He traces their ever-changing relationship from the Chinese Civil War to the present day by exploring the political and cultural factors that have shaped their interactions, shedding light on the ongoing tensions. Where Bush R.C. concentrated more on the historical aspect of the two countries involved, Dustin R. Turin (2010), delves more into the contemporary context of the Taiwan Strait issue, through which he defines the status quo in the Indo-pacific and the determining factors of Taiwanese identity and sovereignty. His analysis helped me focus more on the resolution of these tensions, possible ways to move forward and what this would mean for each of the countries involved.

The second part of my literature review process focused more on the game theoretic perspective, if and how game theory could be a good way to analyse international relations. Mesquita, B. (2010), combines game theory with international politics using the example of Iran's nuclear pursuit. In his work, he sets a stage for 2 players that are in a constant tug-of-war, Iran and the United States. By examining Iran's nuclear aspirations, he opposes the US' preferences against those of the Iranian government, Iran's supreme leader and many more. In doing so, he tries to set up game-theoretic models such as the Median Voter Theorem determining what the most probable outcome could be concerning Iran's nuclear policy. In my example with China and the US, I can assess the situation in a very similar manner. Through informed decisions, I try to construct a realistic approach to how this conflict could be solved or at least what the most probable outcome could be.

To understand why the United States is so interested and invested in Taiwan's defence, I researched one of the most influential corporations in the 21st century to try to uncover one of the strongest bargaining tool's held by a single corporation, situated on a relatively small island.

Shattuck, T. (2021) explores how TSMC is trapped in a tech war between the two global superpowers, China and the US. He talks about the importance of any decision that TSMC makes from here on out as it can determine who will dominate the tech industry. Shattuck explains that one of the potential futures for TSMC could involve moving closer to the US through the new manufacturing sites (fabs) in Arizona but he acknowledges that this would have dire consequences and China would not accept this outcome lightly.
Kawakami, M. (2022) highlights how moving closer to the US would pose significant challenges, as China remains a significant market and production base for TSMC, thereby arguing against the rapprochement showing that the interdependence in the high-tech industry cannot be so simply severed and made to function as if nothing changed.
Kawakami examines another important element that I shall touch upon later, concerning the ongoing global semiconductor shortage that forces TSMC's hand into expanding abroad. With new fabs planned not just in the US, but also in China, Japan and possibly Germany, this can be very detrimental to Taiwanese deterrence strategies.

John Fuh-Sheng Hsieh & Yi-Tzu, (2023), approach the US-China-Taiwan dynamics with a game theoretic analysis, the authors make an important remark regarding Taiwan's internal politics which influence its foreign policy regarding the US and China, they best describe this by constructing a two-level game. At one level the model analyses the internal politics, which can be very volatile depending on what political party is in power, this can then determine future consequences for Taiwan as a significant difference in political opinions can come from one leader to another ultimately leading to a large shift in Taiwan's policies to both countries. This ties into the second level of the game which incorporates international politics showcasing why despite China's desperate obsession with a reunification with Taiwan, they want to limit their aggression to when it is the only resolve left. According to the authors, the US aims to maintain the status quo while China seeks a reunification ideally peaceful, but under threat of using violence if Taiwan declares its independence.

Tung, C. and Wan, H. (2019), decided to construct an extensive form game to examine TSMC's fabs, the game models the strategic interactions between a fabricator (F) and a designer (D) in a multi-stage process involving commitment, investment, consultation, and marketing, with the potential for trust issues and strategic behaviour affecting the outcomes. The use of game theory here helps to predict the likely actions of each player and to find strategies that could lead to mutually beneficial outcomes and I would like to construct a similar model involving China and the US. Tung and Wan prove that a complex

process such as managing relations between designers and fabricators is indispensable for the fluid manufacturing of semiconductors and can be simplified and clearly laid out in a game theoretic framework, I would like to build on this and create my own extensive form game based on Bueno de Mesquita's tree form model, to find the potential outcome of the US-China standoff.

2. Methodology

2.1. Using Game Theory as a conceptual tool

Game Theory is a branch of applied mathematics that studies the behaviour of rational agents in a conflictual situation, it was first properly introduced in the 1950s and has since served in various fields ranging from evolution to social sciences. The brilliance behind using game theory is its simplicity, it builds models and games which try to simplify reality, the essential goal of models being to transfer complex and multifaceted information into simple straightforward explanations. A model is nothing more than a "simplified picture of a part of the real world, (March and Lave 1975). Game theory is a valuable conceptual tool because it simplifies real-world complexities into mathematical models, and it allows researchers and policymakers to distil key elements of decision-making processes and predict possible outcomes.

"Why use formal mathematical models to study international politics? The reason is that mathematics provides a precise language to describe the key elements of a problem, a powerful deductive machinery that extends the logical power of our theories, and an important means to expand our understanding and interpretation of the world. Used properly, which means never in isolation from less formal theory or empirical analysis, mathematical models can greatly enrich our analysis of international politics." (Snidal, 2004, p.227)

This simplification is crucial because it helps to clarify the underlying dynamics of complex situations, making them more understandable and tractable for analysis. Moreover, using models and games allows for the exploration of different scenarios and their potential consequences in a controlled environment, facilitating strategic thinking and policy formulation. Ultimately, in this thesis, this approach enables me to gain deeper insights into

the dynamics between different stakeholders and develop more effective strategies for achieving their objectives.

2.2. Reasoning behind the models and player's assumptions

In the thesis, I plan to employ three different game theoretic models, the Median Voter Theorem which is a spatial model, positioning each actor on a specific space on a preference continuum, I will also employ the two by two games, such as the Prisoner's Dilemma and the Game of Chicken and finally the more complex of them all, an extensive form game which combines both the previous models and provides an insightful outlook on the outcome of a potential China-US conflict in the Indo-Pacific.

In the Median Voter Theorem (MVT), each stakeholder, in the Taiwan Strait scenario, has preferences regarding key issues such as sovereignty, economic interests, and security concerns. China's preferences may, for example, prioritise territorial integrity, asserting control over Taiwan, and securing access to advanced semiconductor technology through TSMC, whereas Taiwan's preferences may prioritise maintaining sovereignty and preserving economic autonomy, all the while avoiding military conflict with China. The Median Voter Theorem posits that in a political decision-making process, the outcome tends to reflect the preference of the median voter or the voter whose preference falls in the middle of the preference distribution, an outcome that, I shall further explore in the model. In the Prisoner's Dilemma and the Game of Chicken, I oppose the two main actors, China and the US, to see what they have to gain or lose by 'Cooperating' or 'Defecting'. These two actors engage in a one-time interaction, facing the dilemma of whether to cooperate or defect, each with their respective payoffs using the Nash Equilibrium to determine optimal strategies for the players. The final model involves an extensive form game between the US and China in a tree form which is determined by its sequential properties, as mentioned before, the model combines the MVT with the two by two games, where I analyse each player's preference and examine their decisions at each stage of the game using the Subgame perfect Nash Equilibrium explained further on. This model is a more precise adaptation of the decision-making process that each actor has to consider, based on the repeated interaction between them, each player can use the information of what the other player did at any point of the game and base their own choice and decision accordingly, thereby reflecting reality much more precisely.

2.3. Limitations of Game Theory

While game theory is insightful in understanding strategic choices, it carries limitations like most attempts at simplification. One notable constraint lies in its assumption of rationality and perfect information, which may not always align with actual conditions. Human actors can act irrationally, and information can be incomplete, leading to outcomes diverging from theoretical predictions. Additionally, game theory often oversimplifies intricate societal, political, and cultural elements, neglecting their impact on decision-making. Furthermore, the static and deterministic nature of game theory models overlooks the dynamic nature of real-world conflicts. Emotions, perceptions, and non-material factors also play significant roles, which game theory may not adequately address. Thus, while game theory offers valuable insights, a comprehensive understanding of international relations necessitates complementing it with other analytical approaches.

3. Historical Context

3.1. The Cross-Strait Dispute

Exploring the historical intricacies of China-Taiwan relations unveils a tapestry woven from centuries of shifting powers, geopolitical rivalries, and evolving national identities. Taiwan, a de facto sovereign entity, bears witness to the historical ebb and flow of imperial dominance and post-war realignments, beginning with its rule under the Chinese Qing dynasty and subsequent Japanese occupation following World War II. Reverting to Chinese control under the Republic of China (ROC) after the war, Taiwan's unique trajectory shifted from that of mainland China, setting the stage for divergent national identities and political aspirations. The absence of a formal peace treaty between the ROC and the People's Republic of China (PRC) underscores the unresolved tensions simmering beneath the surface, with Beijing steadfast in its assertion of Taiwan as a renegade province awaiting reunification, a sentiment reiterated by the Communist Party of China (CPC) under the leadership of Xi Jinping (Al Jazeera, 2024). In contrast, the United States assumes the role of Taiwan's de facto guardian,

leading a coalition of support from other non-NATO allies such as Korea and Japan, amplifying the strategic significance of the island in the broader Indo-Pacific region.

The geopolitical chessboard of the Taiwan Strait is further complicated by the economic imperatives and technological prowess embodied by TSMC, an institution that stands as a linchpin in the global semiconductor industry. Revered as the "foundry that rules the world," TSMC's ascent to prominence underscores Taiwan's emergence as a technological powerhouse with outsized influence on the global stage. TSMC's monumental stature within the semiconductor industry, exceeding $686.06 billion in valuation as of April 2024 and single-handedly driving Taiwan's semiconductor exports, positions the company at the nexus of economic vitality and geopolitical strategy, shaping the contours of regional power dynamics and international relations (Braun, 2020; Chiang, 2024).

Amidst this backdrop of historical legacies and technological ascendancy, Taiwan's pivotal role as a semiconductor supplier to mainland China adds a layer of complexity to the geopolitical calculus. The symbiotic relationship between Taiwan and the PRC in the semiconductor domain belies the geopolitical tensions simmering beneath the surface, with Beijing representing a dominant force in the global semiconductor market, accounting for approximately 60% of global demand (Kharpal, 2022). Taiwan's critical role as a semiconductor supplier to the PRC underscores the intertwined economic and security imperatives that define the Taiwan Strait, highlighting the delicate balance of power and vulnerability inherent in the region's geopolitical landscape.

Considering China's rising assertiveness and Taiwan's strategic significance, the prospect of a Chinese invasion looms large, presenting a stark calculus of risk and reward for both Beijing and Taipei. Beijing's potential gains from securing Taiwan's semiconductor fabs could afford it a decisive advantage in technological superiority and military prowess (Yoshihara, 2012). However, the spectre of destruction and sabotage casts a pall over the feasibility of such a venture, underscoring the inherent risks and uncertainties in coercive strategies.

In response, the United States employs strategic manoeuvres like the First Island Chain, a chain of archipelagos ranging from Japan to Indonesia, to counterbalance China's ambitions, exerting control over key maritime chokepoints to curtail Beijing's influence and enhance deterrence capabilities. The strategic calculus of the Taiwan Strait, amplified by Taiwan's robust estimated GDP of $791.61 billion in 2024, underscores technological innovation, and geopolitical manoeuvring that defines the region's dynamics.

