An Analysis of Nuclear Acquisition Theory Hedging Strategies

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1. Introduction

The advent of nuclear weapons radically changed how nations would approach threats to their national security, with the nuclear weapons and their promise of mutually assured destruction acting as an unpalatable deterrent to any power considering military action against a nation possessing them. The security this deterrent effect provided was the envy of many powers, particularly those facing security threats or 'duress' from rivals or neighbours; doubly more so if their rival was already armed with nuclear weapons. But the path to acquiring a nuclear weapon is both a long and complex process, with most nuclear programs spanning decades from outset until completion or 'acquisition' of a nuclear weapon. Numerous important choices must be made along this path, with all these decisions being fueled by cohesive strategies based on realist thought and the security needs of the actors involved.

The majority of the literature that exists on the strategies nations use to strengthen their nuclear capabilities has two main consistencies. The first apparent commonality is that research tends to conceptualize the trajectory of nuclear acquisition as a linear process of increasing capabilities, as opposed to a complex and evolving process with many potential outcomes. The second commonality in existing literature is the central tendency to focus on specific milestones of achievement, which results in overlooking the broader strategic progression of a nuclear pursuer Additionally, research that exists in the domain of strategic reasoning behind nuclear pursuits lacked comprehensive frameworks that provided rationales for their steps. Vipin Narang, an MIT based scholar has recently developed a theory (2017), Nuclear Acquisition Theory (NAT), to classify forty-seven strategies employed by twenty nine nations that have attempted acquiring or producing nuclear weapons, using four broad categories of strategies (with three subtypes of the hedging strategy also being observed) to categorize and explain the choices these nations have employed on their path of nuclear proliferation; employing an explanatory framework for motivations behind these choices. NAT seeks to correctly explain "the vast majority—more than

85 percent—of the empirical strategies, and for the correct hypothesized reasons."[1]. Narang's research on the technical process of a nuclear pursuer building a weapon, focused on specific steps in a non-linear process; outlining that nations could shift or adopt different strategies based on evolving security needs and concerns.

NAT takes a different approach than most literature, addressing 'how' go about nuclear proliferation as opposed to 'why'. Narang accomplishes this by incorporating a nonlinear approach to nuclear proliferation processes, and attempts to establish a theory explaining varying strategic decisions and the motives for said actions. Thus, building on this contemporary perspective, the purpose of this work is to employ NAT to individual cases using different indicators for Narang's variables. By staying consistent to Narang's variables and design, there is an opportunity for direct comparison of the compiled data against Narangs classifications based on his variables. By employing the use of alternative indicators from reputable and publicly available data, this research will produce evidence supporting NAT as an accessible framework in explaining nuclear proliferation strategies. Furthermore, the alternative indicators selected focus on the broader strategic situation a nuclear pursuer faces, as opposed to Narrang's focus on specific progress milestones within their nuclear program. By focusing on the broader strategic situation, but keeping Narang's typology, alternative indicators can add an extra dimension to the analysis of nuclear proliferators; and supports the validity of Nuclear Acquisition Theory by exposing it's typology to a reputable data set tracking related phenomenon. My chosen alternative indicators come with a plethora of interrelated and extensive datasets that provide much further details about the variables, for example precise dates escalation in conflict or details of formalized alliances, that further substantiate the case classifications. The addition of these details help strengthen the case selections and rationales between hedging strategies, and make way for further analytical comparison between the cases. For instance, the use of three separate data sets to determine the formal security pact to mitigate nuclear threat provides both extensive detail, as well as high validity in indicating the presence of this variable. How these new indicators were derived will be

[1] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 133

detailed further in the paper. This work ultimately aims to strengthen the validity and reliability of NAT by producing empirical evidence through theory testing, and contribute research towards an intriguing approach investigating the nonlinear approaches states take to nuclear proliferation

1.1 Research Question

Hedging is a series of strategies employed by a potential nuclear pursuer that has the intent to develop a bomb option, but has mitigating factors deferring a decision on actual weaponization work. They are in possession of nuclear infrastructure, but are not actively building a weapon, withholding those efforts until a change in their strategic situation warrants such a move (or 'hedging' their bets on the need for a nuclear weapon). Narang uses these strategies to explore cases that have the ability to become active pursuers, that is, engaging in weaponization work, as well as classifying their varying degrees of passive efforts.

The research question for this thesis is: To what extent can Narang's classification of technical and insurance hedging cases, based on his nuclear acquisition theory, can be supported or refuted by the use of alternate indicators and data sources?

Sub-Questions

1) How many of the examined cases conform to NAT's classification of a technical hedging strategy?

2) How many of the examined cases conform to NAT's classification of an insurance-hedging strategy?

3) Do any of the examined cases Narang classified as technical or insurance hedging conform to other strategies?

Through answering these sub-questions, the research question will be answered, as all of the cases examined within this research will be classified into one of three potential categories pertaining to NAT 1) Technical Hedging, 2) Insurance Hedging and 3) Other Strategies.

This research seeks to focus on the first two hedging strategies - technical and insurance hedging - and will adopt different indicators to the variables put forward by Narang. The motivations for this are multifold, with the first being the availability of data. Narang's suggested set of indicators focus heavily on technical milestones in a program, such as fissile

material production or theoretical weaponization work. Simply put, technical and insurance strategies are the first steps in a nation's pursuit of nuclear proliferation and represent a country that has the ability to pursue but not a focused effort underway. Technical refers to a nation that has peaceful nuclear capabilities (power generation, medical isotopes, etc.) but no clear ambitions to pursue nuclear proliferation; where an insurance hedger has clear peaceful nuclear capabilities and the latent need for militarized nuclear technology. This research will explore the various strategies in the Body of Knowledge section more in-depth. These indicators pose considerable difficulties, as information regarding them would be considered national-security secrets by the pursuer themselves, adding to the difficulty in data collection particularly regarding consistency and availability of sources. Furthermore, the variables ascribed to technical and insurance hedging focus exclusively on the broader strategic context a pursuer experiences - the security situation of the nation and its diplomatic alliances mitigating those challenges - and because of this the adoption of indicators that better present a pursuers strategic situation instead of technical milestones in their nuclear program is more appropriate.

1.2 Academic Relevance

This work seeks to test NAT theory with alternative indicators for Narang's variables. using the case studies Narang classified as technical or insurance hedgers. The alternative indicators will be derived from data in the Correlates of War project. This project contains datasets pertaining to MID's (militarized interstate disputes), formal diplomatic alliances, and memberships to international governmental organizations as alternative indicators to a state's immediate security environment. These indicators directly represent the two variables identified by Narang, stating that variables: (1) their immediate security environment, (2) their internal domestic context...capture the intensity of demand [for a nuclear weapon] generated by a state's immediate security environment."[2] If the theory testing put forward conforms with Narang's classifications in regards to proliferation choices, then this thesis will further strengthen the validity of Narang's NAT by analysing a portion of presented case studies against alternative indicators.

[2] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 126

Narang highlighted the limitations of his initial article outlining NAT in saying "it is beyond the scope of this article to provide a full test of nuclear acquisition theory"[3], and while this research does not seek to conduct a full test of the theory itself, it does seek to examine all cases ascribed as technical and insurance hedging using indicators based on variables outlined in Narang's article presenting NAT. This research will broaden understanding of NAT's strengths and blind spots. This will be accomplished by using indicators that differ substantially from Narang's chosen indicators, but tie directly into his proposed variables; approaching the topic from a new perspective while holding true to his theorized framework. By comparing the results of this research to his analysis, NAT can be strengthened through establishment evidence that has varying research manipulations from the original study design. This research will provide insight to future prospective research designs in their process of selecting indicators, as well as constructing a research design that is both measurable yet encompassing the intricacy pursuer's pathway.

The academic relevance of this research is derived in the production of empirical evidence using NAT that contributes to the understanding and explanation of the experiences of nuclear pursuers. By focusing on variables to determine how states will pursue nuclear initiatives on a case by case basis, this research will directly address the shortcomings of many of the previous literature surrounding nuclear pursuit. The specific indicators were chosen from datasets with significant amounts of available data, and specifically providing empirical evidence of both variables in terms of documented militarized interstate disputes, varying alliances of varying degrees, and memberships to intergovernmental organizations. Another benefit of using such an abundant data source was having accessible indicator data before and after the periods of interest. Having this additional data proves useful when examining a nonlinear approach and individual outcomes of each pursuer's strategy.

My data substantiates the ideology and purpose of viewing these proposed models as tools and not specific pathways, as they aid in understanding patterns, trends, and commonalities between events. My selection of new indicators for Narang's variables seeks to showcase the

[3] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 135

fallibility in even minimal modification to a model's framework. This is not to invalidate the findings per say, but instead strengthen frameworks by constant adaptation and improvement in trying to quantitate aspects of intricate phenomena such as nuclear proliferation. The results of my theory-testing will likely only be visible within context to the specific technical and insurance hedging indicators of Narang's NAT. The actual results will be inconsequential to the reliability of Narang's indicators, but instead a dataset to add to the cumulative research surrounding this topic. The inclusion of other authors such as Mark Bell's is to add perspective to the purpose of my work by acknowledging the specificity of this research and my objective of producing justifiable data accompanied by subsequent discussion without formalizing grand conclusions.

Narang has also identified another potential academic application of NAT in saying "Importantly, identifying the conditions that ought to generate a particular variety of hedging provides insights into what might trigger an active weapons acquisition strategy or encourage abandonment of a nuclear weapons program."[4] Through choosing to examine Narang's variables, observable evidence is produced that can be used to academically analyze future cases of nuclear pursuers as they arise.

The motivation for creating new indicators is partly due to the difficulties Narang highlighted in using the suggested indicators he created. Indicators focusing on technical milestones such as theoretical weaponization work or dual-use ballistic missile technology are incredibly difficult to track accurately and in a timely manner. By using military interstate disputes and formalized alliances - activites a nuclear pursuers engages in that are public knowledge and easily tracked- data tied to indicators can be reliably verified and collected. Furthermore, the choice to use data sets put forward by the Correlates of War project adds validity and reliability to this research, as the data is both publicly available and peer reviewed; and captures all cases being presented thus contributes to the consistency of results as there is no opportunity for data to be misinterpreted through different parameters of datasets (I.E. two different datasets using different terms of a MID that could skew results).

