Explaining Nuclear Force Levels: A Literature Review

Political Science Junior Qual
Brian Brooks
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Contents

Introduction…………………………………………………………………………..3

Explanations……………………………………………………………………….7

Conclusions………………………………………………………………...….25

Research Design……………………………………………………………...…..27

References…………………………………………………………………..………31

I. Introduction

A. Why arsenal size matters

As one of the most revolutionary military technologies ever created and one of the most enduring symbols of the Cold War, nuclear weapons have received considerable attention in the literature of political science. Nuclear weapons affect state behavior in a variety of ways, with domestic and international consequences. Nuclear behavior is then a product of domestic and international factors, and these outputs feed back into the system; understanding the nuclear policy of a state thus has important implications, both in theory and practice. A detailed understanding of state nuclear behavior can provide evidence to support or challenge theories of international relations, such as rationality of actors and policy outcomes, the role of security in determining behavior, and the relative weight of domestic and international factors.

Nuclear policy, of course, is an extremely broad category. This literature review will focus on one specific area: force level and structure. "Force level" is essentially how many nuclear warheads are in the arsenal, while "force structure" is the type and ratio of nuclear delivery systems such as artillery, aircraft, and land and sea-based missiles. Force level and structure can be understood as quantitative and qualitative, respectively. While force level is the basic focus of this literature review, force structure has unavoidable consequences for arsenal size, and must be included in any thorough analysis. The following discussion will use "force level" and "arsenal size" interchangeably, and force structure should be understood as a corollary factor when these terms are used.

Good work has been done on the important question of why states "go nuclear" in the first place (for example Epstein 1977, Sagan 1996-97), but explaining force levels is an effort to take that work to the next logical step. Once a state has decided to produce nuclear weapons, how large (or small) should the arsenal be, and how should it (or should it not) be deployed?

As with nuclear policy in general, arsenal size specifically has important implications for theory and policy. Arguments about nuclear arsenal size are (thankfully) theory-based, reflecting different understandings of the domestic and international environment, and how nuclear weapons interact with them. Policy implications are not regarded to be as pressing as they were during the Cold War, but the 2002 Treaty on Strategic Offensive Reductions (SORT, or the "Moscow Treaty") between the US and Russia demonstrates the continued relevance of nuclear arsenal size. Discussion continues in Britain regarding reductions of their nuclear force, and it appears obvious that negotiating tactics with North Korea would necessarily be different if that nation possessed warheads number in the hundreds, rather than a small number of potentially assembled devices. The "nuclear freeze" movement in the United States demonstrated the role of domestic politics, while the arms race has obvious international effects. Finally, arsenal size is relevant for economic reasons. The US is estimated to have spent $56 billion dollars on nuclear weapons and associated systems in 1990, which was reduced to $34 billion in 1997 as a consequence of force reductions (Schwartz 1997), and cleanup costs for nuclear weapons production has been estimated at $5 million per warhead (Perkovich 1991-1992, 87).

B. Status of Literature

Despite the relevance of force levels, the literature is rather limited. As Desmond Ball explains,

> Strategic debate has tended to focus almost entirely on general arguments about alternative concepts and doctrines, such as Minimum Deterrence, Massive Retaliation, Counterforce, Assured Destruction, Damage Limitation, Flexible Response, and Controlled Escalation; and on arguments about weapons acquisition, such as types, characteristics, basing modes, and numbers of intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and long-range strategic bombers which should be procured. (Ball 1986, 7)

Here, Ball is seeking to address the lack of literature on strategic nuclear targeting, but the argument applies equally to force levels. While he does mention numbers, the debate he refers to is concerned with the US arsenal in the context of the Cold War, rather than general theoretical explanations of arsenal size. "Studies usually assume, whether consciously or not, super-arsenal dynamics for both parties in a dyad. The Cold War has left an enormous legacy of literature that focuses on the US, the Soviet Union, and their respective nuclear-force structures" (James 2000, 727). Not all nuclear states behave as Cold War superpowers, and the diverse arsenals of other nuclear states demonstrates the need for a more complex and broadly applicable understanding.

Because theories of force levels has not been an explicit focus in nuclear literature, this review necessarily draws from the broader literature of general doctrine and case studies, attempting to extrapolate explanations of arsenal size. General doctrine helps provide directionality in arsenal size, while case studies can provide important detail at the state level, which may then be applied more broadly in a theoretical model. One of the best sources explicitly focusing on arsenal size is actually a case study attempting to explain the US nuclear buildup under Presidents Kennedy and Johnson

(Ball 1980). With the end of the Cold War, there is more discussion in the literature on arsenal size, but once again, it focuses largely on what the US should do, rather than offering generally applicable arguments (Perkovich 1992, Glaser 1992, Glaser and Fetter 2005, Woolf 2006a, Welsh 2003). Other nuclear states, particularly China and India, are important subjects of the post-Cold War literature, but these too are primarily case studies (Perkovich 1999, Gupta 2001, Johnston 1995, Basrur 2001, Garrett and Glaser 1995-96, Ollapally 2001, Srivastava 2000).