Through a multidimensional lens encompassing historical narratives, economic imperatives, and strategic calculations, this thesis seeks to unravel the complexities of the China-Taiwan-

US relationship, shedding light on the interplay of power, ambition, and vulnerability in the Indo-Pacific region.

3.2. TSMC and the United States

Exploring the symbiotic relationship between TSMC and the United States unveils a narrative of technological interdependence and strategic imperatives shaping the contours of global power dynamics. Renowned as the preeminent force in advanced semiconductor manufacturing, Taiwan stands as the undisputed epicentre of technological innovation, wielding unparalleled influence over the global semiconductor industry (Coldiron, 2022). Leveraging its absolute monopoly on the production of cutting-edge microchips, Taiwan has crafted a formidable defence strategy, positioning itself as an indispensable asset to both Washington and Beijing.

Giant American tech corporations, including Intel, Nvidia, AMD, and Apple, have embraced TSMC as their primary manufacturing partner, outsourcing the production of advanced chips to Taiwan's highly specialised fabrication plants, or "fabs," to remain competitive in the global market. However, this strategic alliance has introduced a paradoxical conundrum for the United States, as the majority of its military's most advanced chips, powering critical weapons systems such as the F-35 fighter jets and missiles, originate from TSMC's fabs located in close proximity to its geopolitical rivals. Despite the immense profitability for private entities like Nvidia and Apple, this outsourcing phenomenon has catalysed a seismic shift in the global semiconductor supply chain, with profound implications for national security and strategic autonomy (Patterson, 2023).

The centrality of TSMC in the global semiconductor landscape is underscored by its monumental investments in research and development, with the company committing nearly $100 billion over the next three years to spearhead the development of next-generation fabs and semiconductor technologies (Shilov, 2021). Apple, in particular, has emerged as the backbone of TSMC's revenue stream, with the tech giant accounting for a staggering $17 billion in chip manufacturing services in 2022 alone, cementing TSMC's status as a cornerstone of Apple's supply chain (McFarlane, 2023).

Amidst mounting geopolitical tensions and the spectre of a potential Chinese invasion of Taiwan, the United States has reaffirmed its commitment to defend Taiwan, recognising the existential threat posed by Beijing's coercive ambitions. Joe Biden's unequivocal pledge to safeguard Taiwan's security underscores the strategic calculus underpinning Washington's strategic imperatives in the Indo-Pacific region, with Taiwan's semiconductor industry occupying a pivotal role in shaping the trajectory of regional power dynamics (Brunnstrom & Hunnicutt, 2022).

Considering Taiwan's meteoric rise as a semiconductor powerhouse and its entwined relationship with the United States, the future of the Taiwan Strait assumes heightened salience, as geopolitical rivalries intersect with technological innovation to shape the contours of regional stability and global power dynamics.

With China’s increasing pressure of reunifying with Taiwan, I can delve into my first model, examining different preferences of relevant actors regarding this potential geopolitical shift using the Median Voter Theorem. This will serve as a very basic and simplified introduction into the status quo of the Cross Strait dispute.

4. Median Voter Theorem

4.1. Introducing the model

The Median Voter Theorem (MVT) predicts the outcome of a decision-making process when preferences are single-peaked and voters' preferences are arranged along a single dimension (in our model scaled from 0 to 1). It's essential to interpret the MVT predictions with caution, I am fully aware of its limitations, such as its reliance on simplifying assumptions and its inability to account for strategic behaviour, coalition formation, and power dynamics among stakeholders, but its conceptual clarity, baseline prediction capability, and comparative value make it a useful tool for understanding complex geopolitical dynamics.

All values are based on informed assumptions and extensive research, but they remain assumptions. When I determine utility for different actors, it is important to remember that all values are arbitrarily chosen and that the actual values themselves do not matter as long as the relative distance remains the same, meaning that any scale can be chosen, I could analyse player’s preference choices on a scale of -12 to 14, as well as from 0 to 1, which is what I

have chosen for the Median Voter Theorem. Preferences must also be assigned an order, in which the actor in question would prefer one to the other.

1. China deescalates or steps back
2. Status Quo is maintained
3. China gains control of Taiwan

The US prefers outcome 1 to outcome 2 but prefers 2 to 3.

4.2. Status quo

Taiwan is a self-governed democratic region with its own constitution (since 1947), military, and foreign relations, but its sovereignty is not universally recognised.

- China views Taiwan as a part of its territory and has not renounced the use of force to bring it under its control, while also seeking to isolate Taiwan internationally.
- Taiwan views itself as an independent nation, separate from the PRC, despite increasing pressures from the mainland.
- The United States among others, have significant economic and strategic interests in this region.
    - Economic interest: The US relies on TSMC for advanced semiconductors and supports Taiwan’s participation in international organisations such as the WHO, which despite many efforts, is still being thwarted by China. They also have policies to deter any forceful change in the status of Taiwan by China (The Taiwan Relations Act, 1979). However, they don’t recognise Taiwan as a sovereign state. The US doesn’t consider Taiwan a sovereign state but it also doesn’t consider it part of the PRC, it considers the matter unsettled (Tkacik, 2007).
    - Strategic interest: The United States and its Southeast Asian allies, including Japan, Korea, the Philippines, and Indonesia, hold control over vital 'choke points' that hinder China's Pacific expansion and global influence, known as 'The First Island Chain'. Among these choke points lies Taiwan, whose control by China would signify a breakthrough in this island chain, granting China the

freedom to expand its sphere of influence, into the Pacific and ultimately to the world.

- TSMC has increased their cooperation with the United States in the past few years as proven by the recent pledge to construct the $40 Billion Arizona fabs. TSMC Arizona. (2024).

4.3. Actors

For the chosen actors, I must stress that as the MVT model is a very simplified representation of reality, I consider that one actor, usually one state, is summed into one ‘preference’ on the scale, despite there being different views and opinions within the stakeholders themselves (i.e. Taiwan will be represented as one actor on my MVT preference continuum, despite having different ministers or political parties within itself that would disagree on their positions).

- China (Xi Jinping, CCP)
    - For China, a preference value of 1 might indicate its strong preference for Taiwan's reunification with the mainland, ensuring territorial integrity and strategic influence.
    - ‘We prefer a peaceful reunification to an annexation, but we prefer an annexation, to Taiwan becoming a sovereign state, recognised internationally.’
- Taiwan (Lai Ching-te, DPP)
    - For Taiwan, a preference value of 0 could signify its strong rejection of any outcome involving Chinese interference or coercion, such as military annexation or pressure for unification.
    - ‘We prefer full independence as a sovereign state to the status quo (SQ), but we prefer the SQ to a forceful reunification’
- United States
    - The United States' preference value could be around 0.2, reflecting its current strategic reliance on Taiwan's semiconductor industry. This preference stems from the recognition that the United States has not yet achieved semiconductor independence from Taiwan, underscoring the crucial role of TSMC's

microchips in the US economy. Thus, while the US does not prioritise Taiwan's status for ideological reasons, its economic interest in safeguarding access to TSMC's technology elevates the importance of maintaining the status quo in the region.

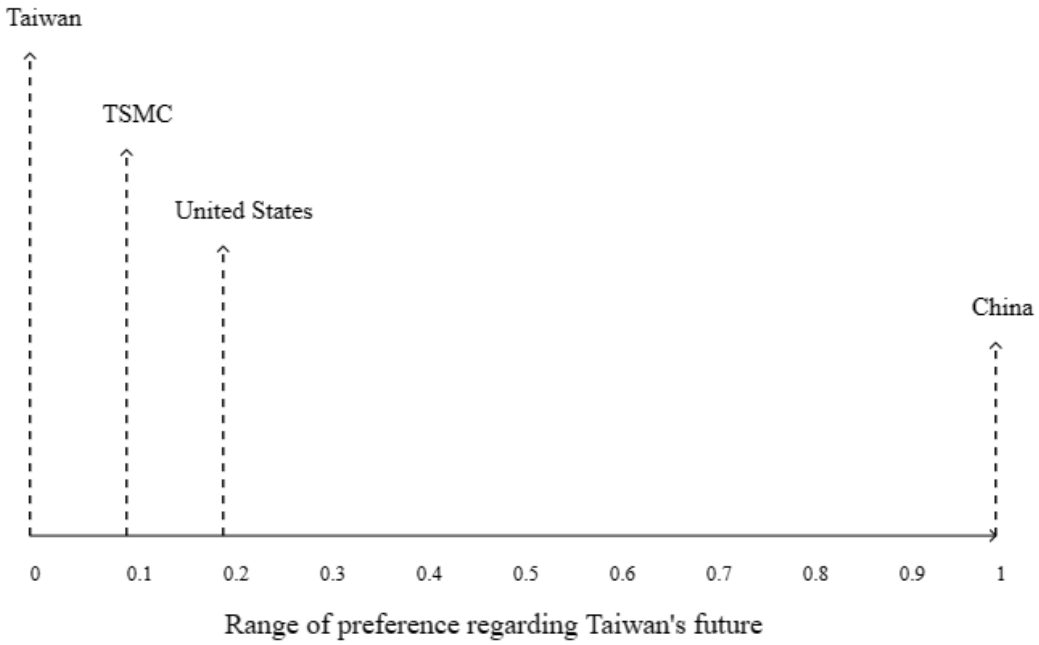
    - The United States wants to maintain the First Island Chain and its strategic influence in the Indo-Pacific region.
    - "We prefer that Taiwan shares its manufacturing information, to the island being annexed by the PRC, but we prefer an attempt of a Chinese annexation to a peaceful reunification in which the US would have no say over TSMC's future"

- TSMC
    - TSMC's preference value of 0.1 signifies its firm opposition to reunification, aligned with Taiwan's government stance. Despite the largest shareholder being the central government of Taiwan, TSMC operates as a business, with international shareholders influencing its decisions. TSMC's founder, Morris Chang, has criticised increased TSMC-US cooperation, labelling it as detrimental to Taiwan's strategic autonomy, and accusing both Washington and TSMC of eroding Taiwan's strategic defences.
    - "We prefer a sovereign Taiwan to the SQ, but we prefer the SQ to an official reunification"

4.4. Implications of the model

The Median Voter Theorem predicts that the winning outcome or the most likely outcome is the position of the median voter. In this case, if I order the preferences, we get Taiwan (0), TSMC (0.1), US (0.2) and China (1), the 'Median Voter' being TSMC and the US.

Figure 1: Outcome Preferences for Selected Stakeholders



Adapted model from B. de Mesquita, 2010.

The outcome projected by the MVT is predominantly shaped by the United States, indicating that it will likely align with the US's strategic objectives in the region, aiming to strike a balance between China and Taiwan. This may entail the US assuming a central role in mediating tensions or even intervening directly in the event of a conflict. The US's position as the median voter suggests that their preferences would be the most significant in determining the outcome of this specific situation.