[4] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 120

A separate motivating factor for creating new indicators is to better capture the strategic motivations that drive a country towards a specific type of hedging. Narang's indicators focus on technical progress to determine the type of hedging being employed, where this research will focus on the strategic pressures motivating a selection of specific types of hedging. While ambiguity exists with Narang's indicators, specifically towards difficult-to-ascertain technical decisions; clearly defined indicators tracking MID's and alliances allow for less ambiguity in these determinations. The presence of a formal alliance, or show of force between nations, is a clear and present phenomenon less ambiguous than the degree of progress towards theoretical work on a weapon is. Ambiguity is still present in these indicators (what constitutes a formal alliance, is it committed enough to deter a nuclear aggressor, etc.) but well defined parameters of what is being observed can provide clarity. The variables presented by Narang are much less tied to a nation's strategic concerns, and more tied to its initial progress on a nuclear weapon; however the first two variables are clearly tied to strategic concerns. By using indicators that bridge this gap; this research further explores the strategic factors that motivates a state towards or away from pursuit of nuclear weapons.

1.3 Societal Relevance

With NAT providing a framework to analyze how nations approach acquiring nuclear weapons, the theory has been a topic that has been highly relevant in the current global security climate with North Korea and Iran both pursuing nuclear weapons. The importance of NAT and this research specifically is in showing how nuclear programs employing differing strategies can be slowed, scaled back or convinced to abandon their desires for proliferation by various means such as formalized security guarantees. As the indicators used in this research will be tied to strategic-level variables, such as formal diplomatic security guarantees, the research provides insight into the impact of real-world diplomatic action on a nuclear-pursuers weapons program.

The societal relevance of this paper can best be identified by a quote from Narang in describing a pursuers motivation for pursuing insurance and technical hedging strategies, saying "A state confronting an acute security threat alone must consider additional variables in choosing a proliferation strategy. One option is to seek a formal superpower protector or a nuclear

umbrella so that it is not forced to pursue an active proliferation strategy.”. Through examining the broader strategic context of each case's security environment, a better understanding of the conditions that motivate nuclear pursuit can be ascertained. These results have real-world implications for nuclear-armed states in regard to their interactions with potential pursuers such as Japan and South Korea; where the reduction or ending of formal security guarantees could reinvigorate more committed pursuit strategies; or an abandonment of hedging completely.

2.Body of Knowledge

Narang is neither the first nor the last academic to attempt to quantitate patterns and events as indicators to explain past instances and predict future proliferation. Several proposed models have been conceived, each varying in design and intricacy, with most variation lying within the collection of variables found in extant literature proposed to be determinants of proliferation. In his work *Examining Explanations for Nuclear Proliferation*, professor Mark Bell from University of Minnesota published an article collectively appraising and examining over 30 variables from various sources using bound analysis, cross-validation, and random forests. In the midst of a plethora of indicators, his consensus largely remained that although some performed better than others, the majority failed to provide concrete accounts for previous patterns of proliferation, and even fewer offer any ability to predict proliferation.[5] Bell would presumptively propose that my indicators will yield different results than Narang’s, and that neither will offer an adequate explanation of the events that took place, nor be able to predict future ones. If this were in fact his belief, I would wholeheartedly agree, and thus solidifying the aim that my work, briefly summarized, is to contribute further evidence to the many distinguished models that will continue to be reviewed and revised in attempts to come.

Existing Literature on Nuclear Proliferation

Other author’s working on the topic of nuclear proliferation have focused on the interactions between aspirant proliferators and nuclear armed states, or more specifically the

[5] Bell, Mark S., Examining Explanations for Nuclear Proliferation, International Studies Quarterly, Volume 60, Issue 3, September 2016, Pages 520–529, https://doi.org/10.1093/isq/sqv007

calculus and strategy employed by established nuclear powers towards proliferators and their level of involvement in forcibly delaying or degrading a proliferators effort towards developing a weapon [6],[7]. A hefty assumption implemented in these works in comparison to NAT is that it again assumes that all pursuers seek to weaponize as an end-goal, instead of potentially maintaining a hedging strategy long-term as a means of enabling future nuclear capabilities while not actively moving towards weaponization. NAT differs from other research on the topic in moving away from viewing acquisition as a linear process, with pursuers switching strategies based on broader strategic concerns; moving to less committed strategies or scaling back efforts when situations demand. This could be caused by some authors focusing on states that are more likely to be regarded as 'pariah' or 'rogue' states.

Narang's Strategies of Nuclear Proliferation was searched amongst the popular academic database Google Scholar. Inquiry into works that have cited Narang's article was completed to determine the nature of existing literature, and how subsequent works have contributed to the topic of the work's release. The vast majority of the cited articles, 33 of the 37 ,merely referenced Narang's article and offered no application of theory testing, nor substantial adjustment/ critique of his work. Of the four remaining articles that cited his work, the only article providing critique of Narang's NAT is authored by Gaurav Kampani & Vipin Narang and focuses exclusively on the case of India; not NAT as a broader theory, which is expanded on in the next paragraph. The nature of Narang's inclusion in the three other articles by Ladha, Park & Peh, and Nutt is also detailed in the following paragraph.

Kampani wrote a criticism on Narang's application of NAT to the Indian case, examining the specific milestones Narang identifies as motivating changes to the Indian nuclear proliferation program. This work represents the most comprehensive academic criticism of NAT to date. Kampani's critiques focus on what he terms "supply-side material and technical constraints", or internal factors influencing India's proliferation efforts. His two main veins of criticism can be summarized in saying the NAT fails to "demonstrate that supply-side material and technical

[6] Bas, Muhammet A., and Andrew J. Coe. 2016. "A Dynamic Theory of Nuclear Proliferation and Preventive War."
[7] Fuhrmann, M., & Kreps, S. E. (2010). Targeting Nuclear Programs in War and Peace: A Quantitative Empirical Analysis, 1941-2000.

constraints were not a significant factor…during its quarter-century of hard hedging." and that "it cannot account for why India took so long to pursue a nuclear weapons capability once a political consensus for doing so had formed"[8]. His argument also focuses on when a case, in this situation India, can be considered to have weaponized successfully. Due to this criticism being mostly unrelated to the theory testing this research seeks to accomplish, it will not be used within the research and further supports the decision to focus solely upon Narang's initial article *Strategies of Nuclear Proliferation* where he lays out the tenants of NAT.

Outside of his reply to Kampani's work, Narang himself has not referenced NAT significantly in his other academic works. Narang's primary research has been on nuclear posturing and associated strategy; with a particular focus on the North Korean and Indian cases. After an extensive search of both Narang's published works, and Google Scholar citations of *Strategies of Nuclear Proliferation*, it can be determined no prior academic work has been conducted using this research's set of indicators with application to NAT; and supports the originality of this research. In *Nuclear Strategies of Emerging Nuclear Powers: North Korea and Iran*, a 2015 article authored by Narang, he identifies similar indicators and challenges to the strategic posturing of nuclear powers; with the key difference being this work examines how nuclear powers use their weapons strategically once they are in possession of them not how they go about acquiring them in the first place. The key variables of NAT are present in this work, focusing on a state's resource constraints, civil-military environment, broader security situation and availability of a third-party patron; highlighting a key evolution and shared commonality of Narang's theories on nuclear strategy. These five identified variables present in both works, as well as Narang's book *Nuclear Strategy in the Modern Era: Regional Powers and International Conflict*, where he presents Posture Optimization Theory (a theory focused on how state's use their nuclear weapons to a create a 'posture' that guarantees a deterrence effect from their nuclear arsenal), form the core variables of nuclear strategy in Narang's academic works. Due to the similarities of variables being shared among many of Narang's work on the topic, the use of new indicators on this set of variables through this research opens doors for future theory testing on

[8] Kampani, Gaurav & Narang, Vipin. "India's Pursuit of the Bomb and Strategies of Nuclear Proliferation." International Security, vol. 43 no. 1, 2018, p. 177-180. Project MUSE muse.jhu.edu/article/701870.

other related theories presented by Narang; such as his Posture Optimization Theory.

Three other authors directly used classifications or ideas presented in NAT, but do not use NAT as the central topic of their research. Rizwan Ladha, in his article *In the Shadow of the Umbrella: U.S. Extended Deterrence and Nuclear Proliferation in East Asia, 1961-1979*[9], uses Narang's concept of sheltered pursuit within his hypothesis; but does not use further components of NAT within his research. Soul Park & Kimberly Peh cited works on nuclear proliferation and broader nuclear strategy multiple times within their article *Leveraging towards restraint: Nuclear hedging and North Korea's shifting reference points during the agreed framework and the Six-Party Talks*.[10] They use multiple concepts presented in *Strategies of Nuclear Proliferation*, such as the concept of 'duress' as well as Narang's specific definition of hedging and associated hedging strategies, however this work does not focus on NAT, make an attempt at theory testing; or take a critical stance towards the theory. Cullen Nutt, in *Proof of the Bomb: The Influence of Previous Failure on Intelligence Judgments of Nuclear Programs*, directly uses both Narang's definition of a 'hiding' strategy, as well as 11 of the specific cases identified within NAT; this work does not take a critical or theory testing stance towards NAT instead using Narang's work to support case selection.[11]

Narang's Nuclear Acquisition Theory

Narang would summarize the purpose of NAT in saying "It identifies the diversity of proliferation strategies; develops a theory for why states select a particular strategy; and shows."[12] He argues that these differing strategies of proliferation affect the character of a states nuclear proliferation and non-proliferation. Narang seeks to expand the scope of the proliferation literature

[9] Ladha, Rizwan. "In The Shadow of the Umbrella: U.S. Extended Deterrence and Nuclear Proliferation in East Asia, 1961-1979." The Fletcher School of Law and Diplomacy. Apr. 2017.
[10] Park, Soul, & Peh Kimberly. "Leveraging towards restraint: Nuclear hedging and North Korea's shifting reference points during the agreed framework and the Six-Party Talks." *European Journal of International Security* 5 (2019): p. 94 - 114.
[11] Nutt , Cullen G. "Proof of the Bomb: The Influence of Previous Failure on Intelligence Judgments of Nuclear Programs." Security Studies, 28:2, 2019. p. 321-359.
[12] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 110

by asking how states try to acquire nuclear weapons. This sentiment shows that NAT is focused almost exclusively on the 'how' question of nuclear proliferation, a break from established research on nuclear weapons proliferation that focused heavily on the 'why' question of nuclear pursuit. This is further reinforced by Narang in stating that NAT "is the first effort to analyze how states…have sought nuclear weapons, and why they chose a particular strategy to do so."[13] Previous research on nuclear proliferation mainly focused on the tangible technical details of constructing nuclear weaponry in a linear manner, with a pursuer moving from one phase to the next in the process of weaponizing with the sole goal of the process being construction of a nuclear stockpile.[14] [15]

Nuclear Acquisition Theory (NAT) tries to explain the process of how states - 'nuclear pursuers acquire a nuclear weapon, and why some states will adopt different strategies that dictate how much effort and resources will be exerted in their pursuit. NAT presents six potential strategies that can be broken into two overarching categories - hedging strategies and weaponization strategies. Hedging strategies prescribe that a pursuer has some degree of 'groundwork' to accomplish, thought of as the initial phases, for a nuclear program completed - but is not actively pursuing acquisition of a working nuclear weapon. A pursuer would adopt these strategies when their strategic situation could be complimented by a nuclear weapon - but has mitigating factors tempering the necessity of acquisition - such as having an alliance with a nuclear power that brings the pursuer into a 'nuclear umbrella' or no clear acute security threat to face.