One interesting area of literature that does consider force level has been the attempt by scholars and analysts to measure the nuclear balance in some meaningful way. Such analyses give us measures of static, retaliatory, and multiple exchange nuclear forces, using indices of megatonnage, equivalent megatonnage, warheads, delivery vehicles, throw weight, and soft-area and hard-point kill capability (Richelson 1982). Such calculations are predictably arcane: even perfectly symmetrical force levels and structures may have asymmetrical effects due to variation in geography and relative concentration of military, political, population, and economic targets (Hoeber 1978-79, 56). Because "disputes over public policy often turn quickly into disputes over measurement strategies" (Richelson 1980, 779), these competing measures are highly relevant to arsenal size, thought "their results are more theoretical than real" (Tsipis 1983, 131). Though such measures start from the disputed assumption that these differences are militarily and politically meaningful, they provide an important area of discussion. Thomas Brown provides a useful summary of the three basic points of view regarding nuclear arsenals:

> The first point of view holds that, once you have passed a certain level, the strategic balance becomes meaningless; the second holds that the strategic balance is primarily a mater of perceptions; the third maintains that the strategic balance is essentially a question of probable outcomes of strategic conflict (Brown 1980, 19).

These three views give a useful reference point to ground even the most complex theories, making their ultimate impact on nuclear force level more readily apparent.

II. Explanations

There are four basic categories of explanation for arsenal size: practical, military, organizational, and political. Practical factors include technical considerations, such as the design of warheads and availability of fissile material for bomb cores, and economic considerations. Military factors include doctrinal objectives, such as counterforce versus countervalue, and the requirements of nuclear capability; lethality, survivability, penetrativity, and connectivity (Perry 1984, 87-88). Organizational factors include bureaucratic politics, budget maximization, and the military-industrial complex. Finally, political factors include the obvious domestic and international arenas, as well as the role of perception. An effort has been made to separate these four factors, but interaction effects are very important. Some overlap is inevitable: military choices can justify political arguments, technical limitations can influence doctrine, or any other possible combination. Two (or more) factors may compete, but they can just as easily be complementary and mutually reinforcing, complicating any simple explanation.

A. Practical Explanations

i. Technical

Technical factors are important for their effects on both weapons production and nuclear doctrine. Once a country is in possession of a workable warhead design,

inexperience may keep the initial rate of production slow. Less advanced designs may provide incentives to delay any large-scale production and arsenal expansion. Development of light and compact warheads is necessary for multiple independently targeted reentry vehicles (MIRVs), a technology that helps increase warhead stockpiles (Greenwood 1975), but China's warheads are too large and heavy to fit more than one on an ICBM (Lewis 2005). Availability of fissile material is a key limiting factor, which sets a maximum limit on arsenal size at any given time. Enriching uranium is a complex process, and plutonium production requires nuclear reactors and further enrichment. In India, for example, "technological constraints" (primarily lack of fissile material) will be the key factor which will "slow down the growth of the nuclear force" (Gupta 2001, 1050). China, on the other hand, "has sufficient fissile material to expand its warhead stockpile two to three times its present size" (Johnston 1995), demonstrating this is not always a limiting factor, and the reasons for restraint can lie elsewhere.

Because it is not enough to simply possess warheads, delivery systems become a crucial and potentially limiting factor. As Robert Lieber has observed, "whereas the initial nuclear capability depends mainly on the development of an atomic bomb, the second generation presents far more formidable technical problems." His subject of France in 1966, for example, had to "develop a nuclear powered submarine, a solid-fuel Polaris-type missile, a complex guidance system, a hydrogen bomb, [and] a miniaturization of the bomb so that it can be used as a warhead" (1966, 425). Because nobody would wish to invest heavily in an already obsolete arsenal, development of delivery systems slows down large-scale weapons production in less technologically advanced states. Accuracy of these delivery systems provides a final technical factor, as

a consequence of the affect of accuracy on doctrine. Because counterforce doctrine strongly justifies arsenal expansion by using relative measures (discussed below), and "accuracy is of primary importance" (Tsipis 1983, 130) for effective counterforce, technical barriers to weapons accuracy can indirectly affect arsenal size. If a state cannot develop accurate missiles, they cannot have an effective counterforce doctrine, and will be more likely to refrain from deploying a large arsenal. Pakistan, for example, "lacks the scientific and economic resources to match the India development of a counterforce capability" (Gupta 2001, 1051), and all early ICBMs and SLBMs have lacked the accuracy for counterforce missions (Freedman 2003).

ii. Economic

As with any government program, economic factors play an important role in determining nuclear force level. As noted in the introduction, nuclear weapons and their associated systems are very expensive, representing a significant obstacle for countries like India and Pakistan, and even for wealthier countries such as France. "From 1963 to 1992, French nuclear forces consumed more than 30 percent of defense procurement budgets, and this figure did not include other costs associated with nuclear weapons" (Perkovich 1999, 316), which can be even higher than the weapons themselves. France cut conventional spending significantly to develop nuclear capabilities, and even so, budgetary pressures and a monetary crisis in 1968 caused ambitious French plans to be "postponed for several years, if not indefinitely" (Kohl 1968, 84).