In a traditional MVT, actors are assumed to have equal weight in their decisions, but in reality, this is not the case. For instance, in my model, China and the US wield considerable influence over the outcome, followed by Taiwan and TSMC. It's important to note that this is a simplification of a complex situation. While the model suggests a probable outcome with the US as a key player, exploring a weighted MVT could have been insightful if the model seemed skewed towards an improbable outcome. This weighted approach would assign different weights to stakeholders based on their power and influence, likely placing China and the US at a higher weight than TSMC for example. Despite its simplifications, this model

serves as a useful introduction to the thesis topic, providing a foundational framework and preliminary insights into the situation. It prepares us for deeper analysis while acknowledging the nuances and complexities inherent in real-world dynamics.

"Assumptions restrict how we think about the world. However, without them, we could say that anything is possible, and so we could not choose among competing explanations of how international politics works. Assumptions are an important part of constructing expectations and give us a basis for making predictions, but we must always be clear and explicit about what we are assuming so that everyone can tell on what basis we arrived at our predictions." (Bueno de Mesquita, 2013).

The United States and China are arguably the most influential actors in these situations, being global superpowers, they wield the influence to sway the outcome in their favour. For strategic positions but mostly economic incentives characterised by TSMC's influence, let us consider more closely what a potential stand-off between these two superpowers might signify, what payoffs and risks would each actor face and what strategic calculus must be considered in moving forward. For this let us look at the very basic yet insightful two by two game-theoretic models, the Prisoner's Dilemma and the Game of Chicken.

5. Two by two games

5.1. Prisoner's Dilemma

The Prisoner's Dilemma (PD) model offers valuable insights into the dynamics of the Taiwan Strait tensions due to its ability to capture the inherent conflict between individual and collective interests. In this scenario, rational actors face a dilemma where mutual cooperation yields the best overall outcome, but individual self-interest incentivises defection, leading to a suboptimal result for both parties. By examining the trade-offs between mutual cooperation and unilateral action, the PD model provides a lens through which I can analyse the strategic calculations and decision-making processes of the involved parties amidst competing priorities and uncertainties in the Indo-Pacific region.

Let’s assume, for simplicity, that cooperation and defection bring the same payoffs for both players (so for example defection has the same benefit and risk for China as it does for the US). In the traditional model of the PD game, if one side cooperates whilst the other defects, the latter has a large payoff, it is a one-time interaction. In reality, however, the circumstances modify the model, where retaliation must be evaluated when choosing the optimal strategy, but we shall touch upon this further on. Bearing that in mind, one-sided defection still brings the highest payoff, but it is only a short-term advantage as retaliation is always an option for the other side, even after having cooperated in the first place. This then turns into a situation where each side must weigh their short-term gains against long-term effects and consequences.

5.2. Assumptions of the game

To construct the model effectively, it's essential to determine the distinct choices of either cooperation or defection available to both actors and the implications thereof.

- **China**
    - **Cooperation**: In the context of China's cooperation, it would involve the de-escalation of tensions and a focus on establishing stable relationships with Taiwan, albeit, most likely, without conceding its claim to Taiwan's sovereignty. This could entail initiatives to preserve and enhance trade ties and diplomatic engagements. Essentially, China would seek to avoid significant losses and mitigate the risks associated with escalation by adopting a cooperative stance. Doing so aims to safeguard its strategic interests while minimising potential negative consequences, such as economic disruptions or military conflict.
    - **Defection**: China's defection strategy, on the other hand, would involve diplomatic coercion and intensifying claims and threats against Taiwan. This could manifest in various forms, including escalating rhetoric, imposing

economic sanctions, conducting military exercises near Taiwanese territory, or heightening diplomatic pressure on Taiwan's allies. The objective of this defection strategy would be to assert China's dominance, compel Taiwan to acquiesce to Beijing's demands and advance China's strategic interests in the region. However, such actions could escalate tensions, increase the risk of conflict, and adversely affect regional stability and international relations.

- **United States**

    - **Cooperation:** In the scenario of US cooperation, de-escalation efforts could involve seeking compromise with China to prevent direct military confrontation. This might entail initiatives such as fostering improved diplomatic relations, easing restrictions on semiconductor trade (‘The US chip export ban’, Shivakumar et al., 2024) and adopting a more conciliatory stance towards China's regional influence. The aim would be to reduce tensions and promote stability in the Taiwan Strait.

    - **Defection:** In the scenario of ‘defection’, the US may advocate for Taiwan's sovereignty, provide economic aid, and reaffirm its commitment to defending Taiwan. This might mean bolstering partnerships in the Indo-Pacific to counterbalance China's influence and enhance regional stability, implementing sanctions or trade measures targeting China's destabilising actions in the Taiwan Strait, and ramping up efforts to rally international support for Taiwan's security and sovereignty through diplomatic channels.

All numbers are arbitrarily chosen and are for illustrative purposes only. (China’s payoffs are located on the left and the US payoffs on the right)

Figure 2: Sino-American Standoff, a Prisoner's Dilemma model.

		United States	
		Mutual Benefit (Cooperation)	Opportunism (Defection)
China	Mutual Benefit (Cooperation)	(+75, +75)	(-100, +100)
	Opportunism (Defection)	(+100, -100)	(-50, -50)

While unilateral defection may offer immediate benefits, mutual cooperation yields the most favourable overall outcome, fostering mutually beneficial relationships among involved parties. However, the challenge lies in navigating the inherent tensions between individual interests and collective welfare, requiring careful consideration of strategic decisions in light of immediate gains and enduring implications. Ultimately, the prisoner's dilemma underscores the importance of cooperation, and advancing shared interests on the global stage.

The prisoner's dilemma also highlights the challenge of cooperation in situations where individual incentives clash with collective welfare. In this scenario, both China and the United States face the temptation to defect, as it offers the highest individual payoff regardless of the other player's choice. Because of this, the dominant strategy for both players becomes defection, resulting in a Nash Equilibrium and a solution to the game being, mutual

defection. A Nash equilibrium being a situation where no player can benefit by changing their strategy, given the strategies chosen by others. It's a stable outcome where each player's choice is optimal given the choices of others. This highlights the tension between short-term self-interest and long-term collective benefit, despite the potential for cooperation to yield superior outcomes for both parties, the risk of defection prevails due to uncertainty and the lack of trust between the players. As a result, the prisoner's dilemma showcases the challenges of achieving cooperation in competitive environments where individual gain often takes precedence over mutual welfare ultimately leading to an outcome that is Pareto or socially inefficient.

5.3. Game of Chicken

The Game of Chicken is a classic scenario in game theory that captures the dynamics of risky behaviour and brinkmanship. In this game, two players engage in a high-stakes confrontation where each must decide whether to "swerve" or "go straight." Swerving represents backing down or compromising, while going straight signifies maintaining a course of action despite the risk of collision or conflict. The key dilemma arises from the mutual desire to avoid a disastrous outcome, such as a collision, while also wanting to demonstrate resolve and avoid appearing weak. This strategic tension between assertiveness and prudence makes the game of chicken a compelling model for analysing scenarios of conflict, negotiation, and deterrence in various contexts, including international relations and strategic decision-making.
Along with the Prisoner’s Dilemma, these models offer complementary insights into decision-making under uncertainty and conflict. The Prisoner's Dilemma illustrates the trade-offs between short-term gains and long-term cooperation, while the Game of Chicken emphasises the strategic calculus of deterrence and escalation.
The relevance of using this model to analyse the Sino-American tensions is well founded and a good starting point is the US Speaker of the House of Representatives, Nancy Pelosi’s visit to Taiwan in early August 2022. In response to this, Beijing initiated joint military drills near the island and suspended or terminated eight official dialogues and cooperation channels with the United States. Taiwan experienced unprecedented provocations, including ballistic missile launches over its territory, air and naval manoeuvres along the centerline and near its

territorial waters, and a surge in cyber attacks, surpassing the previous daily record by 23 times. Both superpowers have entered into a dangerous game of Chicken in the heart of the Indo-Pacific (Klare, 2022).

In the simplest form swerving means that a country decides to not get involved militarily, which means the actor either does nothing or even withdraws its troops from key areas. Mutual swerving leads to a payoff of $(0; 0)$ because no one does anything, China doesn't deploy their military and neither does the US meaning that nothing changes hence $(0; 0)$. Mutual involvement leads to a 'collision' which is a disastrous outcome, a conflict of this magnitude will leave both sides devastated, hence a payoff of $(-100; -100)$.

Military involvement from one side and a military absence from the other results in a mixed strategy, where one side demonstrates military strength and asserts dominance, while the other retreats and is consequently labelled as the 'chicken', hence the name. The payoff for the 'chicken' is (-1) for backing down, while the opposing side gains a payoff of (1) for their unopposed aggression. The (-1) payoff also reflects the perception of weakness, as backing down may be interpreted as a lack of resolve in a highly competitive geopolitical environment, potentially inviting exploitation by other global powers.

5.4. Assumptions of the Game of Chicken

To set up the game of chicken, I will determine the implications of different combinations of choices to help understand each actor's payoff.

- **China**
    - Swerving, for China, could entail a de-escalation of military manoeuvres, such as withdrawing naval vessels or aircrafts from sensitive areas near Taiwan, to reduce the risk of conflict and demonstrate a willingness to negotiate.
    - Going straight, for China, could involve escalating military actions, such as deploying additional forces near Taiwan and engaging in a full-scale invasion to attain full sovereignty.

- **United States**
    - Swerving, for the US, may involve scaling back military exercises or deployments in the region, signalling a desire to avoid confrontation and prioritise diplomatic solutions to resolve tensions peacefully.
    - Going straight for the US comes down to defending Taiwan militarily, if China swerves and the US decides to go straight they will reinforce military presence in the region, such as deploying additional naval assets or conducting joint exercises with regional allies. If China goes straight and so does the US, the US strategy will involve defending Taiwan militarily.

Figure 3: Demonstration of Sino-American Brinkmanship based on the Game of Chicken

		United States	
		Military Absence (Swerving)	Military Engagement (Straight)
China	Military Absence (Swerving)	$(0; 0)$	$(-1; 1)$
	Military Engagement (Straight)	$(1; -1)$	$(-100; -100)$

This game illustrates a precarious playing field in which actors must demonstrate strong resolve and select a strategy that avoids mutual collision while maintaining credibility and deterring adversary actions. Thus, achieving a solution in the game of chicken entails striking a delicate balance between assertiveness and prudence, ultimately steering clear of a collision course towards conflict. While unilateral aggression may appear advantageous in the short term, the potential costs of escalation are catastrophic. Conversely, mutual de-escalation

and diplomatic resolution offer the prospect of averting catastrophic outcomes and fostering stability in the region.