The three hedging strategies are as follows - technical hedging, insurance hedging, and hard hedging. Technical hedging is the least committed of hedging strategies, with the pursuer facing no acute security threat to motivate pursuit of a nuclear weapon - but the state has the technical and resource capabilities to begin the groundwork of a nuclear program. Insurance hedging is the next escalatory step after technical hedging, with these pursuers having both the technical resources to create the groundwork for a nuclear weapons programs and are facing an

[13] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 110
[14] The Correlates of Nuclear Proliferation: A Quantitative Test.pp. 862,
[15] Achieving Nuclear Ambitions: Scientists, Politicians, and Proliferation.

acute security threat from a neighbouring state or nuclear armed rival. The unique factor of insurance hedgers is that they have strong security guarantees from another nation capable of mitigating the threat faced by the pursuer - such as being in an international alliance or being covered by another nation's nuclear umbrella - with this protection removing the need for further progress of their nuclear acquisition; while still having initial progress completed in case changes in their strategic situation cast doubt upon those protection guarantees and reinvigorate the need for their own nuclear arsenal. Hard hedging is the final hedging strategy and is the most committed of the three. Hard hedgers - sometimes referred to as 'turn-key' nuclear powers - have both the resources and the security need for nuclear weapons and have no mitigating alliances to temper their pursuit; with the factor separating them from full pursuit or 'weaponization' being a lack of domestic consensus for pursuit of weapons. Hard hedgers are not destined to become weaponizing pursuers, as states can both scale back as well as escalate from this stage; however, this strategy represents a state that must determine the cost/benefits of pursuit before fully committing to a course of action that brings it a functioning nuclear weapon. All three hedging strategies allow for states to have the precursor requirements of a nuclear program, such as fissile material production or development of a dual-use delivery vehicle (missiles which can be used for both peaceful and military purposes) without committing to active pursuit of a weapon.

The final three strategies fall into the category of 'weaponization', and as the name implies are states that are actively pursuing the end goal of a functioning nuclear weapon through their nuclear programs. All three weaponization strategies can lead to a functioning nuclear weapon and will be determined by a state's broader strategic situation instead of commitment or resources towards a nuclear weapon. The three strategies are Sprinting, Hiding, and Sheltered Pursuit. Sprinting is the strategy employed when a pursuer has determined it is impervious to military or economic disruption of its nuclear program - and can openly progress towards a nuclear weapon without fear of retaliation- 'sprinting' towards its goal of a nuclear arsenal because it does not need to be concerned with the strategic implications this rapid pursuit will bring. The next strategy is hiding, and as the name implies, it is where a pursuer is vulnerable to economic or military retaliation meant to dissuade the state from its pursuit of a nuclear weapon and therefore must hide its progress from the international community. This strategy forsakes speed for secrecy, with a pursuers primary concern being tied to its ability to weaponize without

incurring retaliation from its rivals, neighbours or the broader international community. The final weaponization strategy is sheltered pursuit, and is where a nuclear pursuer has the protection of a major power patron that protects it from retaliation tied to its nuclear pursuit, even if the protection is not tied to its nuclear pursuit but the broader strategic relevance of the pursuer to the patron. Narang describes the objective of this strategy by saying it is "to develop a nuclear weapons capability before the major power patron abandons the client." [16]

Strategy *Weaponization Strategy	Intent
Hedging (see below specific hedging strategies)	Preserve or develop the ability to produce a weapon
Sprinting *	Produce a weapon as quickly as possible
Hiding *	Produce a weapon without being discovered
Sheltered Pursuit *	Produce a weapon before relationship with patron fails

Table 1- The two overarching (weaponization or hedging) strategies Narang's proposes states will adopt to pursue nuclear acquisition.

As previously described, the purpose of this research will be to classify each of the cases as either a technical hedger, insurance hedger, or other strategy. The main reason for the exemption of hard hedging in terms of data collection is due to the complexity of gathering data to assess the variables for hard hedging. Referring to NAT's hypothesis, that changes in variables predict change in strategy, insinuates that using proper indicators to measure said variables is imperative to predicting change and subsequent strategy. Narang himself even points out the difficulty in assessing hard hedging, arguing that "hard hedging may be difficult to observe in real time because much of the distinctive work is likely done in secret."[17] Narang's broader framework suggests

[16] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 122

[17] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 119

avoiding unit level indicators, and the first two variables in the theory look at broader strategic factors to determine technical or insurance hedging. In order to assess additional strategies, including hard hedging, you would have to create unit level indicators for complex domestic political discourse, and to maintain a directed purpose, the scope of this work will only focus on the first two types of hedging strategies.

Hedging

Hedging has been described as "a transitory strategy. A state that ultimately wants to acquire a nuclear weapons capability must switch to an active nuclear weaponization strategy. Alternatively, a hedger that decides that it wants to foreclose the option to produce nuclear weapons exits the universe of cases, because its intent to pursue nuclear weapons evaporates."[18]. This is an important point to note, as states pursuing hedging strategies have a much 'lower' investment in their nuclear programs in comparison to weaponization strategies. Furthermore, "hedging can theoretically persist indefinitely, as hedgers may reap some deterrent benefits without paying the costs of overt proliferation, such as sanctions, reactive proliferation by adversaries, or the financial obligation of maintaining an overt deterrent." Due to the very different objectives/intents of these two groupings of strategies (hedging and weaponization), the set of indicators is much more complex for the hedging strategies; as differentiating hedging strategies focuses more on the *degree* to which a pursuer is developing individual capabilities and systems that *could* lead to a weapon instead of pursuing a weapon itself.

Types of Hedging Strategies

Technical Hedging: This strategy is based on creating civilian nuclear capacities that could be used as a foundation for a nuclear weaponization program, with no work or clear intent towards weaponization being present in this strategy of hedging. "This sort of hedging may arise because access to nuclear technologies may tempt certain constituencies within the state to flirt with the

[18] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 120

idea of pursuing nuclear weapons. The demand for nuclear weapons, however, is weak and often confined to fringe elements…Technical hedging is perhaps closest to the concept of pure latency, lacking centralized—but not entirely absent—intent for further nuclear weapons pursuit."[19]. In terms of investment in pursuit of a weapon, a technical hedger would be the absolute minimum position a state could take and still be considered a pursuer.

Insurance Hedging: This strategy is employed by nuclear pursuers who can rely on major allies for protection from acute security threats, such as being under another nations "nuclear umbrella" (even potentially having foreign nuclear weapons based on their territory). Most activity towards proliferation in this strategy is designed to "reduce the time required to build a bomb should a state need to weaponize (for example, if a security threat intensifies or if the hedger is abandoned by an ally). Insurance hedging explicitly threatens breakout under specific conditions, to "collect" on the insurance policy so to speak."[20].

Hard Hedging: The key factor to hard hedging is that "The state has a potentially intense demand for nuclear weapons, but it consciously stops short of weaponization. Hard hedgers can approximate "turnkey" nuclear weapons states, standing on the precipice of nuclear weapons acquisition but restraining themselves from going over the brink."[21]. This is the most 'invested' of the hedging strategies, with the next step dictated by NAT crossing the threshold from hedging to weaponizing.

Narang's Variables and Indicators

Narang presented his variables in the format of a decision tree saying that "The decision tree makes a prediction for the strategy chosen by a given state at a given point in time, based on the values taken by a sequence of variables at that time.". This decision tree is a fluid tool, with

[19] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 117

[20] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 118

[21] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 118

each change to the a cases broader strategic situation requiring analysis to begin from the start of the decision tree flowing down though each set of variables. Narang summarized this in saying "Because the value of each variable can change (e.g., a state's threat environment may change), these predictions are not static. If a change in a variable occurs while a state is pursuing nuclear weapons, the theory would predict that a change in the state's proliferation strategy should also occur." [22]. This thesis seeks to test NAT with alternative indicators and contrast the choices made by cases Narang classified as insurance and technical hedging. Narang presented a table of potential indicators to gauge what strategy was in place, with these suggested indicators focusing heavily on specific technical milestones a nuclear program would reach in its pursuit of a weapon. The following five categories are the specific indicators used to determine which (or if a hedging strategy has been pursued.

Potential Indicators for Varieties of Hedging

	Technical Hedging	Insurance Hedging	Hard Hedging
Fissile material production	Nonweapons-grade	Nonweapons-grade; potential work on capability to produce weapons-grade	Capability for weapons-grade production
Weaponization work	None	Possibly limited (secret?) theoretical work	Theoretical work; no physical work
Nuclear delivery vehicles	None	Possibly dual-use delivery vehicles	Dual-use delivery vehicles; potentially dedicated delivery vehicles
Declared interest in weapons	Fringe elements	Surfaces only periodically	Mainstream debate
Intent: explicitly not now but . . .	Implicitly not never	Explicitly if X happens	Explicitly not never

Figure 1 – The 5 potential indicators used to determine if and which hedging strategy has been adopted.

[22] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 125

Fissile Material Production: This indicator is implemented to track a proliferator's ability to enrich its own nuclear material to weapons-grade levels (most commonly Uranium-235 and Plutonium-239). In practical terms, a nation's ability for fissile material production and enrichment could be tracked (roughly) by available knowledge relating to the proliferator's possession of diffusers and (much more likely) centrifuges. Centrifuges are the preferred method, due to reasons related to efficiency and capacity [23].

Weaponization work: Weaponization as an indicator refers to the efforts or choices a nation has undertaken/made towards designing its own nuclear weapon (such as payload, fission versus thermonuclear, 'gun'-type or implosion type method of assembly, strategic vs tactical application, etc.). This category does not seek to measure physical construction of the weapon; it specifically measures how much progress has been made on the theoretical design. This is because physical work on a weapon would firmly push a proliferator out of the realm of 'hedging' and firmly into a weaponization category (as it would literally be building the device itself not its predecessor components).