Proposals in India for a force of 400 intermediate range ballistic missiles (IRBMs) could cost an estimated $40 billion, putting "severe constraints on the domestic economy" Gupta 2001, 1052), and proposals for a nuclear triad would be even more

costly. While India has invested significantly less than it is capable of (Perkovich 1999, 451, Basrur 2001, 190), "there seems to be general consensus that India cannot hope to match Chinese capability without disastrous economic and political results" (Ollapally 2001, 942). The wealth of the United States has not made it immune from such considerations either, and it would be "unrealistic to believe that economic considerations never affected defense decisions" (Ball 1980, 262). US behavior may appear less fiscally constrained than other nuclear powers, and "in the early Kennedy years, a political decision was made that much more could be spent on defense…but after a brief period of exuberance the old constraints reappeared" (Ball 1980, 262) resulting in a return to lower spending and less expansion.

While economic factors are typically assumed to act as limits, there can also be economic incentives to expand nuclear forces as well. In 1953 US Defense Secretary Charles Wilson declared that nuclear weapons offered "a bigger bang for the buck" (Powaski 1987, 62), while others have reported similar Chinese expansion of tactical nuclear weapons to substitute for an expensive conventional buildup (Wang 1984, 1045). For the British, "the low cost of the *Polaris* [SLBM] was an extremely influential factor" in its adoption, primarily a consequence of "the enormous American subsidy in making available information relating to the design of the submarines and warheads" (Freedman 1980, 32). The replacement of the three warhead *Polaris* with the 10-14 warhead *Poseidon* demonstrated another economic factor favoring expansion, because "a British commitment would lower the unit cost of the missile and so make it more attractive to the US administration" (Freedman 1980, 38).

B. Military Explanations

i. Doctrine and the US-Soviet Debate

Because security concerns are generally assumed to be the primary factor affecting nuclear weapons, military explanations have attracted by far the most debate in the literature. At the most basic level, military factors are reduced to debates over the requirements of credibility and relative versus absolute force levels. Issues of deterrence, war fighting, counterforce, countervalue, and credibility all interact extensively, but will be treated separately to the extent possible.

Comparisons of US and Soviet doctrine were particularly popular during the Cold War: US doctrine has been exceptionally well studied, which has provided an expansive literature. Those favoring expansion frequently made arguments along the lines of Albert Wohlstetter; "Russian casualties in WWII were more than 20,000,000. Yet Russia recovered extremely well from this catastrophe" (1989, 153). Others, such George Seignious and Jonathan Yates, questioned the relevance of this argument, claiming that "those 20 million casualties were inflicted over a period of 6 years, not 6 hours or 6 days; and the costs of a nuclear exchange would be incalculably higher" (1984, 48). It was frequently argued "the Soviets do not make the sharp distinction we do between strategic nuclear and other levels of nuclear and conventional war" (Hoeber 1978, 70). "The Soviets seemed to assume that even a central nuclear war to be 'winnable'" (Glynn 1984, 31), indicated a "lack of dedication…to concepts of assured destruction" (Scowcroft 1984, 81), and designed their arsenal to enable a "serious capability for waging global nuclear war" (Odom 1983, 126). Interpreted in this way, Soviet behavior was understandably seen as very threatening to the US.

The US position, on the other hand, was often described as purely defensive. The US was a "status quo nation" (Hoeber 1978, 70), with nuclear forces "tailed for retaliation and defense, not territorial offensive operations. Precisely the opposite is true of Soviet nuclear forces" (Odom 1983, 133). "Western deterrence theory differs fundamentally from [the Soviet] approach in that it tends to treat operational art and tactics as irrelevant in the event nuclear weapons are used, placing serious military attention only on the strategic level" (Odom 1983, 128), while "US defense planners have not thoroughly studied the problems of nuclear war nor thought through the meaning of strategy in relation to nuclear war" (Gray and Payne1989, 468).