5.5. Combining the two games and drawing conclusions

In the game of chicken, the rational choice depends on the potential consequences and perceived risks involved. If a player believes that the other side will swerve, the rational choice is to continue straight ahead, as this results in the best outcome for the player. However, if one player believes that the other will not swerve and instead go straight ahead, the rational choice is to swerve to avoid the collision and minimise potential harm. Therefore, the rational choice in the game of chicken depends on the player's assessment of the other player's actions and their willingness to take risks. The game of chicken, unlike the Prisoner's Dilemma, highlights a situation where there is no dominant strategy and yet there are two Nash Equilibria. This means that if the United States, for example, is convinced that China will 'Go Straight', the rational choice would be to 'Swerve' and avoid a catastrophic outcome, if, however, the US thinks China will eventually back down, their rational choice now becomes to 'Go straight'. This shows that there is no dominant strategy and a player must weigh the other player's resolve, when making their own strategic decision, unlike the PD where a strategy is dominant no matter what the other player chooses. This observation accurately captures the recent dynamics between the two sides, as both have engaged in calculated brinkmanship manoeuvres, carefully assessing each other's intentions and capabilities.

6. Taiwanese Deterrence

6.1. Official deterrence strategies

In the two-by-two games I have analysed, I assigned equal payoffs to China and the US across all outcomes, revealing the tragic nature of rational behaviour in international relations always resulting in Pareto inefficiency. However, upon deeper examination, I have recognised Taiwan's array of strategies to deter China's aggression and potentially shift the

balance in their favour, and by extension, the US's. There are a few official deterrence strategies that Taiwan can employ to avoid escalation ranging from diplomatic and economic negotiations to military threats. Both Realism and Liberalism offer valuable perspectives into these considerations.

At the heart of Taiwan's security strategy lies its microchip industry. TSMC owns about a dozen fabrication plants, which are not only extremely expensive but also highly specialised, making TSMC the only corporation in the world able to produce these high-end chips. Knowing this, Taiwan has always guarded this secret, guaranteeing themselves what many call a "silicon shield." The theory of the silicon shield follows the logic that the outside powers who have come to rely on Taiwan's microchips such as the US, Japan or Korea, will be heavily economically incentivised if not 'forced' to protect TSMC's foundries and thus be highly incentivised to protect Taiwan's sovereignty in itself, aligning with liberal notions of cooperation through mutual dependence. Keeping the third parties incentivised, however, is only half of the semiconductor deterrence strategy, the fact remains that China has become highly dependent on the steady supply of Taiwan's microchips, despite having set a target of 70% self-sufficiency in microchip production by 2025, China has as of 2023 only reached a comparatively measly 16% (Register, 2023). The semiconductor industry is one of the biggest in the world, and the chip shortage that many countries have been experiencing in the last few years would pale in comparison to the losses that would be generated by a disruption in TSMC's supply chain, estimated by some experts to a loss of roughly 1.6 trillion $ to the US alone (Walters, 2023). Knowing this, the US has been trying for years to 'erode' Taiwan's silicon shield by learning the manufacturing secrets, in order to minimise their losses in case of a disruption to TSMC's supply chain (Powers-Riggs, 2023). A major step for the US was announced in 2022 by the Biden administration with the 'Chip and Science Act' that involves $52 billion pumped into the US research and business communities (Probasco, 2023). TSMC has also invested around $40 billion of their own money into new foundries in the US (Jie & Thomas, 2022), which has since been criticised by the now 90-year-old TSMC founder, Morris Chang, who accused TSMC and the US of piercing Taiwan's shield. A statement that was later addressed by TSMC itself, reassuring the Taiwanese, that they were only constructing fabs outside of Taiwan capable of developing the older 10-nanometre chips, keeping the production of the 5 nm chips in Taiwan, where research and development have already started into 3 and 2 nm chips (Clover, 2024). The silicon shield represents both a defence mechanism and an economic leverage point as Taiwan's control over advanced chip manufacturing gives it significant bargaining power in

international relations. This erosion of Taiwan's silicon shield due to US policies highlights the complexities of balancing economic interests and security concerns. While the US aims to bolster its domestic chip manufacturing capabilities, it inadvertently weakens Taiwan's economic leverage and undermines its security. This tension between economic interdependence and military deterrence underscores the intricate relationship between realism and liberalism in shaping Taiwan's security landscape.
This dynamic is not without challenges as Taiwan faces the constant threat of military aggression from China, driven by its desire for regional dominance and demographic concerns. China's aggressive military buildup, as highlighted by Admiral John Okalino, underscores the realist perspective of power struggles in the region and Taiwan's security strategy must navigate this precarious balance between economic leverage and military deterrence.

6.2. Unofficial Deterrence Strategies

Two more military strategies have been talked about for Taiwan, deterring China from initiating a conflict. One of these strategies suggests the targeting of the Three Gorges Dam in the heart of China's mainland with long-range ballistic missiles. It is a dam built on the Yangtze River which is the third biggest river in the world and the dam holds around $40km^3$ of water, to put this into perspective $40km^3$ of water equals 40.000.000.000.000 Litres, an amount if unleashed that would cause the worst flood ever seen in human history (Chan, 2022). Within 24-36 hours, major cities such as Wuhan, Nanjing and Shanghai would be fully submerged underwater resulting in tens of millions of civilian deaths. By leveraging long-range ballistic missiles, Taiwan could potentially inflict catastrophic damage on China's infrastructure, serving as a deterrent against aggression. However, this strategy also underscores the risks of escalation and retaliation inherent in realist power dynamics. It is important to mention that there are significant flaws in this plan, one of them being an almost immediate retaliatory attack from China resulting in the complete destruction of the ROC. There have also been doubts expressed about these missiles being able to reach the dam and whether or not they would even get past Chinese anti-missile defences, with many experts even saying that were all Chinese defences to fail, the dam itself could probably withstand hundreds of ballistic missiles while still maintaining structural integrity. What remains crucial for Taiwan and detrimental for Beijing, however, is the fact that, no matter how unlikely the

success of the ‘Three Gorges Dam’ strategy is, Beijing cannot afford to ignore the looming catastrophic consequences of such a scenario.
There is one more strategy that has not even officially been talked about among Taiwan’s military strategists but must all the same remain in China’s calculations and that is the potential to develop their own nuclear weapon. There is a very high chance that Taiwan has the knowledge and definitely has the capabilities of creating their own nuclear weapon but this would almost certainly trigger an immediate full-scale invasion of the Island by the PRC (Lo, 2022). The threat of nuclear retaliation serves as a means to dissuade potential aggressors, aligning with realist notions of power projection and deterrence through strength. Taiwan's security strategy is shaped by the interplay between realism and liberalism. While economic interdependence fosters cooperation and deterrence, traditional military capabilities and power dynamics drive concerns of aggression and conflict. Navigating these dynamics requires a nuanced approach that balances economic interests with strategic security imperatives, as Taiwan seeks to safeguard its sovereignty in an increasingly volatile geopolitical environment.

Having analysed and examined all the implications of deterrence and aggression, through the MVT and the two by two games, let us look at one final model that takes into consideration expected utility of each actor and thereby tries to find a solution to a multilayered game.

7. Extensive Form Game

7.1. Introduction to Extensive Form Games

The following chapter is very closely based on Bueno de Mesquita’s models used for the Iranian-US nuclear weapon conflict (Mesquita, 2010). Extensive-form games are very useful and insightful because they offer a comprehensive framework for analysing interactions between multiple players over a sequence of decision points, incorporating uncertainty and strategic foresight. In examining the tensions between China and the United States over Taiwan, extensive form games are particularly pertinent as they allow for a more nuanced exploration of strategic options and their consequences. Unlike the simplified scenarios of the Prisoner's Dilemma or the Game of Chicken, extensive-form games capture the dynamic nature of real-world conflicts, where decisions are made sequentially, responses

are contingent on previous actions, and players must anticipate each other's moves. This provides a more realistic representation of the strategic complexities inherent in geopolitical situations, enabling a deeper understanding of the incentives, risks, and potential outcomes. An extensive form game follows the structure of a tree-like model, meaning that at position one or the starting node we have one player making a choice, branching the model to two or more nodes and so on until we reach the so-called terminal nodes, which end the game by providing the players with their respective payoffs or expected utilities of following that path. I shall construct this model with China representing Player 1 and the United States representing Player 2. I've designated China as player 1 since their initial decision to engage or abstain sets the stage for subsequent gameplay.

7.2. Setting up an Extensive Form Game

The model comprises five terminal nodes, each representing a distinct path with associated payoffs for the player's decision.
The five possible outcomes in this game (in no particular order):

1. The United States and China find a diplomatic solution, in other words, a compromise, possibly avoiding conflict.
2. If China attacks Taiwan, the US chooses not to intervene militarily, in other words, backing down.
3. The US deploys its own military to defend Taiwan after China's attack, in other words, the US retaliates.
4. China maintains its stance of de-escalation after the US reinforces its military presence in the region.
5. China directly challenges the US due to perceived aggression.

For each of these five potential outcomes, we must allocate expected utilities or payoffs to aid in formulating the equation necessary for solving these games. In the Median Voter Theorem, I assigned the US a utility of 0.2 on the continuum, aligning with its interests in the island and the region as closely as possible. For simplicity, however, because I will only be analysing two players in this model, I will position them at each extreme of the continuum: the US's utility equals 1 at position 0 on the preference continuum, signifying an unchallenged

presence in Taiwan and a large influence over TSMC, and China's utility equals 1 on position 1, denoting control over Taiwan.

As an example, $China\ (0) = 0$, is read as follows: The position on the continuum at point (0), which is 'US holds major sway over Taiwan' has '0' utility for China meaning that it is the worst possible outcome for them.

$$China\ (0) = 0\ \&\ China\ (1) = 1$$
$$US\ (0) = 1\ \&\ US\ (1) = 0$$

Let's suppose China and the US negotiate and deescalate the situation, this would be considered as cooperation:
I will call cooperation or compromise, 'C', and 'U' denotes utility.
$U_{US}(C) = 1 - C$, given that the US derives 0 utility if C, the proposed compromise is at position 1 on our scale.

$$i.e.if\ C = 0.55$$
$$=> US\ (C) = 1 - C$$
$$=> US\ (0.55) = 1 - 0.55$$
$$=> US\ (0.55) = 0.45$$

7.3. Constructing relevant equations

Let's consider the scenario where China chooses to attack instead of cooperating. If the attack succeeds and Taiwan falls under Chinese control, the utility of this outcome for China, denoted as $U_{China}(1) = 1$ aligns with China's objectives. However, it's crucial to recognise that any attack, regardless of its outcome, incurs various costs such as economic, diplomatic, and human losses. Let's denote these costs as 'L' for the attacker/initiator and 'l' for the defender/retaliator. Moreover, an attack may not always be successful, leading to adverse consequences for China, including international condemnation and military setbacks. In such a case, the utility for China would be 0, accounting for the incurred costs. Therefore, China's success, is $1 - L$ if it attacks and $1 - l$ if it retaliates, whereas if it fails, it becomes $0 - l$ or $0 - L$. To go a little further, we can get more precise and assign different payoffs to the variable 'l' and 'L' for both countries, if the US proceeds in an aggressive manner after China

de-escalates, the domestic and international backlash would be intense making ‘L’ quite high and the same applies for China if they are the first to attack, the cost ‘L’ would very likely incur many problems for the country.
We cannot know for certain whether a Chinese offensive will be successful or not, numerous variables can influence the outcome, we can, however, assign probabilities to these outcomes in terms of unknown variables. Let’s say that the variable $'p'$ represents the probability of a successful Chinese attack, meaning that $1 - p$, is equal to a failed attack.
I would like to add one more important variable that can be rather important. The element of surprise is one of the most crucial determinants in warfare, the perfect example being Germany's swift invasion of France, which was shrouded in mystery along with its lightning speed. Although modern warfare eliminates a lot of this mystery of ‘when and where’ with advanced espionage and satellite technology, the strategic advantage of withholding obvious tactics persists in delivering the decisive initial strike. Arguably neither country possesses a significant element of surprise, China has been threatening Taiwan one way or another for the past few decades and the US has openly stated to come to Taiwan’s defence, were it ever in imminent danger. Even though the element of surprise would probably not be the decisive factor, it is still an important criterion to assess.