Nuclear delivery vehicles: The purpose of this category of indicator is to measure a nation's capability to deliver a functional nuclear weapon to a desired target, and the arsenal of 'delivery vehicles' that a proliferator may possess. This indicator can come in many forms, ranging from gravity bombs (such as 'little boy' and 'fat man' used against Japan in WWII), to more sophisticated missile delivery systems used exclusively for nuclear payloads (such as the thermonuclear **I**nter-**C**ontinental **B**allistic **M**issile near synonymous with the Cold War arms race in common nomenclature). This indicator can also account for 'dual-use' delivery vehicles (platforms that are not exclusive to nuclear weapons, but can fulfill such a task), such as gravity bombs, some varieties of cruise missile, SRBM's and MRBM's (short-range and medium range ballistic missile's respectively).

Declared Interest in Weapons: Creation of a nuclear weapon is an exceptionally large under-taking for any state in terms of the resources that need to be mobilized across various cross-sections

[23] "Uranium Enrichment." World Nuclear Association, World Nuclear Association,

of society towards the common goal of weaponization. Actors within the political, scientific, military and public spheres of a proliferator's nation need to coordinate in unison for weaponization to be successful; with organized opposition from any one of these actors delaying or derailing a proliferator's efforts. This indicator measures the intensity and frequency of rhetoric (statements made by public officials or institutions, public opinion polls, media releases, etc.) towards weaponization from the four aforementioned spheres within a state pursuing proliferation to gauge to extent of commitment towards the goal of weaponization (and inversely any of the three hedging strategies).

Intent: Intent as an indicator measures the strategic purpose of a proliferator's pursuit. Simply put, it seeks to define the strategic 'why' question in why would X nation need the foundations of a nuclear program and under what conditions would the proliferator seek to push further towards weaponization or deepen its commitment to a more invested hedging position. This indicator is arguably the most difficult to determine, as most nations (especially those committed to long-term hedging) will not want to explicitly define the conditions under which they would pursue a 'breakout' or push towards full weaponization of their nuclear program. This indicator can be determined by applying what role X hedging strategy plays within the broader geopolitical position and aspirations of a state. For example, a state with a strong alliance to a nuclear-armed power would logically be more likely to have an intent more reflective of technical or insurance hedging (as they have a formal security guarantee providing a 'nuclear umbrella' against any possible security threat whether it is present or not, mitigating the need for further or immediate investment in its nuclear pursuit) where a nation without access to an ally's nuclear protection or with stated desires to acquire/maintain its status as a hegemon (in some capacity) would be much more enticed by the possibility for a 'turnkey' weapon to facilitate a nuclear 'breakout' should the situation arise.

3. Methodology

3.1 Research Design

The research will be conducted as a case study of the 16 individual cases Narang

presented in his article detailing Nuclear Acquisition Theory. By employing both of Narang's variables, into his created framework (NAT), and researching the same cases, it minimizes the effect these aspects will have on the outcomes, increasing the influence of the alternative indicators. To assess the transferability and generalizability of Narang's work, it is imperative to keep true to original aspects of his design with the exception of the study area that has been manipulated, the indicators.

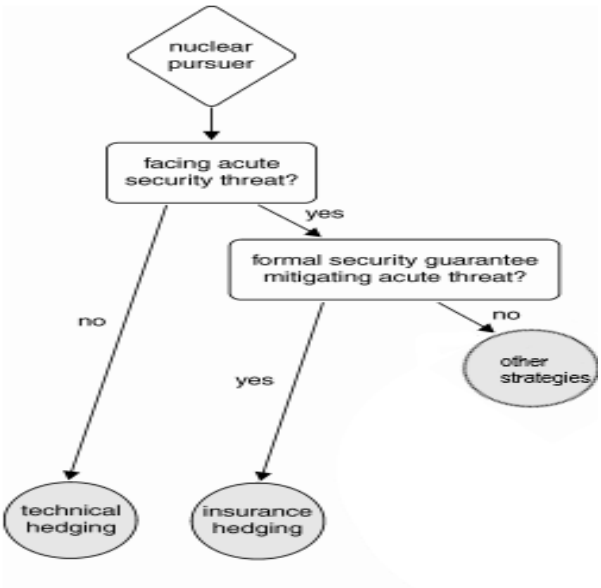

Figure 2- A simplified pathway diagram that depicts the predicted path to aqcusition

The above figure is a simplified chart to explain the various choices a nuclear pursuer will have to face along their path to acquisition, and how these various choices will culminate in what strategy a given state employs – with Narang stating that this process can predict the strategy a nuclear pursuer employs with "the vast majority—more than 85 percent—…for the correct hypothesized reasons."[24]. The visualization of the framework above was added to make it easier for readers to understand the way in which each of the variables will be assessed and the ways in which predicted hedging strategies will be derived. The quantitative research to be used for comparison to Narang's classifications will be produced by using alternative indicators from

[24] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 133

Correlates of War datasets to classify each case as a hedging strategy based on the framework above.

3.2 Justification of Case Selection

The cases examined will be as follows, with time period to be examined included in brackets after each case: Argentina (1968–76), Brazil (1953–76), India (1948–64), Iran (1974–78), Libya (1970–81), Norway (1946–62), South Africa (1969–74), Australia (1956–73), France (1945–54), Italy (1955–59), Japan (1954–present), Romania (late 1960s–89), South Korea (1975–present), Taiwan (1967–74), West Germany (1956–69), Yugoslavia (1948–60). The motivation for selecting these cases is straightforward, NAT classified these cases as either Technical or Insurance hedgers. This research is based on using data that can determine, according to Narang's presuppositions of a broader strategic environment motivating the adoption of these strategies, if a state has selected an appropriate strategy. To properly test NAT as it pertains to insurance and technical hedgers, examining every case classified as adopting those strategies adds validity to the results of this research.

This research seeks to explore insurance and technical hedgers specifically because the variables for these cases as laid out by Narang has the most accessible publicly available data. This choice is driven by the constraints of this research. While the research does not seek to test all cases presented within NAT, it does seek to explore sixteen of the forty-seven cases presented, or roughly a third of all cases presented under the theory. In terms of time span to be examined, the cases will be examined for the exact span of time as specified in Narangs initial research to ensure the validity of the findings, and contribute to the replicability of this research. See below (Figure 3) for a specific listing of cases, by country, time span examined and Narang's own codings of the cases.

Empirical Codings of Strategies of Proliferation		
	Proliferation Strategy	Country (Approximate Years)
Hedging strategies	Technical hedging	Argentina (1968–76) Brazil (1953–76) India (1948–64) Iran (1974–78)* Libya (1970–81) Norway (1946–62)* South Africa (1969–74)
	Insurance hedging	Australia (1956–73) France (1945–54) Italy (1955–59) Japan (1954–present) Romania (late 1960s–89) South Korea (1975–present) Taiwan (1967–74) West Germany (1956–69) Yugoslavia (1948–60)*

Figure 3- A list of the 16 cases Narang classified as either Technical or Insurance hedgers.

3.3 Data Collection/Sampling

In order to collect the necessary data to answer both the proposed research and sub-questions, publicly available (and widely circulated/reviewed) sources will be used. Sources will be drawn from the data sets created by the *Correlates of War (CoW)* project, with data sets specifically focusing on militarized interstate disputes, formal alliances, and membership in international governmental organizations such as NATO and the Warsaw Pact. The Correlates of War project has been active since 1963, and is hosted by multiple academics and a number of different institutions, primarily in the United States. The goal of the project is the collection, dissemination, and use of accurate and reliable quantitative data pertaining to the study of conflict and associated phenomenon.

This data will be used to answer indicators which are based on the variables presented in Narang's decision tree (such as answering the Yes/No question of a nation having a formal security guarantee, which can be empirically proven through the 'formal alliances' data-set provided by the CoW project). The specific data-sets that will be used are: 'Militarised Interstate Disputes (v4.3)', 'Formal Alliances (v4.1)', and 'Intergovernmental Organizations (v2.3)'. The data set 'Militarised Interstate Disputes (v4.3)' will provide the data indicative on the first indicator, if a state is facing an acute security threat. The data sets 'Formal Alliances (v4.1)' and 'Intergovernmental Organizations (v2.3)' will be indicative of the second question, if a state has

a formal security agreement mitigating this threat. The 'Intergovernmental Organizations (v2.3)' data set will also be used in the analysis, investigating memberships in NATO, and the Warsaw Treaty Organization/Pact in addition to the findings from 'Formal Alliances' data-set. This is to consider cases where a nation that does not have an individual formal alliance with a relevant power but does have membership in an IGO that guarantees the nation's security and extends a nuclear umbrella. The above data-sets are publicly available for review and regularly updated for accuracy.

3.4 Indicators

Narang presented a table of potential indicators to gauge what strategy was in place, with these suggested indicators focusing heavily on specific technical milestones or decisions a nuclear program would reach in its pursuit of a weapon. Narang's suggested indicators such as fissile material production or progress of weaponization work would be considered national security secrets of a given case's government, thus lacking publicly available data to apply to the variables. Due to these constraints, this thesis will create a seperate set of indicators tied to the first two variables presented in NAT's decision tree; focusing on 1) the presence of an acute security threat facing a proliferator, and 2) the presence of formal security guarantees in the form of mutual defense agreements.

Narang's decision-making process as to his selection of variables tied to NAT was described in saying "In the tradition of neoclassical realism, the theory privileges systemic variables ... I take care... not to introduce unit-level variables in an ad hoc fashion, or perceptual variables.... Instead, I specify when and where unit-level variables might intervene and develop ex ante indicators for those variables; in this way, the theory remains both testable and falsifiable. Elsewhere, I employed this broader theoretical approach to predict which strategies of deterrence states might select."[25] Due to these design choices, the indicators for this research will remain at the systemic level, focusing specifically on a criteria reflective of a case's broader security situation and alliances that are universal to all actors at the systemic level. This decision was made to avoid

[25] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 125

using unit-level variables that would detract from the theory-testing purpose of this research, leaving the implementation of unit-level variables for other exploratory research using NAT that seeks to add a new layer of analysis to the theory; not the application of different data to the same variables that is the purpose of this research.