Others note that the US often "seems to have had, at least in important steps, the initiative" (Hall 1983, 300): the first to use an atomic bomb, first to develop intercontinental bombers, the hydrogen bomb, SLBMs, MIRVs, neutron bombs, and cruise missiles. Far from not seriously planning for nuclear war, "the current requirement [for nuclear command capability] is measured in terms of weeks and even months" (Ball 1981, 2). Rather than an exclusively strategic, deterrent force, "the American suspicion of nuclear weapons embraced the 'theater' or 'tactical' as well as the 'strategic' variety. Thousands of short-range 'tactical nuclear weapons,' conceived of as providing a massive supplement to conventional firepower, had arrived in Europe" (Freedman 1980, 20). Robert Jervis seeks to point out that "many statements made by Soviet generals are similar to statements by American generals when the latter are not influenced by the ideas or constrained by the power of the civilian leadership" (1979-80, 630).

The point of this discussion is to demonstrate that nuclear doctrines and interpretations can vary widely, with significant consequences. State doctrine is

important, but the ways in which the doctrine of potential adversaries is understood is equally important. Despite these alleged differences however, the US and Soviet Union both deployed massive arsenals around the globe with diverse force structures.

ii. Deterrence and War Fighting

Meeting the requirement of deterrence is perhaps the most important requisite of a nuclear arsenal. Deterrence requires the ability "to inflict an arbitrarily-determined level of 'unacceptable damage'" on the adversary, in order to outweigh any possible gains they might hope to achieve. While the general definition may be accepted, what counts as "unacceptable damage" has been the subject of considerable debate. In the US "it was often argued in the 1960s that the Soviet Union would be deterred from a massive attack on US cities if surviving US forces could respond by destroying approximately one-third of the Soviet population and two-thirds of the Soviet industry" (Richelson 1980, 796). In 1978, Secretary of Defense Harold Brown defined unacceptable damage as the "destruction of a minimum of 200 major Soviet cities" (Ball 1986, 27). Kenneth Waltz has described such estimates as "absurdly high" (2003, 22), arguing, "a low probability of carrying a highly destructive attack home is sufficient for deterrence" (2003, 22). A small force can deter a larger one by taking advantage of uncertainty, so that the attacker cannot be sure they will escape punishment. Numerical estimates of required arsenal size obviously vary, but none come anywhere near US-Soviet levels.

As a democracy with a basic and rather undeveloped nuclear arsenal, literature on India often includes discussion of specific numbers. Vivek Monteiro estimates that, to deter the US, India would need "the capability to deliver thermonuclear warheads by the hundreds into the US hinterland" (1986, 58). Some Indian analysts have called for "a

nuclear force that comprises from 100 to over 400 warheads" (Gupta 2001, 1047) to deter China and Pakistan, while others consider less than 100 to be adequate (Basrur 2001, 192). A 1947 British force requirement estimate is too amusing not to mention. "Having been informed that the Home Defense Committee believed that twenty-five atom bombs would be needed to knock out Britain, the Research Policy Committee observed that the geographical area 'we have in mind' (the USSR was still not officially designated as a potential enemy) was forty times that of the United Kingdom. Thus 25 x 40 = 1,000" (Freedman 1986, 110).

While US doctrine has shifted, smaller nuclear powers have generally held fairly consistent doctrines based on some variation of "minimum deterrence." While this does not specify any set number of warheads, the fact that Britain, China, France, India, Pakistan, and Israel all posses less than 600 warheads each (NRDC 2007), suggesting some general level of agreement. China, for example, has declared a policy called "the minimum means of reprisal" (Lewis 2005). While China has engaged in limited force modernization, most literature considers the arsenal to be based on some variant of minimum deterrence, particularly when considering the need to deter both the United States and the Soviet Union (Wang 1984, Johnston 1995, Ollapally 2001, Waltz 2003). France has adopted what it calls "proportional deterrence" (Yost 1986, 127), which is essentially the same as generic minimum deterrence. Official statements by the British government have declared, "the Government has always been committed to maintaining only the minimum nuclear deterrent capability required for our security" (Larkin 1996, 76). Academic literature agrees with this assessment: Lawrence Freedman states "what is impressive about official statements on the role of the nuclear force, apart from their

rarity and brevity, is not the adaptation to the shifts in the international context but their unchanging character" (1980, 127). State acceptance of minimum deterrence thus means that "within wide limits one state can be insensitive to changes in another state's forces" (Waltz 2003, 30), reducing incentives to expand arsenals.

Second-strike capability, the ability to respond after absorbing a full nuclear attack, is universally accepted as a requirement for credible deterrence, though the precise robustness of this capability is debated. Second-strike capability can be enhanced in three basic and related ways: concealment, diverse forces, and numerous forces, the latter two providing incentives to expand arsenals. Concealment is accomplished by dispersing forces and/or keeping them mobile, reducing the possibility that they will be destroyed in a first strike. The method considered most effective is the use of nuclear-armed submarines, which can remain mobile and hidden until launch, and is embodied in the British and French reliance on submarines for survivable deterrent forces (Seignious and Yates 1984, Freedman 1986, Yost 1986). Waltz places considerable faith in the second-strike capability of even small forces (2003, 24-25), while Scott Sagan questions their survivability (2003, 69). States who lack Watlz's optimism are then likely to build larger forces for greater second-strike security. Building more weapons to provide more targets than an attacker can destroy is an obvious response, but one that is always combined with concealment and/or force structure diversity.