“*The desire of the attacking power is to strike a blow so powerful and so damaging that the enemy will either capitulate or negotiate a satisfactory settlement. The first strike is critical. Central to striking a successful first blow is the element of surprise. If one side is aware of the intent and the plan of its enemy, a peer power will alert its forces and concentrate them to defeat or deflect the blow.”(George Friedman, 2021).*

7.4. Calculating Expected Utility

Now that I have laid the foundations for the expected utility, costs and benefits and the probabilities of a successful attack, let us look at a way of combining these into an insightful equation that can help us determine the payoffs for each player at the end of the game.

$$EU\ (China|Attack) = p(U_{China}(1) - L) + (1 - p)(U_{China}(0) - L) + s$$

(EU: Expected Utility) *(Adapted from Mesquita's equation, 2010)*

This means that the expected utility for China in attacking is defined by the probability of a successful attack multiplied by the benefit of the successful attack minus the costs, plus the probability of a failed attack multiplied by the benefit of a Chinese failed attack minus the costs of that attack, plus the element of surprise.

I then extend and simplify the equation:

$$EU\ (China|Attack) = p(1 - L) + (1 - p)(0 - L) + s$$

$$EU\ (China|Attack) = p - pL - L + pL + s$$

$$EU\ (China|Attack) = p - L + s$$

In these simple terms, $p - L + s$ denotes the expected utility of a Chinese attack.

I can now use this to compare it to the aforementioned cooperation situation in which the compromise equals $China\ (C) = C$ and $US\ (C) = 1 - C$.
This means for China that if the expected utility of an attack is higher than the utility of a compromise they are better off attacking Taiwan.

$$p - L + s > C$$

If, however, the compromise turns out to be greater than the expected utility for an attack, the rational choice is to cooperate and take the compromise.

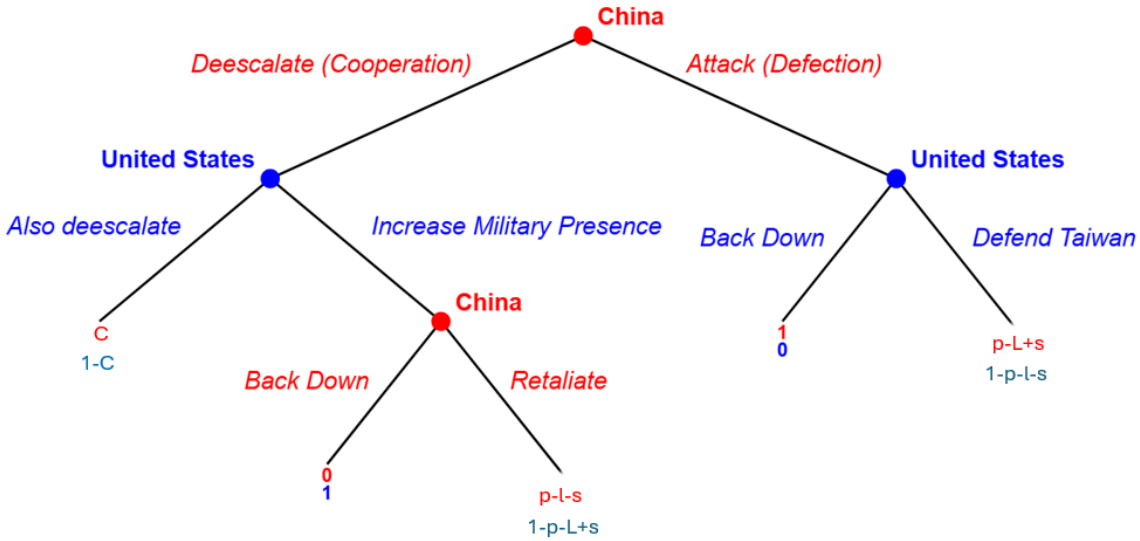
$$p - L + s < C$$

This simple equation, although not perfect, already brings us closer to being able to better understand the outcome of a potential US-China conflict in the Indo-Pacific. With the correct values substituted for the variables, both countries can use relevant data and information to try and assess their chances of success and at what cost. This shows that by using the model, the two sides see what their best choice of action is, based on the other players' assumption of following the same strategy.

Although the element of surprise 's' incentivises to attack first by gaining the advantage of making the first move, we can see that it is almost inversely proportional with the cost, variable 'L', where if one side attacks first they gain the advantage 's' but lose from variable 'L' which introduces the international backlash. If one side loses the element of surprise, therefore making the second move following the other side's aggression, they count with a loss of 's' but not a higher 'l' that the first side must incur.

With the important variables defined, both countries have the ability, through calculations, estimates and careful surveillance, to estimate each other's expected utilities for different outcomes. This allows them to determine various payoffs associated with choosing different paths. In an extensive form game, the model is represented as a tree, with choice nodes where players must decide between different paths and terminal nodes that show the payoffs for each player. Unlike simple non-sequential games where only Nash Equilibria can be found, extensive form games offer the advantage of Subgame Perfect Nash Equilibria (further denoted as, SPNE). These equilibria determine the best possible choice for a player at every point (subgame) of the model, enabling players to make decisions based on past experiences and future payoffs, knowing that their opponent can do the same.

Figure 4: Extensive Form Game with incomplete information, China - United States



Adapted from Bueno de Mesquita, 2010

In Figure 4, we have a tree-form game in which there are two players, player 1, denoted as China and Player 2 denoted as the United States. Contrary to my previously analysed games, this a sequential game, meaning that apart from the very first move, a player decides on his best path or strategy based on the other player's previous move, unlike the prisoner's dilemma, for example, where both players make their moves simultaneously thus not incorporating their opponent's decision in their immediate strategy. I have chosen China as player 1, because this whole situation develops according to China's initial move, to cooperate or to defect. If China chooses to cooperate, the US is left with two choices, to also cooperate by de-escalation or to increase their military presence in the Indo-Pacific. If the US chooses to also cooperate, we are left at a terminal node denoting payoffs for both players, for China, we have the above-defined 'C', the expected utility of a compromise and we have the inverse result for the US $1 - C$, meaning that if $C = 1$ for example, the expected utility of a compromise for the US equals 0 and equals 1 for China. If the US chooses the latter option however, there is one move left for China to make, in response to the US's increasing military presence, they can either back down leading to a payoff of 0 for China and 1 for the US or they can choose to retaliate and deploy their own military, in this case, we must implement the payoffs accordingly. For China, the payoff would equal their probability of success 'p',

minus the entire cost of the attack ‘l’, minus the element of surprise that the US gains for initiating aggression first, giving us, $p - l - s$. The payoff for the US is as follows, 1 minus the probability of a Chinese success $'p'$ minus ‘L’ which is the cost of a US-led aggression (different to ‘l’) plus the element of surprise $'s'$ giving us, $1 - p - L + s$.
If however, China initially chooses to defect, meaning that they attack Taiwan, the United States has two choices as were presented to China before, to back down or to defend Taiwan in response to China’s aggression. If they back down, the payoff is simple and results in an expected utility of 1 for China and 0 for the US, if the US chooses to retaliate, however, and defend Taiwan, China will have the probability of success ‘p’ minus the cost of being the aggressor ‘L’ plus the element of surprise ‘s’, $p - L + s$, for the US the payoff would equal 1 minus the probability of Chinese success ‘p’, minus the cost of getting involved militarily ‘l’, minus the element of surprise ‘s’, $1 - p - l - s$.

7.5. Substituting Variables

The extensive form game gives us a very basic yet insightful tool to try and deduce the possible outcome at any given time of a conflict. As mentioned before, a country with enough gathered information and intel can generate a more or less accurate depiction of the outcomes. To prove this, I can generate my own values that are based on informed decisions and thorough reviews, that could substitute the variables in my tree-form game and show us the relevance of the model in real time. It is important, however, to mention that these values do not represent reality accurately, despite being based on informed decisions, they are still for illustrative purposes only. Let us substitute these variables with values and show that through backward induction, where one starts from the end of a game and works backward to determine optimal strategies, I can solve the game and find the most probable outcome based on Subgame perfection. Subgame perfection ensures that strategies are optimal not only at the beginning of the game but also at every possible point throughout, given rationality and complete information.

The probability of a successful Chinese attack is by many considered to be relatively low, most experts believe that this undertaking would be the biggest amphibious invasion in history and a task almost impossible when facing the strongest military in the world, ‘A Chinese invasion of Taiwan would probably fail if the United States helped defend the

island', (The Guardian, 2023). Although the probability of a Chinese success is relatively low, probably even lower than the value I shall assign to it in my model, China still is a global power with an extremely strong and not to be underestimated military, therefore a value of $p = 0.3$, seems relatively fair. As mentioned earlier, the element of surprise is important but it is not the determining factor, let us assign a value of $s = 0.1$.

The costs of escalation, for China, would involve direct human and economic expenditures, costs of garrisoning Taiwan, the PRC's post-war diplomatic and economic isolation, and incorporating 23 million people into the PRC. Another factor to consider is the potentially very destabilising process of counter-insurgency as proven by the US spell in Afghanistan or Iraq in the early 2000s, which showed very poor results. The invasion would without any doubt invite serious international scrutiny (Oriana, 2021).

An invasion of Taiwan would trigger terrible consequences, according to U.S. Secretary of State Antony Blinken (Reuters, 2021). For this reason, let us assign a fairly high cost of 0.7.

$$L_C \approx 0.7$$

For the US, the criteria to consider for costs are similar to that of a Chinese attack on Taiwan, in that the US has to consider, human and economic costs, a certain degree of economic and international backlash for getting involved militarily and dealing with losses of one of its most prominent trade partners.

A survey conducted by the Chicago Council in 2021 revealed that 52% of respondents supported using U.S. troops to defend Taiwan (Lami Kim, 2022). This shows that almost half of the population is against any kind of military intervention, potentially sparking a large backlash and undermining the US government.