The first indicator, tied to the first variable of the presence of an acute security threat, is the presence of militarized interstate disputes involving the country being examined either as an aggressor or defender. Narang provided a very specific definition of this variable; "does it face either a conventionally superior proximate offensive threat that can pose an existential threat to the state, or a primary adversary that itself possesses nuclear weapons?"[26] The indicator for this variable is Militarized Interstate Disputes. The Correlates of War project, where the data tracking MID's will be drawn from, defines a MID as "instances of when one state threatened, displayed, or used force against another."[27] Narang has also identified MID's as " a reasonable indicator for conflict."[28]. For the purpose of this research, limitations will be set as a minimum value of 7 or greater on the "highest action in dispute" scale, and a value of 3 or higher on the "Hostility Level of dispute" scale, from the the CoW MIDB 4.3 Dataset codebook (see Appendix 2 for coding scheme of data). Both of these values represent actions greater than threatening rhetoric between states, focusing on direct use, or shows of, military force to indicate an action representing an acute security threat. This safeguard applied to the indicator prevents documented disputes and threats between states being misclassified as acute security threats, and bypassing the case as a potential technical hedger.

The second indicator is the presence of a mutual defense agreement with a nuclear power, or membership in a broader organization dedicated to the defense of its members; specifically NATO or the Warsaw Pact. This is based of Narangs second variable, which he explained in saying "Second... does it confront that security threat alone or does it have a formal alliance with

[26] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 127

[27] "Militarized Interstate Disputes (v4.3)." Correlates of War, Updated 5 Mar. 2020, correlatesofwar.org/data-sets/MIDs.

[28] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 114

a major power that mitigates the severity of the underlying threat?"[29] In order to determine the second variable, research will track individual alliances between nations in the form of mutual defense agreements, as well as membership in organizations dedicated to mutual defense such as NATO and the Warsaw Pact. The mitigating effects of a security agreement and memberships can be tied to the second variable of a formal security agreement mitigating a nuclear-armed threat and the variables are properly represented by the indicators.

It is to be noted that each of the cases will be assessed for each variable regardless of the impact on the outcome of predicted hedging strategy. In other words, cases that have no presence of an acute security threat will still be assessed for the second variable regardless of the fact they are predicted to adopt a technical hedging strategy based on NAT. Whether the state has the presence of formal security guarantees or membership to intergovernmental organizations is still pertinent data and is necessary for proper interpretation and discussion of the compiled research. As earlier stated, hedging is a transitory strategy and although we are classifying them into groups, each of the 16 cases will be individually analyzed to account for the differences in each state's unique experience with nuclear acquisition. Case studies strengthens the quality of research compiled on each nation's strategy by avoiding generalizations associated with linear views towards nuclear proliferation strategies. The use of these two indicators is based on Narang's reasoning for strategy selection, with these two variables being key in the decision to adopt a hedging strategy. Narang summarized this logic in saying " If a state is not facing an acute security threat alone—either because there is no such threat or because the state has a formal superpower guarantee mitigating a threat—then it should choose one of the hedging strategies."[30] The set of indicators created for this research encapsulates this core logic, seeking to identify the broader strategic environments each case inhabits and the nation's subsequent decision on adopting a hedging strategy. Table 2 illustrates the indicators to be used in research.

[29] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 127

[30] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 127

Hedging Strategies	Technical Hedging	Insurance Hedging
Militarized Interstate Disputes	Absent	Present
FormalAlliances/ Defence Pact	Absent	Present

Table 2 [31]*- The two primary indicators this research will use to predict hedging strategy.*

3.5 Data Analysis

The process in which the data will be analyzed will be initially determining the two indicators tied to the two variables presented in the NAT decision tree; acute security threats and formal security agreements/memberships of the 16 individual cases with the proposed indicators from the Correlates of War data sets. After applying to NAT to each case with my indicators, I will assign that case to its determined hedging strategy (technical hedging, insurance hedging, or other strategy). The strategy employed by each case will be determined based on our design, with the indicators supporting their assignment. The analysis of the indicators will be done quantitatively, specifically looking at the presence or absence of the variables captured by the research's indicators presented in the data sets.

After presentation and justification of the results from our research, I will compare the findings against Narang's classifications and coding notes to critically appraise the two sets of analysis. This will include direct comparison of cases in matching predictions, as well as discrepancies results, potentially stemming from differences in case study selection and justification, as well as the research design, specifically strength and weaknesses of both mine and Narang's choice of indicators. This data will answer the research question of how many cases grouped based on my indicators conformed with Narang's classification of hedging strategies. Comparison will take place using both sets of classifications, evidenced by both Narang's coding notes and the case notes produced from my research in Appendix A.

[31] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 119 Table1.

Furthermore, analysis will include critical appraisal of the broader study design, as well as the original and alternate indicators. Trends and important themes in the data will also be identified. Finally, the study will identify areas subsequent research could address in regard to NAT and the proliferation of nuclear capabilities by states.

4. Results

The 16 cases were analyzed using NAT with the substituted indicators as outlined earlier in this research. Each case was assigned a hedging strategy of technical, insurance, or other strategy based on data from the Correlates of War datasets tied to indicators designed around variables presented in NAT. The results of the research conducted is displayed in table format in Appendix A. Of the 16 states; 12.5% or 2 were classified as technical hedging (Italy & Romania), 68.75% or 11 were classified as insurance hedging (Argentina, Australia, Brazil, France, Iran, Japan, Libya, Norway, South Korea, Taiwan, and West Germany), and 18.75% or 3 were classified as other (India, South Africa, Yugoslavia). Below is a synopsis of the rationale for each classification based on evidence compiled from the datasets Militarised Interstate Disputes (v4.3), Formal Alliances (v4.1), and Intergovernmental Organizations (v2.3). When applicable, disputes will have a value for Highest Level of Incident, and Hostility Level to provide context about the dispute. For example when looking at Country A's MID's, if listed was Country B(14,4), it is interpreted as Country A's highest level of incident was a value of 14 and hostility level was a value of 4 towards country B. Referencing Appendix B, this means that Country A highest level of incident was occupation of territory, and hostility level was use of force. The meaning of these values, as they are directly tied to actions within the escalation of MID's, can be found in Appendix B.

4.1 Country Analysis

Argentina

During the observed time period of 1968 to 1976, there were several militarized interstate disputes involving Argentina noted in the Militarised Interstate Disputes (v4.3) dataset. Examples of acute security threats noted in the data were: Chile in 1967-68 (16,4), Uruguay 1969 (14,4), and the United Kingdom in 1976 (16,4). These conflicts indicate the presence of acute security threats

against Argentina, thus ruling out technical hedging as the assigned hedging strategy. Next, Argentina's formal alliances and membership to international organizations were investigated to determine whether an insurance strategy would be the final outcome. Upon review of the Formal Alliances (v4.1), and Intergovernmental Organizations (v2.3) datasets, it was noted that Argentina is a part of the Inter-American Treaty of Reciprocal Assistance, the "Rio Treaty". Signed in 1947, the treaty is a defence agreement amongst the majority of the Latin American states, stating that an attack against one nation is to be considered an attack against them all; and is notably endorsed by the United States. This agreement means Argentina did have a formal security guarantee mitigating this threat. Thus, with the presence of multiple acute security threats, and the presence of a formal security agreement to mitigate them, Argentina is classified as an insurance hedger in terms of acquisition strategy.

Australia

During the observed time period of 1956-1973, Australia was involved in several instances of not only militarized interstate disputes (MID's), but also an 8 year involvement in the Vietnam War (1964-72). Some of its other militarized interstate disputes are between China and Laos in 1962, and Malaysia 1963-65. From the evidence provided, it is evident that Australia was facing several significant security threats during the period of interest, especially from a nuclear armed China as its primary adversary. Next the presence of security guarantees to alleviate these threats was determined. The Formal Alliances (v4.1) data set corroborated Australia's well established formal alliances with two global superpowers; the United Kingdom and the United States. This means that Australia was under acute security threats while involved in the Vietnam War and other MID's and had the security of a formal alliance with both the UK and US. Thus, Australia nuclear acquisition efforts are classified as insurance hedging.

Brazil

The data set revealed that from the years of 1953 to 1976, Brazil faced several acute security threats from both neighbouring and distant states. Disputes were observed with neighbouring Guyana in 1975-76 (12,3), as well as with the Soviet Union in 1968 (15,4). Both conflicts indicate the presence of acute security threats. In terms of security guarantees mitigating these threats, Brazil had a formal security agreement during this period with the United States. Furthermore, Brazil was

also a part of the Inter-American Treaty of Reciprocal Assistance (Rio Treaty). Brazil has confirmed security threats from both neighbouring Guyana and the Soviet Union in the form of MID's, as well as confirmed security guarantees of the majority of the western hemisphere via the Rio Treaty. Thus, Brazil was classified as insurance hedging in terms of nuclear acquisition strategy.

France

The time period the French case study was observed for was 1945-1954. During this 9-year time span, France was involved in several significant militarized interstate disputes, as well as conflicts, that qualify as acute security threats. Their first MID occurred with the Soviets in 1948-49. The second and most notable security threat was their two year involvement in the Korean War from 1951-53. Both of these conflicts confirm the presence of an acute security threat for the French. France also had a MID with Thailand in this period, tied to France's colonial involvement in Indochina. During this period, France had a well established formal security alliance with the United Kingdom and the United States that was found in the data sets. Both France's alliances with the United Kingdom and the United States confirm the presence of a formal security guarantee to mitigate the security threats. Furthermore, France was also a founding member of NATO and active in the alliance during the time period observed. Thus France was classified as insurance hedging in terms of nuclear acquisition strategy employed over the time period observed.

India

During the time period of 1948-64, there were several recurring security threats against India from multiple states found in the Militarised Interstate Disputes (v4.3) data set. India faced two notable long running series of MID's, with its set of disputes with Pakistan spanning the first decade of the time frame. The data highlights Pakistani MID's present in 1947, 1951, 1955, 1956, 1958-59. India's second long standing set of MID's, with China, has documented disputes appearing during the later portion of the researched period; 1959-61, 1961-62, and in 1964. Lastly, India also had an interstate dispute with Portugal in 1954-55. These three sets of MID's provide sufficient evidence to the presence of Indian acute security threats: especially from a nuclear armed China. Upon analysis of both the Formal Alliances (v4.1), and Intergovernmental Organizations (v2.3) datasets, there was no recorded evidence that India having any formal security guarantees, nor any

membership to any intergovernmental organizations that could provide such guarantees during the time period observed. Thus, India was classified as other strategies in terms of assigned nuclear acquisition strategy.