The most effective way of creating survivable second-strike forces is weapon diversity, deploying a "triad" of land, sea, and air-based forces. Each "leg" has particular advantages, as well as greatly complicating any attempt at a disarming first strike by an attacker (Woolf 2006b, Scowcroft 1989). Bombers can be launched quickly for high

survivability and carry multiple highly accurate weapons, as well as having the advantage of potentially being recalled before actually delivering a weapon. Submarines can stay hidden underwater for long periods of time, while carrying large numbers of warheads. Finally, ICBMs have advantages in command and control, accuracy, and quick retargeting and launch (Scowcroft 1989, 487). While such arguments have convinced many of the need for a triad, Britain and France have abandoned triads and China's is "more nominal and symbolic than real" (Perkovich 1999, 480), with one barely mobile submarine and obsolete air-delivery capability. The decision to develop a triad, however, creates incentives for arsenal growth because each leg must be independently survivable (Basrur 2001, 193, Ollapally 2001, 936).

Finally, deterrence is generally considered to be enhanced by developing explicit war fighting doctrines and preparing for conflict at all levels, from tactical to full strategic warfare. According to Michael Quinlan, "the fact is that the deterrent effect of weapons and plans is not something separate from and independent of their capability for actual use; deterrence operates precisely *through* capability for actual use" (1984, 57). The US followed this dictate in the "flexible response" doctrine under Kennedy, a program designed to offer alternatives to the "massive retaliation" response of the Eisenhower administration (Powaski 1986, 95). By threatening a response at all levels of aggression, rather than relying on the threat of large-scale city attacks for any act of aggression, flexible response sought to enhance the overall credibility of deterrence. Jervis and others question this conclusion, arguing that flexible response supporters "commit the fallacy of believing that escalation can be carefully manipulated" (1979-80, 621). Flexible response and similar war fighting doctrines thus require "a wide variety of

weapons in terms of yield and range is required to cover various military contingencies" (Buteux 1977, 802), justifying large arsenal expansions.

iii. Counterforce vs Countervalue

The alternative doctrines of counterforce and countervalue demonstrate the fundamental debate between relative and absolute numbers of warheads, perhaps the most important military factor in determining arsenal size. Countervalue consists of targeting cities and industrial centers, threatening the ultimate punishment to deter attack. Counterforce is primarily directed against enemy nuclear weapons and associated infrastructure—missile silos, airfields, and submarine ports—with conventional forces as secondary targets. Because cities are large, soft, immobile, and fixed in numbers, countervalue targeting does not require high weapon accuracy (Tsipis1983, 130), and can be accomplished with a relatively small arsenal (Glaser 1992, 74). Small arsenals cannot credibly threaten other arsenals numerically regardless of whether they are larger, equal or even the slightly smaller, because high-confidence attacks require multiple warheads for each target (Lee 1986). Small arsenals such as those of France (Lieber 1966), India (Basrur 2001), and Britain (Freedman 1980) become countervalue oriented by default.

Nuclear attacks against cities are powerful threats, but early on it was recognized that "an attack on cities leaves the enemy's nuclear power almost 100 per cent intact" (Wolfers 1953, 9), doing nothing to prevent retaliation. Many also find counterforce targeting morally repugnant, arguing that only military targets should be attacked. Finally, once nuclear exchange escalates to city attacks, there would be no higher threat and thus no bargaining leverage to end the conflict. As noted above, counterforce is in many ways a luxury of the superpowers, dependant on large and highly accurate arsenals,

while the logic of counterforce encourages further arsenal growth by targeting weapons against weapons, recreating the action-reaction cycle of conventional forces (Perkovich 1992, Glaser 1992, Glaser and Feter 2005, Jervis 1978).

When Secretary of Defense Robert McNamara announced the new "no cities" counterforce doctrine in 1962, it quickly drew criticism from all sides. Domestically, it was criticized for its first strike implications: the Soviets denied the possibility of controlled counterforce, and the British and French criticized it for weakening the credibility of their independent nuclear capabilities (Ball 186, 67). Aside from the arsenal expansion implications, Glaser and Feter warn against exaggerating the damage-limitation potential of counterforce (2005, 15). Additionally, Jervis cautions that counterforce may not be able to reduce damage significantly, and both sides are required to recognize and agree to a counterforce exchange (1978, 630). What US planners "might regard as distinct target sets…could well appear to be a general urban-industrial attack to those responsible for attack assessment in the USSR" (Ball 1983, 37).