President Joe Biden's recent commitment to Taiwan's defence has ignited debate. During his trip to Asia, he stated that the U.S. would consider military action to protect Taiwan, which is a departure from the previously maintained policy of "strategic ambiguity", (Kim et al., 2022).

In the event of conflict, global firms and investors would perceive high risks due to U.S. military intervention and escalation and this would almost certainly lead to big economic losses not only for the US but worldwide stock prices would plummet. Let us assign a cost of 0.5 for the US if China escalates first.

$$l_{US} \approx 0.5$$

If the US escalates tensions first, the values are slightly less founded on research and are more based on logical and rational consequences that could follow from such an act. If the US were to continue escalating tensions and deploying more troops in and around the island, the backlash could be even more severe than if they were the ones to retaliate. As I have mentioned before, the whole Afghanistan chapter is something the US would rather forget about, meaning they could expect to receive similar accusations and criticisms if they initiated aggression in the Indo-Pacific. This could also be perceived by many as an unnecessary provocation towards China and even Taiwan would view this as detrimental to its security, “A considerable portion of Taiwanese voters worry about entrapment by the United States" (Alastair, et al., April 5, 2023).

Conversations would start centring around deterrence and provocation as China would perceive the US troop deployment as a direct challenge to its core interests. Beijing might view it as a violation of the “One China” policy and an infringement on its sovereignty, retaliatory measures would then become highly probable. For this reason, let us assign a value of 0.6 for the US escalating tensions after a cooperating move from China.

$$L_{US} \approx 0.6$$

If the US was the one to escalate tensions despite Chinese cooperation, we could expect the narrative to shift from China being the aggressor to the US provoking a response. International actors would consider the context and sequence of events with countries recalibrating their stances. Some might criticise the US for escalating tensions, while others would emphasise the importance of maintaining regional stability.

Within China, the government would frame its actions as a necessary response to US aggression. Nationalistic sentiments would surge, emphasising sovereignty and self-defence. The Chinese economy, global trade, and social stability would be at stake. Leaders would weigh the costs of retaliation against the risks of further escalation. Let us give a cost for China of 0.4.

$$l_C \approx 0.4$$

7.6. New Equations

For my own example, we have the following values:

Probability of Chinese success: $p = 0.3$

Element of surprise: $s = 0.1$

Cost for China as the aggressor: $L_C = 0.7$
Cost for China as the retaliator: $l_C = 0.4$

Cost for the US as the aggressor: $L_{US} = 0.6$
Cost for the US as the retaliator: $l_{US} = 0.5$

We can now return to the equations and plug these values, determining the payoff for each actor.
If China cooperates and the US increases their aggression, then:

For China: $p - l - s$

$$0.3 - 0.4 - 0.1 = -0.2$$

For the US: $1 - p - L + s$

$$1 - 0.3 - 0.6 + 0.1 = 0.2$$

If China defects and the US retaliates:

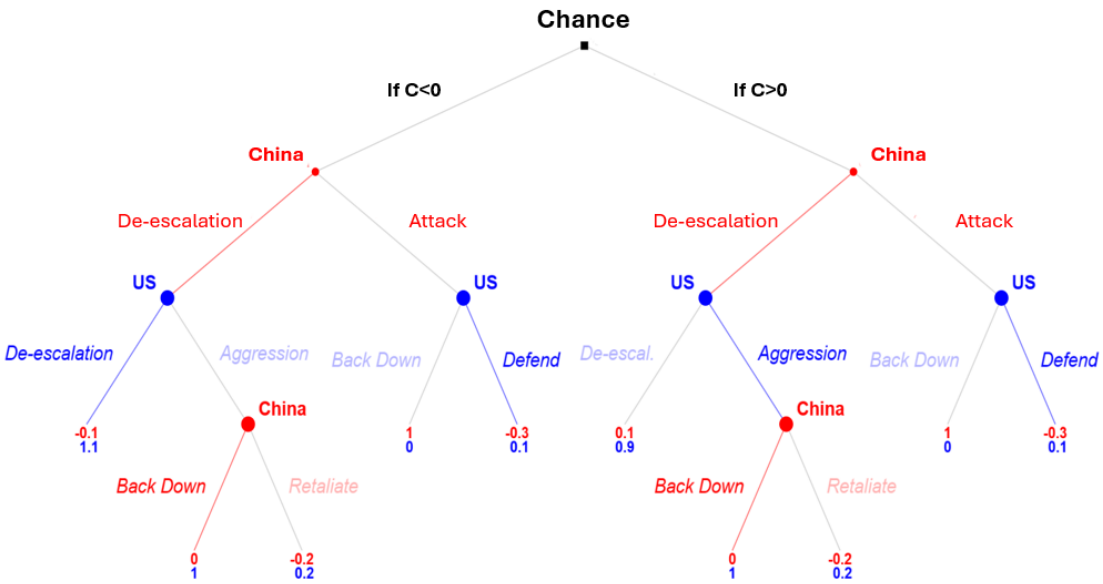
For China: $p - L + s$

$$0.3 - 0.7 + 0.1 = -0.3$$

For the US: $1 - p - l - s$

$$1 - 0.3 - 0.5 - 0.1 = 0.1$$

Figure 5: Extensive Form Game with Uncertainty, China - United States



Adapted from Bueno de Mesquita, 2010

7.7. Interpreting the results

In figure 5, we see a more complete representation of the possible outcomes of an extensive form game. The starting node is denoted as 'Chance', but it could also be denoted as 'Nature', this represents two different directions the model could develop in, depending on external events. If the compromise 'C' is smaller than 0, we will move to the left-hand side of the tree and if the compromise 'C' is larger than 0, we shall move to the right-hand side of the tree. We can also see the different payoffs and outcomes for each direction that can be taken,

meaning that the game can be solved through backwards induction, finding the Subgame Perfect Nash Equilibrium. If the compromise 'C' is smaller than 0, it means it is negative, which would bring the US a payoff higher than 1 and China a payoff lower than 0. This is possible if the compromise worsens China's position in the status quo and China would be incentivised to take the compromise as the alternative could be even worse, depending on the size of 'C'. Let us assume that if $C < 0$ then $C = -0.1$. To solve the game backwards, I look at the terminal nodes first, China has a choice of a payoff of 0 or -0.2, backing down is, therefore, a SPNE, highlighted in red, $0 > (-0.2)$. The US is now considering 1 against $1 - C$ and seeing as $C = (-0.1)$ the US will choose to compromise, $1.1 > 1$. Knowing that the US will compromise, China must now weigh, -0.1 against -0.3, on the other side of the left-hand tree, and as $(-0.1) > (-0.3)$ China also chooses to cooperate. This solves the game through backward induction and tells us that if China were to make a move it would be to cooperate knowing that the US would also cooperate.

When $C > 0$ then $C = 0.1$ and we move to the right-hand side of the tree. If we work through backwards induction again, we have the same first choice as we did before. Would China prefer a payoff of 0 in backing down or -0.2 if they retaliate following a US-led aggression? As $0 > (-0.2)$ we have the same outcome: China would be better off backing down and the US now must evaluate whether they prefer 0.9 in cooperating or 1 in being aggressive and having China back down, the US will therefore choose to initiate aggression as $0.9 < 1$. Now on the far right-hand side, on the off-equilibrium path, the US chooses 0.1 over 0, so for my last consideration, China compares 0 to -0.3, meaning that if $C > 0$, China will cooperate and it will then back down after the US intensifies their aggression.

After solving the game I have a few important conclusions to draw from it.

Were these values to be representative of reality, we would have confirmation that the status quo between the US, Taiwan, and China, as of the year 2024, presents very little incentive for China to start a military conflict over the island. This was further showcased after 14 scholars published the major conclusion of a recent 430-page RAND report, "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017." In this report, the scholars talk of 10 major criteria that China would have to dominate in order to be successful in an invasion. In their study, a hypothetical invasion of Taiwan would only score superiority in 2 out of the ten criteria for China and would have parity on 4 more, meaning the US would have superiority in the 3 remaining criteria. The solution to this game provides solid evidence that China is not, as of yet, prepared to compare itself to the US if it hopes to

be successful. If China stays put and ‘enjoys’ the SQ, they will be far better off than any other possible outcome. If they de-escalate, the US will propose a compromise that China will have to accept, leaving them worse off, knowing that if they defect and the US retaliates the outcome could potentially be even worse, which then depends on how low the variable ‘C’ actually is. The colossal costs of an attack for China, and US superiority or parity in most military criteria, show China why any move, be it escalation or de-escalation, would be harmful to them. What is important to note, however, is that the costs of a US success would also be astronomical, so in reality, the US would want to avoid a full-blown military conflict with China and wouldn't therefore propose a compromise that would jeopardise an escalation.

8. Conclusion

8.1. Summary

In this thesis, I delved into the historical complexities of the relationship between China and Taiwan, tracing back to the aftermath of World War II and the Chinese Civil War, resulting in Taiwan's status being fiercely contested by the Chinese mainland. Despite Taiwan's sovereignty, China has consistently laid claim to the island, viewing it as an integral part of its territory, a claim that has been further exacerbated by Taiwan's strategic location within the Indo-Pacific, forming a crucial link in the First Island Chain.

I set out to understand how Taiwan's geopolitical significance is defined, among others, by TSMC, widely regarded as one of the most influential corporations in the world. TSMC's prominence has heightened China's assertiveness in claiming Taiwan, recognising the island's strategic value in the semiconductor industry, transitioning my analysis to a game-theoretic perspective to better understand the dynamics at play.

I began by applying the median voter theorem to introduce the various stakeholders and their respective preferences regarding Taiwan's sovereignty. While providing a simplified overview, this model primarily served as a way to familiarise oneself with the key actors involved. Subsequently, I delved into two-by-two games such as the prisoner's dilemma and the game of chicken to explore the rational decision-making of actors in conflict scenarios. These games highlighted the inherent tensions in international relations, where self-interest often prevails despite suboptimal outcomes.

Transitioning to a discussion of deterrence strategies, both official and unofficial, adopted by Taiwan against potential Chinese aggression, I examined economic and political tactics centred around TSMC's pivotal role. Additionally, I explored more unconventional strategies, including targeting the Three Gorges Dam and the prospect of nuclear deterrence.
Finally, I constructed an extensive form game synthesising the previous models, allowing for a sequential analysis of decision-making. By substituting variables for values, I concluded that China's prospects for successfully invading Taiwan remain slim, given the substantial risks and costs involved. This underscores the intricate interplay between geopolitics, economics, and military strategy in shaping Taiwan's bargaining power vis-à-vis China and the broader international community.