Iran

During the four-year period that Iran was examined between 1974-78, the data set provided a confirmed instance of acute security threat. Between the years of 1974-75, Iran was involved in an interstate dispute with neighbouring Iraq, which escalated to the point of 17 and 4 in terms of highest action of incident and hostility level, respectively. This level of documented dispute provides sufficient evidence to confirm the presence of an acute security threat. In terms of having a formal security guarantee or alliance to mitigate this acute security threat, Iran did have a formal security guarantee during this period. Beginning in 1958 until the last year of the time period being observed (1978), Iran had a formal alliance with the United States, providing security guarantees from a nuclear umbrella sufficient enough to alleviate Iran's acute security threat. Thus, Iran was classified as an insurance hedger during the time period examined in this research.

Italy

Italy's involvement in any militarized interstate disputes was investigated during a four-year period, between the years of 1955-59. After reviewing the Militarised Interstate Disputes (v4.3) dataset for any MID's involving Italy, there were no cases found between these years (with sufficient intensity to be considered constituting an acute security threat). With the absence of a documented threat, the research concluded Italy was not facing an acute security threat at the time period examined in Narang's classification of hedging. Although it doesn't impact its classification as a technical hedger due to the absence of acute security threats, it is to be noted that Italy did have formal security guarantees with both the United Kingdom and France during the period in question. Therefore, Italy was classified as a technical hedger in terms of assigned hedging strategy.

Japan

Japanese militarized interstate disputes as well as alliances were reviewed in the Militarised Interstate Disputes (v4.3) and Formal Alliances (v4.1) data sets from 1954 to present day. Multiple

long running series of MID's were recorded, primarily with the Soviet Union. This is substantial because not only were these MID's sufficient to constitute an acute security threat, but the fact they occurred with a nuclear-armed superpower constitutes a threat in and of itself. In terms of alliances, it was expected that with such an extended duration of time being analyzed, there would be some sort of security guarantee. Indeed, the data displayed a longstanding formal security agreement between Japan and the United States. The presence of Soviet security threat, as well as the presence of American security agreements were the most notable examples of each variable. Thus Japan was classified as an insurance hedger in terms of observed hedging strategies.

Libya

Libya was analyzed over an 11-year time period from 1970-81, in which many notable conflicts and MID's were found within the data. Firstly, a notable involvement in an armed conflict between Uganda and Tanzania, with a peak of conflict reaching (20,5) in 1979. A few years prior in 1976-77, MID's with neighbouring Chad escalated to the point of (17,4), an MID of considerable intensity (both states would be in open conflict with each other from 1978-1987, with most of this conflict outside of the time period observed). Additional MID's in 1973 and 1978 with Israel and Italy were also found within the data. These four instances are sufficient evidence in confirming the presence of acute security threats to Libya at the time. When looking for Libyan formal alliances, a documented entente (a security relationship short of formalized security guarantees) with France is found. Furthermore, formalized security agreements were found with smaller, neighbouring actors at various times throughout the 1970's with Niger (1974-81), Tunisia (ended in 1974), and Algeria (1975-84). The dataset identifies the presence of multiple interstate disputes between both neighbouring and distant threats, as well as a number of formal security agreements with neighbouring countries, underpinned by French support in the form of an entente, providing mitigating factors to the acute security threats faced by Libya through this period. Thus, Libya was classified as an insurance hedger in terms of nuclear acquisition strategies.

Norway

Norway was examined in the Militarised Interstate Disputes (v4.3) and Formal Alliances (v4.1) data sets between the years of 1946-62 for the presence of militarized interstate disputes and formalized security guarantees. In 1956, a MID between Norway and the Soviet Union reached a

value of (15,4) at the height of its escalation. This documented dispute confirms the presence of an acute security threat during this time period, not only because it occurred with a neighbouring state, but that state is a nuclear-armed superpower. Next the Formal Alliances (v4.1) and Intergovernmental Organizations (v2.3) datasets were reviewed for formal alliances in the form of security agreements with other states during this time period, as well as membership in security-oriented intergovernmental organizations. There were formal security agreements found with both the United Kingdom and the United States, as well as Norway's membership in NATO. The datasets provided documented instances confirming the presence of both security threats and mitigating formal security guarantees from major global powers during this time period. Thus, Norway was classified as an insurance hedger in terms of classified nuclear acquisition strategy.

Romania

The time frame of observation for Romania is a 24-year period from 1965-1989. There were no records of any militarized interstate disputes of sufficient intensity to constitute an acute security threat involving Romania in the data set during this time period. This means that this research can not prove the presence of an acute security threat during this time. While Romania was a member of the Warsaw Pact during the years observed, the nation had no MID's of any intensity with a nuclear armed state, or NATO member state during the time period observed; and therefore membership of the Warsaw pact alone does not constitute an acute security threat from rival power blocs. Although it does not impact the outcome of the predicted strategy, it is worth noting that Romania did have a formal security agreement with the Soviet Union and the broader Warsaw Pact during this time. Thus, due to absence of an acute security threat, Romania was classified as a technical hedger in terms of observed nuclear acquisition strategy.

South Africa

South Africa was observed over a 5-year period between 1969-74 for militarized interstate disputes. The most notable dispute within this brief time frame was with neighbours Zambia and Zimbabwe in both 1973 and 1974. At the height of aggression, the MID with both states was valued (17,4), confirming the presence of an acute security threat against South Africa. Next, the attention was turned to investigating any formal alliance and security agreements that would mitigate acute security threats to the country. There was no recorded evidence present that South

Africa had any formal security guarantees, nor any membership to any intergovernmental organizations during this time period after reviewing both the Formal Alliances (v4.1), and Intergovernmental Organizations (v2.3) datasets. The evidence of these datasets suggests South Africa having an acute security threat with no formal security guarantee to mitigate that threat. Thus, South Africa was classified as inhabiting the 'other strategy' category, which represents hard hedging or all three weaponization strategies in terms of adopted hedging strategy.

South Korea

South Korea presented a long time period of observation, assessing the datasets for information from 1975 until present day. In terms of militarised interstate disputes, South Korea has a widely acknowledged acute security threat in its bordering neighbour, North Korea. The long-standing conflict was documented in the data, confirming the presence of an acute security threat. In terms of formal alliances, South Korea has also a well-established formal security agreement with the United States. Evidence of the presence of an American security guarantee was also found in the data sets. The data supports both the acute security threat from North Korea, as well as American support in terms of a longstanding formal security guarantee. Due to these factors, South Korea was classified as implementing an insurance hedging strategy.

Taiwan

Taiwan was observed over a seven-year time period between the years of 1967-74. During this time period, Taiwan experienced militarized interstate disputes, with its most notable dispute with China in 1967 (12,3). This data confirms the presence of an acute security threat and shifts the focus to the presence of formal alliances, security guarantees, or membership to security-oriented intergovernmental organisations. Upon reviewing the Formal Alliances (v4.1), and Intergovernmental Organizations (v2.3) datasets, there was evidence of Taiwan having confirmed formal security guarantees during this time period, with the most notable being with the United States. The data shows evidence of both an acute security threat from China, and formal security guarantees from the United States to alleviate these threats. Thus, Taiwan was classified as adopting an insurance hedging nuclear acquisition strategy during the time period observed.

West Germany

West Germany, also known as the Federal Republic of Germany, was observed over a thirteen-year period from 1956-1969. When reviewing the datasets, multiple instances of militarized interstate disputes were noted. There were noted security threats from East Germany in 1961 and 1962. Furthermore, there were disputes involving multiple parties such as Soviet Union and East Germany in 1961-62 that indicated the presence of acute security threats; given the Soviet Union's status as both a nuclear power and the leader of a super-power bloc. After confirming the presence of an acute security threat, West Germany's formal alliances and security guarantees were reviewed, and evidence supported the presence of a formal security guarantee. During this time period, the datasets identified established formal security agreements between West Germany and both the United Kingdom and the United States, as well as West Germany's membership in NATO. This means the data confirmed the presence of both Soviet and East German security threats, as well as alliances with the United States, United Kingdom and NATO. Due to these factors, West Germany was classified as adopting an insurance hedging strategy over the time periods observed.

Yugoslavia

The data reviewed showcased several instances confirming militarized interstate disputes. The first was a series of MID's with the Warsaw Pact; with several noted events between 1949-51 as well as 1952. Yugoslavia also had documented interstate disputes with Albania not only in 1949, but in 1952 as well. Lastly, a documented dispute occurred with Italy in 1954. These instances confirm the presence of an acute security threat against Yugoslavia, primarily emanating from the Warsaw Pact during this time period. In terms of formal alliances or membership to intergovernmental organizations, there were no documented instances in either of both datasets. This lack of evidence means this research cannot confirm the presence of formal alliance or security guarantee to mitigate Yugoslavia's acute security threats. Due to these factors, Yugoslavia was recorded as adopting an 'other strategies' (representing hard hedging and the three weaponization strategies) in terms of nuclear acquisition strategy.

4.2 Discussion of Results

Correlates of War Country Code	Country	Year	Variable 1: Militarized Interstate Disputes: Absent, Present	Variable 2: Formal Allaiances/ Defence Pact: Absent, Present	Predicted Hedging Strategy: techinical, insurance, other	Conforms to Narang's Results: yes, no	Case Notes on Disputes: (Highest Action of Incident, Hostility Level) Correlates of War Codebook	Cases Notes on Formal Alliances
160	Argentina	1968-76	Present	Present	insurance	no: technical	Disputes: Chile 1967-68 (16,4), Uruguay 1969 (14,4)UK 1976(16,4)	South American Powers (Inter-American Treaty of Reciprocal Assistance, Rio Treaty)
900	Australia	1956-73	Present	Present	insurance	yes:insurance	Disputes: China/Laos 1962, Vietnam War 1964-72, Malaysia 1963-65	Formal with UK and US.
140	Brazil	1953-76	Present	Present	insurance	no:technical	Dispute: France 1963, Guyana 1975-76 (12,3), Soviet Union 1968 (15,4)	Formal with US and South American Powers (Inter-American Treaty of Reciprocal Assistance, Rio Treaty)
220	France	1945-54	Present	Present	insurance	yes:insurance	Dispute: Soivet Union 1948-49, Korean War 1951-53,	Formal with UK and US.
750	India	1948-64	Present	Absent	other	no:technical	Dispute: China 1959-61, 61-62, 64-66, Portugal 1954-55, and 1961, Pakistan 1947, 51, 55, 56, 58-59	
630	Iran	1974-78	Present	Present	insurance	no:technical	Dispute: Iraq 1974-75 (17,4)	Formal with US 1958-78
325	Italy	1955-59	Absent	Present	technical	no:insurance		Formal with UK and France
740	Japan	1954-Present	Present	Present	insurance	yes:insurance	Disputes: Soviet Union 1982, 84 (7,3)	Formal with US
620	Libya	1970-81	Present	Present	insurance	no:technical	Disputes: Uganda/Tanzania 1978 (16,4), 79 (20,5), Israel 1973, Chad 1976-77 (17,4), Italy 1978 (15,4)	Formal with France , Niger (1974-81), Tunisia ended in 74, Algeria (75-84)
385	Norway	1946-62	Present	Present	insurance	no:technical	Disputes: Soviet 1956 (15,4)	Formal with UK and US.
360	Romania	1965-89	Absent	Present	technical	no:insurance		Formal with Russia
560	South Africa	1969-74	Present	Absent	other	no:technical	Disputes: Zambia/Zimbawbe 1973,74 (17,4)	
732	South Korea	1975-Present	Present	Present	insurance	yes:insurance	Disputes: North Korea	Formal with US
713	Taiwan	1967-74	Present	Present	insurance	yes:insurance	Dispute: China 1967 (12,3)	Formal with US
260	/est German	1956-69	Present	Present	insurance	yes:insurance	Disputes: East Germany 1961-62, Multiple parties (Soviet,USA, East Germany) 1961-62	Formal with UK and US
345	Yugoslavia	1948-60	Present	Absent	other	no:insurance	Dispute: Warsaw Pact 1949-51,52, Albania 1949,52, Italy 1954	