iv. ABM

As a final military factor—one that is currently relatively minor—anti-ballistic missile (ABM) defenses can influence decisions, promoting arsenal expansion. Soviet ABM development in the 1960s was a cause of great concern, particularly between Britain and France, who feared their small arsenals would be neutralized by effective defenses (Kohl 1968, 87). Soviet ABM development was the "most important" (Greenwood 1975, 83) factor promoting MIRV development and deployment, which led to a significant expansion of the US arsenal size. Because the simplest way to defeat ABM systems is to saturate them with warheads, they create significantly increased force

requirements. The 1972 ABM treaty restricted US and Soviet ABM deployment, but US withdrawal in 2002 has upset this balance. The most widely anticipated response to limited US ABM system is an expansion of the Chinese arsenal (Johnston 1995, Garrett and Glaser 1995, Welsh 2003, Lewis 2005), but a Chinese expansion could have a domino effect, encouraging expansion of India's and Pakistan's arsenals in turn (Sagan 2003).

C. Organizational Explanations

i. Bureaucratic Inertia, Pressure, Competition, and Politics

While military concerns are important, more parochial concerns inevitably play a part. "Interservice rivalry" (Scowcroft 1984, 69) was an important factor "because each of the military services wanted to play a role in the US nuclear arsenal. However, during the 1960s and 1970s, analysts developed a more reasoned rational for the nuclear 'triad'" (Woolf 2006a, 20). The first strategic nuclear delivery vehicles were bombers, but even after the deployment of ballistic missiles, "the Air Force has resisted any effort to eliminate the strategic bomber force; even without such resistance it is very difficult to eliminate a whole segment of the armed forces once it is well established" (Tsipis 1983, 159). The US nuclear forces in the 1950s saw a serious lack of coordination (Rosenberg 1986) between commanders tasked with drawing up target lists, and "consequently, targets were frequently covered in two or more target annexes" (Ball 1986, 58), leading to significantly inflated demands for warheads. This issue was only partially addressed in the 1960s, as Henry Kissinger observed "disputes about targets are usually settled by addition–permitting each service to destroy what it considers essential to its mission" (Ball 1983, 4). The US Air Force and Navy both pursued aggressive budget

maximization goals, lobbying for large numbers of ICBMs and nuclear submarines. Formal Air Force requests in the early 1960s were "usually for about 1,000 more [missiles] than the Defense Department was willing to authorize" (Ball 1980, 244), and it was only when the Air Force realized "that its case for more Minutemen was hopeless did it turn to MIRV as the only available option for increasing the number of warheads" (Greenwood 1975, 38-39). Similarly, "the Navy apparently made a move to get its goal of 45 submarines accepted by the Defense Department–it proposed a Polaris force of 50 submarines" (Ball 1980, 243). McNamara held the line at 41 submarines and 1,000 Minuteman missiles: strong forces can push for arsenal expansion, but there can be equally important forces limiting such growth.

While bureaucratic factors can clearly create pressures for arsenal expansion, this explanation is far from universal or universally true. Numerous authors challenge simple explanations of internal pressure, conflict, and inertia. Observing the significant Soviet counterforce buildup, William Lee argues, "this is not the result of an accident, bureaucratic inertia, the parochialism of the Soviet 'military-industrial complex,' or Kremlin power politics or whims but of sober military planning and clever negotiating tactics at the SALT talks" (1986, 85). William Odom agrees, stating that because of the scope and cost of the buildup, "it is inconceivable that it just occurred from bureaucratic momentum in the defense industries and the military staffs" (1983, 126). Explaining US MIRV development, Ted Greenwood also disputes theories of unintentional results, arguing that "these programs did not simply move ahead propelled by their own bureaucratic momentum but were actively encouraged, fostered, and supported by senior decisionmakers" (1975, xiii). To move beyond the superpowers, "Indian nuclear

policymaking has been highly personalized and concentrated in a handful of political leaders and scientists" (Perkovich 1999, 9), and this close linkage seems to have "helped insure that the scientific establishment was not going to be driven by purely narrow organizational drives…Indeed, it might be suggested that a sustained, high-level involvement of the scientists served as a brake on the nuclear program" (Ollapally 2001, 939).

ii. Military-Industrial Complex

The military-industrial complex explanation finds relatively little support in the literature. Monteiro states that "the topmost decision makers on nuclear weapons policy in the USA are people who are closely linked with the corporations manufacturing these weapons and their components" (1986, 59), but offers no details, making any claimed effect impossible to measure. Others discuss pressures to maintain qualified design teams and prevent turnover by providing new challenges (Freedman 1980, Greenwood 1975), but these pressures could be solved by qualitative rather than quantitative improvements to the US arsenal. While Freedman acknowledges that there were clearly interests pushing for expansion, "in time, extreme versions of the military-industrial complex theories were undermined by scholarly analysis"(2003, 323). During the major US buildup under Kennedy, Ball finds "little evidence of extensive industrial pressure for a further expansion of the US program" (1980, 254), partly because production was already at record levels. Outside the US, tight civilian control over the Indian nuclear program has helped insulate it from such pressures (Ollapally 2001), and, aside from a small number of individual experts, *India Today* reported that there is "no identifiable bomb lobby" (Perkovich 1999, 283). In China, "state organs do all Chinese design and

procurement" (Larkin 1996, 243), while "the number of industrial units in Britain and France which are heavily dependent on the nuclear program is small" (Larkin 1996, 248).