8.2. Answering the research question and addressing the hypotheses

"To what extent does TSMC's dominance in the semiconductor industry shape the bargaining power of Taiwan in its geopolitical position to China and the rest of the world, and how is this reflected in game theoretic models?". The presence of TSMC serves as a powerful deterrent against potential aggression towards Taiwan, as external actors, particularly the United States, have a vested interest in safeguarding the stability of the semiconductor supply chain. This dynamic demonstrates that credible commitments from external actors to defend Taiwan influence the strategic calculus of China, leading to outcomes characterised by a balance of power and deterrence.
As a critical node in the global supply chain, Taiwan holds considerable leverage in negotiations and diplomatic engagements, thereby enhancing its geopolitical position and reinforcing its deterrence capabilities. It goes without saying that TSMC's dominance in the semiconductor industry not only shapes Taiwan's bargaining power but also serves as a key determinant of its geopolitical standing. Through game-theoretic models, the thesis demonstrated the intricate interplay between strategic calculations and external commitments, highlighting the multifaceted nature of Taiwan's position in the global arena. As long as TSMC's dominance remains unchallenged, Taiwan is poised to wield significant influence and deter potential threats to its sovereignty and security.
"In game-theoretic models of the China-Taiwan dynamics, the presence of credible commitments from external actors, such as the United States, to defend Taiwan will influence the strategic calculus of China, potentially leading to outcomes characterised by a balance of

power and deterrence". Rooted in realism, the first hypothesis posits that states act in their own self-interest and seek to maximise their security and power in the international system. Through the extensive form game, it becomes evident that the costs associated with mounting an attack on Taiwan, both financial and logistical, are prohibitively high for China, aligning with realist principles of cost-benefit analysis and rational decision-making by states. The sheer scale of military operations required, coupled with the need for extensive logistical support and the potential for prolonged conflict, presents a formidable barrier to any aggressive action. Moreover, realism emphasises the importance of power projection and the distribution of capabilities in shaping state behaviour. The credible defence guarantees provided by the United States to Taiwan significantly alter the balance of power in the region, raising the costs and risks associated with any attempt by China to forcibly annex Taiwan. This asymmetric power dynamic creates a deterrent effect, dissuading China from pursuing aggressive actions that could result in a direct confrontation with a strong adversary backed by powerful allies. The prospect of facing widespread international condemnation, diplomatic isolation, and economic sanctions in the event of military aggression against Taiwan serves as a significant constraint on China's strategic options. The United States, as a key ally of Taiwan and a leading global power, wields considerable influence in shaping the international response to any potential conflict in the Taiwan Strait, as the MVT and the extensive form game suggested.

In essence, the interplay of power dynamics, strategic calculations, and the distribution of capabilities in the region underscores the critical role of deterrence mechanisms in maintaining stability and security.

"Game-theoretic analysis of cooperative strategies will demonstrate the potential for economic interdependence to act as a stabilising factor in China-Taiwan relations, contributing to outcomes characterised by cooperation and mutual gains." The second hypothesis is grounded in liberal theory, which emphasises the importance of economic interdependence and cooperation in international relations.

Liberalism contends that economic ties and mutual interests can foster cooperation between states, leading to outcomes characterised by stability and mutual gains. Accordingly, the hypothesis suggests that the presence of economic interdependence between China and Taiwan would incentivise both parties to pursue cooperative strategies, thereby reducing the likelihood of conflict and promoting peaceful relations.

However, the analysis conducted in this thesis reveals a stark divergence from the hypothesised outcomes. Despite the potential for mutual gains through cooperation, the

models employed, such as the prisoner's dilemma, demonstrate the prevalence of defection as the dominant strategy for both China and Taiwan. This outcome highlights the tragic nature of rational decision-making, where states prioritise short-term self-interest over long-term collective benefits, even when cooperation would yield optimal outcomes for all parties involved.

The failure of economic interdependence to serve as a stabilising factor in China-Taiwan relations challenges the core assumptions of liberalism regarding the efficacy of cooperation in mitigating conflict. Despite the clear potential for mutual gains, the allure of opportunistic behaviour and the fear of exploitation by the other party incentivise states to defect rather than cooperate, perpetuating a cycle of distrust and hostility.

Moreover, the analysis underscores the limitations of liberal theory in explaining state behaviour in contexts characterised by geopolitical rivalries and security dilemmas. While liberalism emphasises the role of economic interdependence in fostering cooperation, it fails to fully account for the complex dynamics of power politics and strategic calculations that often drive state behaviour in international relations.

While economic interdependence holds the potential for mutual gains and cooperation in theory, the empirical findings of this thesis suggest that it does not necessarily translate into stabilising effects in China-Taiwan relations. The prevalence of defection as the dominant strategy highlights the enduring influence of realist principles and the challenges inherent in promoting cooperation in the face of strategic uncertainties and security concerns.

Based on the findings and analyses conducted in the thesis, TSMC's status as a critical player in the global semiconductor supply chain bestows upon Taiwan a strategic advantage, as any disruption to its operations would have far-reaching consequences for global electronics manufacturing.

8.3. Discussion and Outlook

Moving forward, several key points merit further discussion and consideration.

Firstly, the evolving nature of global technological competition underscores the continued relevance of semiconductor manufacturing as a strategic asset. As emerging technologies such as artificial intelligence, quantum computing, and 5G networks gain prominence, the demand for advanced semiconductor chips will likely intensify. TSMC's role in driving innovation and maintaining technological leadership will thus remain pivotal for Taiwan's political standing.

Secondly, the interplay between economic interdependence and national security poses complex challenges and opportunities for Taiwan. While TSMC's global integration enhances its economic resilience and bargaining power, it also exposes the island nation to geopolitical risks, particularly amid escalating tensions between major powers. Balancing economic openness with strategic autonomy will be crucial for Taiwan's long-term security and stability.

Looking ahead, navigating the complex geopolitical landscape will require a comprehensive approach that leverages Taiwan's strengths in innovation, technology, and strategic foresight. Strengthening partnerships with like-minded countries, enhancing cybersecurity capabilities, and diversifying supply chains will be essential strategies for safeguarding Taiwan's national interests and preserving regional stability.

In conclusion, while TSMC's dominance in the semiconductor industry confers significant advantages to Taiwan in its geopolitical positioning, it also presents challenges and uncertainties. By understanding and addressing these dynamics, Taiwan can effectively navigate the evolving geopolitical landscape and secure its role as a key player in the global technological ecosystem.

9. References

Anselmo, J. (2024, January 19). *TSMC delays second Arizona chip plant to 2027 or 2028*. Manufacturing Dive.

Any move by China to invade Taiwan would have 'terrible consequences,' Blinken says. (2021, December 4). NBC News. https://www.nbcnews.com/news/world/move-china-invade-taiwan-terrible-consequences-antony-blinken-says-rcna7625

Brunnstrom, David, and Trevor Hunnicutt. "Biden says U.S. forces would defend Taiwan in the event of a Chinese invasion." Reuters, 19 Sep. 2022

Brunnstrom, David, and Trevor Hunnicutt. "Biden says U.S. forces would defend Taiwan in the event of a Chinese invasion." Reuters. September 19, 2022.

Buchholz, K. (2023, May 22). *Advanced Microchip Production Relies On Taiwan [Infographic]*. Forbes. https://www.forbes.com/sites/katharinabuchholz/2023/01/13/advanced-microchip-production-relies-on-taiwan/?sh=156e2747371d

Buchholz, K. (2023, May 22). *Advanced Microchip Production Relies on Taiwan*. Statista Daily Data. https://www.statista.com/chart/30041/global-semiconductor-wafer-fabrication-capacity-by-type-and-location/

Bueno de Mesquita, B. (2013). Tools for Analyzing International Affairs. In Principles of International Politics (4th ed., pp. 47-80).

Bueno de Mesquita, Bruce. "An Introduction to Game Theory." Principles of International Politics, 4th ed., CQ Press, 2010, pp. 51-64

Chiang, S. (2024, January 12). *Taiwan's strength in semiconductors could be its "Achilles heel," economist says*. CNBC. https://www.cnbc.com/2024/01/12/taiwans-strength-in-semiconductors-could-be-its-achilles-heel-economist-says.html

China vs. Taiwan - Peace Research Center Prague - Charles University Center of Excellence. (n.d.). Peace Research Center Prague - Charles University Center of Excellence. https://www.prcprague.cz/fcdataset/china-taiwan

Clover, J. (2024, January 24). *Apple to Get TSMC's First 2-Nanometer Chips*. MacRumors. https://www.macrumors.com/2024/01/24/apple-tsmc-first-2nm-chips/#:~:text=TSMC%20is%20expected%20to%20begin,for%20a%20family%20of%20chips.

Coldiron, K. (2022, December 16). *The World's Most Important Product and the Only Two Companies That Can Make It*. Forbes. https://www.forbes.com/sites/kevincoldiron/2022/12/15/the-worlds-most-important-product-and-the-only-two-companies-that-can-make-it/

Culver, John. “Analysis on the Potential Chinese Invasion of Taiwan.” Carnegie Endowment for International Peace, October 3, 2022.

Deterrence by Uncertainty: A New Defense Posture for Taiwan. (2022, November 1). Global Taiwan Institute. https://globaltaiwan.org/2022/01/deterrence-by-uncertainty-a-new-defense-posture-for-taiwan/

Ex-U.S. Indo-Pacific commander sticks to 2027 window on Taiwan attack. (2023, January 23). Kyodo News+. https://english.kyodonews.net/news/2023/01/018a26a02962-ex-us-indo-pacific-commander-sticks-to-2027-window-on-taiwan-attack.html

Gady Franz-Stefan: “The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017.” RAND Corporation, 430 pages. Accessed April 22, 2024.

Goldberg, Jonathan. “Samsung’s Foundry Business Is in Trouble, and That Could Have Major Consequences.” TechSpot, 6 Apr.2023

Haenle, Paul, and Nathaniel Sher. “How Pelosi’s Taiwan Visit Has Set a New Status Quo for U.S-China Tensions.” Carnegie Endowment for International Peace, August 17, 2022.https://www.carnegieendowment.org/2022/08/17/how-pelosi-s-taiwan-visit-has-set-new-status-quo-for-u-s-china-tensions-pub-87633

Heginbotham, E., et al. (2015, September 14). *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*. RAND. http://www.rand.org/pubs/research_reports/RR392.html

Heydarian, Richard Javad. “US, China in a daring game of chicken over Taiwan.” Asia Times. August 17, 2022.

Hsieh, J. F., & Lin, Y. T. (2023, January 1). *Taiwan Amid the US–China Rivalry: From the Perspective of a Two-Level Game*. Springer eBooks. https://doi.org/10.1007/978-3-031-33776-5_6

Jazeera, A. (2024, April 10). *China’s Xi says outside interference can’t stop reunion with Taiwan*. Al Jazeera. https://www.aljazeera.com/news/2024/4/10/chinas-xi-says-outside-interference-cant-stop-reunion-with-taiwan

Johnston, Alastair Iain, Tsai Chia-hung, and George Yin. “When Might US Political Support Be Unwelcome in Taiwan?” Taiwan-U.S. Quarterly Analysis, updated April 6, 2023.