This chart contains the research compiled after using alternative indicators in NAT against the same 16 cases Narang used. Above includes the cases and years of interest, MID, formal alliances, and intergovernmental memberships documented in the Correlates of War dataset, as well as the predicted hedging strategy and case notes. Furthermore, there is direct comparison in the columns between this research's predicted hedging strategy based off the substituted indicators as well as if the case's predicted strategy differed from Narang's results.

Topic 1- Conforming Insurance Predictions

The findings of this research supported Narang's results on a number of cases classified as insurance hedgers. These cases had clear and frequent MID's with neighbours and/or nuclear armed adversaries that posed an existential threat to the pursuers security. Australia, France,

Japan, South Korea, Taiwan, and West Germany were all re-affirmed as clear insurance hedgers, experiencing conflicts or MID's over the time periods examined. South Korea, Taiwan and West Germany all experienced frequent militarized interstate disputes with their immediate neighbours, some of whom were nuclear-armed, and all who could be considered existential security threats to the cases examined. An interesting theme amongst these cases is that they are all nations born out of the post-war partition of a state. Due to the turbulent origins of these states, it is no surprise they 1) experienced considerable MID's, as their existence is a result of major conflict, 2) had clear alliances with major powers (for all three cases the United States), as they represent geopolitical fault lines between major-power blocs and in the cases of South Korea and West Germany are direct results of major-power postwar negotiation and intervention; 3) face clear existential threats from states that would consider themselves as having a de jure claim to each of these cases territory (China for Taiwan, North Korea for South Korea and East Germany for West Germany). These factors create a situation where the hedgers cannot solely rely on their diplomatic alliances, and need an 'insurance' stance to feel most secure with the security situations they inhabit.

Australia, France and Japan inhabit a much less threatened position than the aforementioned three cases. The primary threats to these nations come in the form of their primary adversaries being nuclear-armed states themselves. Australia's involvement in the Korean and Vietnam conflicts shows they are an active player within the American power-bloc, with Chinese efforts and eventual success (within the time period examined for the Australian case) toward nuclear proliferation posing an existential threat to Australian interests in the region. These findings are supported by Narang's coding notes, which highlight the ambiguity of the nation's classification resting on how one determines the threat posed by China. MID's between Australia and China are present in the two aforementioned conflicts both parties took part in; furthermore, China's status as a nuclear power reinforces this classification of insurance hedging as both MID's and a nuclear armed adversary are present in the Australian case. France is classified as insurance hedging for very similar reasons, being a clearly active member of the American-led power bloc through its involvement in the Korean conflict, as well as its later involvement in south-east Asian conflicts between the power-blocs. Furthermore, France had MID's with the Soviet Union in the late 40's. Due to these factors, it can be ascertained that France faces an acute security threat in

the form of the Soviet Union (as MID's show a clear clash of interests between the states) as well as nuclear-armed China through France's colonial possessions in Asia that become targets of MID's between the power-blocs; especially in the First Indochina War (a precursor conflict to the Vietnam War that directly led to America's involvement in the theatre).

Japan is a unique case, with MID results supporting its classification as an insurance hedger. While Japan was not militarily involved in the great-power bloc conflicts central to the region at the time, the nation did have unresolved territorial disputes with the Soviet Union in the wake of the Second World War. These disputes would be escalated into MID's between Japan and the USSR multiple times over the Cold War period. This supports Japan having a clear acute security threat, as the nation it was in dispute was 1) a neighbour, 2) a super-power and 3) nuclear armed. These three factors highlight a clear need for defensive nuclear capabilities; which are satiated by the country's relationship with the United States - falling firmly within the bloc's nuclear umbrella as well as hosting substantial US military assets.

Topic 2- Discrepancies between Narang's Technical Cases and My Insurance Cases

Another key theme was the stark difference in the number of cases Narang classified as technical hedgers that were classified as insurance hedgers in the results of this research. To reiterate, NAT only predicts a state will adopt a technical hedging strategy in the absence of an acute security threat, in fact this factor is the initial variable in the framework. Thus, by Narang's classification, those cases classified as technical should have no incidence of MID's indicating acute security threats in the data. Argentina, Brazil, Iran, Libya, and Norway were all classified as insurance within our research due to all of these cases in the presence of both acute security threats and formal security guarantees during their time of nuclear pursuit. Thus it seems this discrepancy between my research and Narang's classifications are his addition of personal interpretation to the empirical findings on acute security threats faced by the states. It is important to note that Narang did not entirely omit each of these security threats, with several mentioned within his coding notes. However, based on the provided framework of NAT and the predetermined constitutes of acute security threats, this research determines these cases to be classified as insurance hedgers.

Brazil and Argentina both fail to be classified as insurance hedgers under Narang's indicators, with both nations classified as technical hedgers. Results from this research came to a different finding, classifying both as insurance hedgers. This was motivated by both nations experiencing acute security threats in the forms of MID's with neighbours, and in Brazil's case an MID with the nuclear-armed Soviet Union. Furthermore, both states have clear major power security commitments from the United States in the form of the Rio Treaty; which would imply if there is present enough of a threat to later classify them as hard hedgers then they should both be insurance hedgers as they Rio treaty offers the same level of protection to both powers. The particularly notable issue here is that Narang's coding notes say that the theory does not fully explain either nation's moves away from technical hedging, while this research findings state the opposite; that both nations should have been classified as insurance hedgers and not as either technical or hard hedgers due to the presence of security guarantees relevant to both nations.

The Iranian case presents interesting findings, as the country neither conformed to NAT's predicted expectations of hard hedging, nor Narang's findings of technical hedging. This research classifies Iran as an insurance hedger. The reasoning for this classification is because the country experienced MID's with neighbouring Iraq, to an extent intense enough for NAT's own indicators to debate coding it hard hedging, which clearly rules out technical hedging (using this research's set of indicators). However, data tracking formal alliances showed that Iran did have a mutual defense agreement with the United States active for the years examined (1974-78); with this alliance only dissolving after the 1979-80 Iranian revolution (outside of time period ascribed technical hedging). Due to these factors, this research classifies Iran as an insurance hedger; which conforms to neither of the predictions presented in NAT and highlights the disconnect between classifications based on technical capabilities and strategic concerns of any given case.

Libya is another interesting case, as Narng's own coding notes cast considerable uncertainty over the classification as a technical hedger. Results of this research shows that the case should be codified either as insurance hedger or hard hedging. Libya experienced multiple MID's, between themselves, regional powers such as Israel and neighbours specifically Egypt, Sudan and Chad, all nations capable of posing an acute security threat to the country; ensuring

that technical hedging is not correct because of the presence of multiple acute security threats. Of the years classified as technical hedging (1970-81), Libya experienced MID's or conflicts in 72, 73, and 76-79, six of the eleven years examined; which hardly exhibits a peaceful nation without security threats. Furthermore, coding as a harder hedger is debatable, because while Libya did not have a formal alliance with a super-power or nuclear armed state, Libya does have mutual defense agreements with some of its neighbours (Algeria, Tunisia, and Niger) that could mitigate the threats posed to it from its adversarial neighbours; especially in the event of Libya being involved in a defensive conflict where it could create a coalition of nations. It is for these reasons that Libya's coding as an insurance hedger is accurate, or at the very least casts considerable doubt upon its classification as a technical hedger by Narang's indicators.

While the nation's investment in nuclear technologies are clearly peaceful, with this fact earning Norway its technical hedger classification under Narang's indicators, those same indicators label Norway as incorrectly predicted as an insurance hedger due to the threat posed by the Soviet Union. Norway even experienced an MID with the Soviet Union in 1956, and was involved in another MID in 1960. Due to the threat posed by the Soviet Union, Norway clearly has an acute security threat facing its security situation; but also has mitigating alliances with western powers as the country is a founding member of NATO. This example clearly shows the gaps that using indicators focusing on technical progress and not strategic realities can bring; as Norway's strategic situation matches that of an insurance hedger very strongly but lacks the technical progress to classify it as such. The case also raises another potential shortfall of classifying cases by technical prowess, in that a state with an acute security threat but an exceptionally strong alliance, as seen in Norway's situation being a founding member of a geo-strategic alliance central to the cold war, can deter investment into military applications of nuclear technologies as it is extremely unlikely the nation would ever be abandoned by their ally, or has multiple nuclear armed allies to rely upon (such as the UK or France, if US support was ever insufficient). If nations in these situations are classified by their (lack of) technical investment, it does not accurately reflect the security situation that country faces or their own perceptions of acute security threats facing them.

Topic 3- Romania and Italy reclassified Insurance to Technical

A notable finding observed in the research is the discrepancy between the classification of technical and insurance hedgers - specifically cases Narang defined as insurance hedgers that this research would classify as technical hedgers. The discrepancy stems primarily from Narang's conceptualization and definition of an acute security threat; giving large credence to a pursuer's primary rival being nuclear armed while not tying this to the realities of that state's security priorities. The cases of Romania (late 1960's-89) and Italy (1955-59) exemplify this phenomenon. Both cases were Narang classified as insurance hedgers, primarily because their 'primary adversary' was nuclear armed, the USSR in Italy's case, and the United States for Romania. However, after examining the datasets, neither Romania nor Italy experienced any MID's over the time periods examined with either their primary adversaries or any neighbouring state. An apparent lack of acute security threat for both Italy and Romania would result in a state to be classified as technical hedging. Narang's own coding notes elaborate on his classification, stating that these classifications were made because of their technical progress, not their acute security situations.