D. Political Explanations

i. Domestic

Lieber has argued that the French nuclear force "is so heavily political and psychological that…a solely military argument can hardly stand by itself" (1966, 422). This statement applies to the nuclear forces of all states to varying degrees. Francis Hoeber echoes it in his analysis on US deterrence, saying, "military capabilities are necessary but not sufficient for strategic forces. The interplay of political factors with military capabilities must also—always—be considered in negotiations about these forces and in their planning, deployment, and employment doctrine" (1978-79, 64). Jack Ruina dismisses marginal differences in US and Soviet strategic forces as "inconsequential, except politically" (1987, 187).

These debates were never resolved (Glaser and Fetter 2005, 100). For example, regarding the issue of the alleged vulnerability of the US ICBM force, the debate had little supporting evidence, but thrived "because it suited all the participants." Yet when no solution could be found, "it was quietly redefined so as to become less pressing. While British political parties different on nuclear weapons, the public is generally supportive, as is the French public (Larkin 1996). In China, on the other hand, "much hinges on whether political issues become *at all* a question of public debate" (Larkin 1996, 248), given the tight control exercised by the Party. India's tight nuclear control has led to "insignificant" parliamentary input (Basrur 2001, 189), and public opinion has tolerated nuclear ambiguity, but is likely to reject any effort to roll back nuclear

development (Perkovich 1999, 458). Public (majority) opinion in each case appears generally supportive of nuclear programs, but does not voice strong demands either way. Domestic politics however, including the organizational factors discussed above, remain crucial, and key decisions "will be located in internal politics" (Larkin 1996, 307

ii. International

Beyond the military dimension, nuclear weapons, including arsenal size, play an important role. China, India, Britain, and France have all regarded nuclear weapons as international status symbols (O'Neil 1995, Gupta 2001, Kohl 1968, Johnston 1995, Freedman 2003). British Prime Minister Harold Macmillan, for example, stated that an independent nuclear force "puts us where we ought to be, in the position of a Great Power" (Freedman 2003, 295). China recognizes that simple possession of a nuclear arsenal does not confer automatic high status, and has chosen to stay out of arms control agreements until US and Russian arsenals are closer to 1,000, demonstrating an understanding of their limited bargaining leverage in the international system. India has faced similar realities, seeking a deterrent against Pakistan and China and greater prestige and status in the international system, yet "on both counts India's expectations were unfulfilled" (Gupta 2001, 1045). While nuclear weapons undoubtedly affect their position in international politics, second and third tier nuclear states have learned that mere possession does not grant "a seat at the table," and may even provoke a backlash.

iii. Perception

Perceptions are an important factor frequently neglected in the concern over strictly military matters. Perceptions internally and externally are equally important in motivating behavior, and ultimately force levels. Because deterrence depends on the

perception of the adversary (the fear of “unacceptable damage”), US strategic doctrine and forces are “designed to deter the Soviets, not some group of Western analysts” (Slocombe 1989, 416). As early as 1953, analyses of the role of perceptions called for considerably less than total secrecy regarding nuclear weapons, in order to demonstrate capability and enhance deterrence (Wolfers 1953, 15). Internal perceptions can have significant effects and lead to dramatically different policy prescriptions, as the debate on US-Soviet doctrine shows. Because US and Soviet deterrents are “ample…it is reasonable to set out forces far enough above the danger level to ensure general public confidence (Bundy 1989, 463), and “overinsurance seems clearly preferable to underinsurance” (Scowcroft 1984, 78).

Others see perception rather differently, arguing that “if the United States convinces the Soviet Union that it does not see a meaningful difference in strength, the USSR cannot safely stand firm in crisis bargaining because it will not have any reason to think that the United States is any more likely to retreat” (Jervis 1979-80, 631). Empirical evidence has challenged the role of perception with surveys finding that “in a variety of relevant publics…there was a lack of agreement on which superpower was ahead, and that a large number of respondents believed that the question had little point because the two superpowers could so easily destroy each other” (Freedman 2003, 352). Stephen Kull, a particularly strong critic of perception theories, notes that some policymakers and academics argue that “the illusion must be protected or even actively promoted” (1985, 44) rather than challenged, and used to justify personal policies. This discussion suggests that, while such misperceptions are less common than often assumed, they still exist, though their effect on arsenal size can go either way.