Kharpal, A. (2022, February 15). *Global semiconductor sales top half a trillion dollars for first time as chip production gets boost*. CNBC. https://www.cnbc.com/2022/02/15/global-chip-sales-in-2021-top-half-a-trillion-dollars-for-first-time.html

Kim, L. (2022, June 3). *Should the United States Defend or Ditch Taiwan?* The National Interest. https://nationalinterest.org/feature/should-united-states-defend-or-ditch-taiwan-202772

Kim, S. M., Lee, M. Y. H., & Wootson, C. R. (2022, May 24). *Biden takes aggressive posture toward China on Asia trip*. Washington Post. https://www.washingtonpost.com/politics/2022/05/23/biden-japan-taiwan-china/

LaGrone, S. (2021, June 23). *Milley: China Wants Capability to Take Taiwan by 2027, Sees No Near-term Intent to Invade - USNI News*. USNI News. https://news.usni.org/2021/06/23/milley-china-wants-capability-to-take-taiwan-by-2027-sees-no-near-term-intent-to-invade

LaGrone, Sam. "Milley: China Wants Ability to Invade Taiwan by 2027, But Not Likely to Do So in Near Term." USNI News, 17 June 2021.

Lee, Chung-Shing, Kuei-Hsien Niu, and Jonathan C. Ho. "Analysis of Competitive and Cooperative Technology Strategies of Electronics Firms in the Greater China Region." Journal of International Technology and Information Management, vol. 16, no. 1, 2007, pp. 43-64

Lee, M. (2023, August 24). *US approves new $500M arms sale to Taiwan as tension from China intensifies | AP News*. AP News. https://apnews.com/article/us-taiwan-china-invasion-threat-weapons-sales-military-fb9959dff57d5ac8fd2f8400316185b5

Lee, Seungjoo. "U.S.-China Technology Competition and the Emergence of Techno-Economic Statecraft in East Asia: High Technology and Economic-Security Nexus." Journal of Chinese Political Science, vol. 29, no. 1, 2024, pp. 1-26.

Li, Hailun. "Game Theory for Analysing China-Taiwan Relations." School of Politics and International Studies, University of Leeds, 2020, pp. 1-36.

Lo, A., & Lo, A. (2022, January 4). *A nuclear Taiwan is too terrifying to contemplate*. South China Morning Post. https://www.scmp.com/comment/opinion/article/3162086/nuclear-taiwan-too-terrifying-contemplate

Losing Taiwan's Semiconductors Would Devastate the US Economy. (2024, April 7). Hudson. https://www.hudson.org/technology/losing-taiwan-semiconductor-would-devastate-us-economy-riley-walters

Maguire, D. (2022, August 11). *Why does China want Taiwan when it's already so big and rich? The answer is about more than land and money*. ABC News. https://www.abc.net.au/news/2022-08-12/why-does-china-want-taiwan-military-strategic-location/101321856

Mastro, O. S. (2023, October 2). *The Taiwan Temptation: Why Beijing Might Resort to Force*. Foreign Affairs. https://www.foreignaffairs.com/articles/china/2021-06-03/china-taiwan-war-temptation

McFarlane, G. (2023, January 27). *How Taiwan Semiconductor Manufacturing Company Makes Money*. Investopedia. https://www.investopedia.com/articles/markets/012716/how-taiwan-semiconductor-manufacturing-makes-money-tsm.asp#:~:text=Taiwan%20Semiconductor%20Manufacturing%20Company%20is,America%20is%20TSMC%27s%20largest%20market.

Momoko, Kawakami. "Taiwan's TSMC as a Focal Point of US-China High-Tech Conflict."1 Asia-Pacific Review 29, no. 1 (2022): 5-12. https://doi.org/10.1080/13439006.2022.20554072.

Mozur, Paul, John Liu, and Raymond Zhong. "'The Eye of the Storm': Taiwan Is Caught in a Great Game Over Microchips." The New York Times, 29 Sep.2021.

Owen, Malcolm. "TSMC to build four more $10B chip fabs in Taiwan for 3-nanometer production." AppleInsider, 14 Apr. 2023.

Patterson, A.(2023, June 1). A Vulnerable U.S. Electronics Supply Chain. EE Times.

Peters, Michael A. "Semiconductors, geopolitics and technological rivalry: The US CHIPS & Science Act, 2022." Educational Philosophy and Theory, vol. 55, no. 14, 2023, pp. 1642-1646

Powers-Riggs, A. (2023, February 17). *Why the United States and Taiwan Don't Agree on Semiconductor Policy, CHIPS Act*. Foreign Policy. https://foreignpolicy.com/2023/02/17/united-states-taiwan-china-semiconductors-silicon-shield-chips-act-biden/

Probasco, J. (2023, April 10). *What Is the CHIPS and Science Act of 2022?* Investopedia. https://www.investopedia.com/chips-and-science-act-6500333

Razdan, K., & Razdan, K. (2023, March 23). *War with China 'not inevitable', but helping Russia in Ukraine widens conflict: US General Mark Milley*. South China Morning Post. https://www.scmp.com/news/china/article/3214645/war-china-not-inevitable-helping-russia-ukraine-widens-conflict-top-us-general

Register, E. (2023, October 20). *Can China Leapfrog ASML in Its Quest for Semiconductor Self-Reliance?* The Diplomat. https://thediplomat.com/2023/10/can-china-leapfrog-asml-in-its-quest-for-semiconductor-self-reliance/#:~:text=While%20China%20set%20a%20target,billion%20worth%20of%20semiconductors%20annually.

Register, Eve. "ASML: Chipmaking's Biggest Monopoly." The Diplomat, 28 Oct. 2021.

Reporter, G. S. (2023, January 14). *Taiwan invasion by China would fail, but at huge US cost, analysts' war game finds*. The Guardian. https://www.theguardian.com/world/2023/jan/10/taiwan-invasion-by-china-would-fail-but-at-huge-us-cost-analysts-war-game-finds

Richard C. Bush, Untangling the Taiwan-China Paradox: Economics, Sovereignty, and Security. Washington, D.C.: Brookings Institution Press, 2024.

Shattuck, T. J. (2021, January 1). *Stuck in the Middle: Taiwan's Semiconductor Industry, the U.S.-China Tech Fight, and Cross-Strait Stability*. Orbis. https://doi.org/10.1016/j.orbis.2020.11.005

Shepardson, David. "US Finalizes Rules to Prevent China from Benefiting from $52 Billion in Chips Funding."1 Reuters. September 22, 2023. https://www.reuters.com/article/us-chips-funding-rules.

Shilov, A. (2021, April 2). *TSMC to Spend $100B on Fabs and R&D Over Next Three Years: 2nm, Arizona Fab & More*. AnandTech. https://www.anandtech.com/show/16593/tsmc-to-spend-100b-on-fabs-and-rd-over-three-years-2nm-arizona-fab-more

Shilov, A. (2023, September 3). *Intel To Spend $9.7 Billion On TSMC Outsourcing In 2025: Goldman Sachs*. Tom's Hardware. https://www.tomshardware.com/news/intel-to-spend-dollar97-billion-on-tsmc-outsourcing-in-2025-goldman-sachs

Shivakumar, S., Wessner, C., & Howell, T. (2024, February 21). *Balancing the Ledger: Export Controls on U.S. Chip Technology to China*. https://www.csis.org/analysis/balancing-ledger-export-controls-us-chip-technology-china#:~:text=These%20devices%20feature%20built%2Din,chips%20to%20China%20without%20licenses.

Smith, Zadie. Swing Time. Penguin Press, 2016

Snidal, D. (2004). Formal models of international politics. In D. F. Sprinz & Y. Wolinsky-Nahmias (Eds.), Models, Numbers, and Cases: Methods for Studying International Relations (pp. 227-260). University of Michigan Press.

Snidal, Duncan. "Relative Gains and the Pattern of International Cooperation." The American Political Science Review, vol. 85, no. 3, 1991, pp. 701-726. JSTOR.

Snyder, Glenn H. "Prisoner's Dilemma and Chicken Models in International Politics." International Studies Quarterly, vol. 15, no. 1, 1971, pp. 66-103. JSTOR.

Stone, Gelfer. "Analysis of Nash Equilibrium in the Chicken Game." Accessed April 22, 2024.

Taiwan | GDP | 2023 | 2024 | Economic Data | World Economics. (n.d.). World Economics. https://www.worldeconomics.com/Country-Size/Taiwan.aspx#:~:text=Taiwan%27s%20Gross%20Domestic%20Product%20(GDP)&text=The%20official%20estimate%20for%20Taiwan%27s,in%20puchasing%20power%20partity%20terms

Taiwan's exports to mainland China 2013-2023. (2024, March 1). Statista. https://www.statista.com/statistics/1116752/taiwan-goods-exports-to-mainland-china/

"The Largest Military Buildup Since WWII." (2023, August 21). Station HYPO. https://stationhypo.com/2023/08/21/the-largest-military-buildup-since-wwii/

Tkacik, J. (n.d.). *Taiwan's status remains "unsettled" | The Heritage Foundation*. The Heritage Foundation. https://www.heritage.org/defense/commentary/taiwans-status-remains-unsettled

Toshi Yoshihara, “China’s Vision of Its Seascape: The First Island Chain and Chinese Seapower,” Asian Politics & Policy (First published: 05 July 2012), https://doi.org/10.1111/j.1943-0787.2012.01349.x.

TSMC (TSM) - Market capitalization. (n.d.). https://companiesmarketcap.com/tsmc/marketcap/

Tung, A., & Wan, H. (2019, June 10). *INDUSTRIAL POLICY: CHINESE DEBATE TO TAIWANESE FOUNDRIES*. Singapore Economic Review/the Singapore Economic Review. https://doi.org/10.1142/s021759081950022x

Turin, D. R. (2010, June 1). *The Taiwan Strait: From Civil War to Status Quo*. Inquiries Journal. http://www.inquiriesjournal.com/articles/263/the-taiwan-strait-from-civil-war-to-status-quo

Volk, N. M. (2023, January 30). *Potential Energy Challenges from a China-Taiwan Conflict Scenario*. Center on Global Energy Policy at Columbia University SIPA | CGEP. https://www.energypolicy.columbia.edu/publications/potential-energy-challenges-from-a-china-taiwan-conflict-scenario/

Wang Mouzhou. “Consequences of a Chinese Invasion of Taiwan.” Accessed April 22, 2024.

Yang, Jie, and Ken Thomas. “TSMC Raises Arizona Chip Investment to $40 Billion as Biden Visits.” The Wall Street Journal, December 6, 2022.

10. Appendices

Appendix no. 1: Outcome preferences for selected stakeholders (graph)

Appendix no. 2: Sino-American Standoff based on the Prisoner's Dilemma model (table)

Appendix no. 3: Demonstration of Sino-American Brinkmanship based on the Game of Chicken (table)

Appendix no. 4: Extensive Form Game with incomplete information, China - United States, (adapted from Bueno de Mesquita, 2010). (graph)

Appendix no. 5: Figure 5: Extensive Form Game with Uncertainty, China - United States, adapted from (Bueno de Mesquita, 2010)