This directly casts doubt upon these classifications, as it raises the question of why a nation experiencing no demonstrable conflict would bring risks to its security situation to acquire technology designed to alleviate pressure exerted by threatening adversaries - when no adversaries existed. Neither nation posed an exponential threat to their primary adversary (superpowers such as the USSR or US) and were not experiencing localized conflict, so outside of abstract threats posed by a superpower rival to their associated power bloc - no threat, at least one that constituted an acute security threat existed. This statement is supported by two facts: 1) no MID's existed between these states and powers in the rival super-power bloc, supporting the absence of an acute security threat and 2) both powers are relatively minor players within their super-power blocs and as such would not be the focus of a nuclear-escalatory issue if one were to arise. Simply put, it is hard to envision a situation where superpowers immediately escalate to nuclear retaliation where no other deployments of conventional force were present; which would be present in data tracking MID's. Due to the lack of clear conflict, this research argues both Romania and Italy should be reclassified as technical hedgers - as most of their activity revolved around improving technical

capabilities, and there is no clear acute security threat facing these nations, outside of general tensions in the cold war era, that would drive these nations to such a concern of their existential security as to pursue nuclear weapons.

Topic 4- Yugoslavia & India should be other/ more committed strategies as they lack clear security guarantees

The findings of this research found that some theories classified as Technical or Insurance hedgers belonged to neither category, and those pursuers should be classified as hard hedging or as a weaponization strategy. India and Yugoslavia are the two cases that do not conform to either of the examined hedging strategies. Both nations experienced considerable amounts of MID's between both their neighbours and rival nuclear-armed states. India in particular had near constant MID's between themselves and Pakistan or China. Pakistan's coding raises an interesting point, as it is labeled as a hard hedger during the same dates as India's efforts are classified as technical hedging. It is hard to see a situation where India is not facing any acute security threat, but it's two most powerful neighbours experience frequent conflicting interests (represented as MID's) with them; to the degree where Pakistan clearly classifies these disputes as an acute security threat. The period of India's technical coding is also the same period China is pursuing a bomb via sprinting or sheltered pursuit, and raises the question of how a nuclear pursuer, who was already experiencing MID's against India and in the process of building a nuclear weapon, is not considered an acute security threat.

The Yugoslavian case is much more straightforward, with the Narang's indicators for NAT incorrectly predicting the case as insurance hedging. Narang's coding notes also show that the case was initially coded as hard hedging, but changed to insurance after uncertainty. The results of this research support those initial findings, classifying Yugoslavia as a strategy more committed than technical or insurance hedging. This divergence is most likely owed to the indicators used, where Narang's set tracks technical progress and scales back Yugoslavia's strategy because of technical assistance received from either superpower; this research's indicators focus on the broader strategic situation the case encompasses and concludes that it should be at least hard hedging due to the presence of acute security threat but lack of security guarantees from a power capable of mitigating those threats. Furthermore, while Narang's

coding notes suggest that they were classified as insurance hedgers because of receiving economic and military support from both the US and USSR; none of this assistance can be classified as a security guarantee mitigating threats posed by either super-power bloc.

Topic 5 : Narang's mostly correct about South Africa

South Africa is an interesting outlier in the results of this research. While results from this research would classify South Africa as an 'other strategy' (either hard hedging or a weaponization strategy), this is primarily based on the date Narang chose as the end of the country's 'technical hedging' period. Narang classified South Africa's technical hedging period as 1969-74, with the only MID's present for the country being in 1973-74. Due to this cutoff, technically South Africa is classified 'other' (at least for the years concerned); however doubt over when to place the transitional date in Narang's coding notes support the assertion of South Africa having a technical hedging period. If Narang adjusted his dates for this period to 1969-72, the results of this research would support his conclusions. The results partially support Narang's initial coding of South Africa as a technical hedger despite this research results providing ambiguity to the specifics of that claim. The minor nature of the difference, as the 1974 date does not seem to be a hard cutoff but a rough approximation (as referred to in Narang's coding notes) was the primary factor in deciding South Africa's results as supporting Narang's initial classification. These differences illuminate the transitional nature of hedging strategies, especially in terms of the fluid transition between strategies. Furthermore, the variance between each case attests Narang's assertion that it "in practice, distinguishing among these three types of hedgers may not be straightforward".[32] The case study design was imperative to the validity of the research as well as Narang's data because the justification provided in the coding notes helps decipher the rationale between non-conforming placements.

5. Conclusion

5.1 Answer to Research Question.

[32] Strategies of Nuclear Proliferation: How States Pursue the Bomb, Vipin Narang, International Security 2017 41:3, 119

Based on his nuclear acquisition theory, Narang's classification of technical and insurance hedging in 16 cases can be somewhat refuted by the use of alternate indicators and data sources. Of the examined cases, this research found two cases (Italy and Romania) conformed to NAT's classification of a technical hedging strategy. Of the examined cases, eleven (Argentina, Australia, Brazil, France, Iran, Japan, Libya, Norway, South Korea, Taiwan, and West Germany) conform to NAT's classification of an insurance-hedging strategy. Of the examined cases Narang classified as technical or insurance hedging, three (India, South Africa, and Yugoslavia) conform to other strategies.

5.2 Summary of Results

As detailed in previous in 4.2 Themes, the observed polarity in classifications stems largely from Narang's qualitative interpretation of indicators in contrast to this research's using solely metrics as a determinant of an acute security threat. When analyzing the consistencies between our classifications, roughly 43% or 6/14 cases conformed to Narang's classifications (Australia, France, Japan, South Korea, Taiwan, and West Germany). Notably, all of the agreeable cases were classified insurance hedgers, actors in notable high-profile conflicts, as well as had formal alliances with the United States. With these similarities it is not surprising to see congruence between our classifications of cases as insurance hedgers. The true variance of our indicators was illuminated in our contrasting classifications of technical hedging. Expanded upon in Theme 1, this notable discrepancy between this research's classifications and Narang's classifications of technical hedging are his addition of personal interpretation to the empirical findings on acute security threats faced by the states. As previously stated, Narang did not entirely omit each of these security threats, with many of the indicator events that resulted in different classification of strategies referenced in his coding notes. However, based on the provided framework of NAT and the operationalization measurements set out by this research to determine acute security threats, the context of these security threats constitute classification as insurance hedgers.

5.3 Research Limitations

The use of NAT and Narang's variables, in conjunction with analysis of all 16 cases classified as technical and insurance hedging was necessary to allow for relevant comparison of both sets of indicators. The apparent contrast of data from using alternative indicators suggests that if any further comparative research were to be done, the designs must hold as true as possible and justifiably represent Narang's variables to ensure the same phenomenon is being captured in the research. In terms of my chosen indicators, I feel their strengths lay both in their ability to be easily presented empirically, as well as the fact the data was derived from an accessible, comprehensive, and reputable dataset. My most notable recommendation is that of prudential selection of the indicators as they contain the vast amount of the legitimacy for any referenceable work. The largest challenge to replicating Narang's indicators was the lack of accessible data capturing the technical realities of a nuclear program, especially in a centralized dataset. The transparency and empirical evidence pertinent to a state's nuclear capabilities and desires is rarely substantial nor available in real time. However, Narang's research design is forgiving in that the variables are flexible enough to allow for a wide variety of different data sources to be applicable in design of indicators. For instance, five cases (Egypt, Iraq, Pakistan, Sweden and Switzerland) classified by Narang and NAT as hard hedgers, that when examined under this set of indicators could present different results. While Narang's indicators focus on the technical progress of these cases' nuclear programs, it overlooks strategic factors that could heavily influence the results. Cases such as Switzerland could very likely be a technical hedger given a cursory glance at their strategic situation. The ease of application of new indicators allows opportunities for future research to be uncovered.

5.4 Future Research

The primary motivation for future research would be to capture the cases defined as hedging that were not evaluated in this research, and to see if a different set of indicators would influence a different set of results. This research would not seek to confirm if they were correctly classified as hard hedgers, as much as it would seek to confirm that these cases are not technical or insurance hedgers, supporting their classification as a hard hedger, or a weaponization strategy. Future use of other correlates of war datasets, primarily pertaining to national material

capabilities to track vulnerability to military or economic sanctions, in conjunction with analysis of media documents to track domestic consensus towards nuclear weapons, could be used as indicators to encompass hard hedgers and choice of weaponization strategies for future cases; however, the specifics of how this would be implemented are outside of the purview of this research. Ultimately new indicators that focus on the strategic decisions important to hard hedging and weaponization strategies can be used in conjunction with the indicators presented in the research to attempt theory testing of all cases presented by Narang; departing entirely from focus on technical progress tied to proliferation strategy selection. Further in-depth qualitative analysis of the cases that fail to conform to either (or both) Narang's or this research's results could help shed light onto the unique factors that these studies fail to capture or predict. Research could also focus on the differences and similarities between the sequence of strategies employed nations that successfully acquired a nuclear weapon, those that abandoned their programs, and those states that still maintain a hedging strategy. Specifically, focus on states that abandoned their nuclear weapons programs are particularly interesting, as factors that could be identified from these cases specifically could have considerable societal relevance in discussion on non-proliferation and nuclear acquisition.

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Appendices

Appendix A

A descriptive list for the values assigned to the indicators in the Correlates of War 'Militarised Interstate Disputes' (v4.3). The list details the meaning of the values assigned to the categories highest action in dispute and hostility level.

HiAct	Highest action in dispute [bracketed numbers refer to corresponding hostility level]: 0 No militarized action [1] 1 Threat to use force [2] 2 Threat to blockade [2] 3 Threat to occupy territory [2] 4 Threat to declare war [2] 5 Threat to use CBR weapons [2] 6 Threat to join war 7 Show of force [3] 8 Alert [3] 9 Nuclear alert [3] 10 Mobilization [3] 11 Fortify border [3] 12 Border violation [3] 13 Blockade [4] 14 Occupation of territory [4] 15 Seizure [4] 16 Attack [4] 17 Clash [4] 18 Declaration of war [4] 19 Use of CBR weapons [4] 20 Begin interstate war [5] 21 Join interstate war [5] -9 Missing [-9]
HostLev	Hostility level of dispute 1 No militarized action 2 Threat to use force 3 Display of force 4 Use of force 5 War