III. Conclusions

While there is no dedicated literature to the subject of explaining nuclear force levels, synthesizing a variety of theoretical approaches and case studies can provide a very useful starting point. Military explanations are predictably dominant, but the important effect of domestic politics comes up frequently as well. Three of the four most useful sources have been detailed case studies, demonstrating their ability to illuminate and ground abstract theoretical debates. In *The Evolution of Nuclear Strategy*, Lawrence Freedman concludes:

> What is often forgotten in strategic studies, preoccupied with military capabilities, is that the balance of terror rests upon a particular arrangement of political relations as much as on the quantity and quality of the respective nuclear arsenals (2003, 463).

In George Perkovich's *India's Nuclear Bomb,* he agrees, stating that:

> Domestic factors, including individual personalities, have been at least as important as the external security environment in determining Indian nuclear policy and that of other states (1999, 445).

Desmond Ball reaches a similar conclusion in *Politics and Force Levels*:

> All of the missile decisions of the Kennedy-McNamara Administration, throughout the years of the missile build-up (1961-64), were, in some senses at least, political. In other words, the outcomes of the decision-making process were not wholly or solely the results of objective and systematic analysis, but rather resulted from a reconciliation both of a diversity of values and goals and of alternative means and policies, with the actual outcome reflecting, more than anything else, the relative power of the participating groups. This is not to say, of course, that the numerous analyses on strategic-weapons systems and programs did not figure in the decision-making process. Their conclusions, the cogency of their arguments, and the articulateness of their sponsors were a significant factor in the relative power of the participating groups…But strategic doctrine in the Kennedy-McNamara Administration was never decisive with regard to the missile program; it appears to have served as no more than a rationalization for decisions taken on political grounds (1980, 269).

In *Making the MIRV*, Ted Greenwood offers the most powerful and broadly applicable summary of the four:

> No single-factor explanation - not the popular notion that MIRV was a reaction to Soviet ABM; not Tammen's reliance on domestic factors as the primary determinants; not Kurth's contention that MIRV is "best explained by bureaucratic process" and "also can be fitted into a broader economic analysis"; not York's and Lapp's insistence that MIRV deployment was inevitable once its feasibility was recognized – captures the full complexity or illuminates the interaction between fluctuations in the many separate strands that together produce MIRV programs. Their common failing and the origin of Kurth's *a posteriori* overdetermination is a seemingly innate preference on the part of analysts for neat, single-valued explanations and common, but not universal, reluctance to deal with historical evidence in all it's richness (1975, 143).

In each case, the author appeals to a more complex understanding of their subject than is previously granted. They identify multiple, interacting factors, any of which can be dominant one moment and ignored the next, but the final outcome depends on all of them to some degree. While this does not reduce to a simple, monocausal explanation of nuclear arsenal size, detailed analysis of complex processes rarely does. Perhaps the best that can be done is to stop seeking grand theories and instead take the time to examine each of the relatively small number of nuclear states individually, necessarily sacrificing parsimony for the more important goal of accuracy.

Research Design

The US currently maintains around 10,000 nuclear warheads, and Russia 8,600, with approximately 6,000 each as strategic weapons. The second-tier nuclear powers of France and Britain maintain 350 and 200 warheads respectively, Britain relying on SLBMs and France combining SLBMs with aircraft delivery systems. China remains on the low end of the second-tier powers, with a nuclear arsenal of around 400 warheads, including 20 ICBMs capable of hitting the US. The US, Russia, Britain, and France have been gradually reducing their arsenals while China's has remained relatively stable for the last two decades. Additionally, China has stayed out of international treaties limiting nuclear weapons, free riding from the US and Russia. What explains the Chinese arsenal size and force structure? Preliminary research suggests the modest size of the Chinese arsenal is primarily a result of a countervalue nuclear doctrine, relying on the strategy of minimum deterrence. Economic and technical barriers are likely secondary explanations, given the lack of a credible submarine-based deterrent, the backbone of the other major nuclear powers.

Given China's status as a rising superpower and the concern this has created for many western observers, China's nuclear arsenal is highly relevant. A continuation of current behavior would provide some reassurance of peaceful intent, while any significant nuclear expansion might be seen as an effort to disrupt the nuclear and global status quo, altering and likely destabilizing relations with the west and regional powers. While countervalue doctrines are much less dependent on the actions of potential adversaries than counterforce doctrines, some response to changing external circumstances may be necessary to maintain credibility. Understanding the factors that

determine the size and force structure of China's nuclear arsenal is thus important for predicting future behavior. Any significant Chinese action will affect the decisions of the major nuclear powers, as well as the regional nuclear powers of India and Pakistan. This research also affects international relations theory by questioning basic realist assumptions of the primacy of security concerns. It is also relevant to the basic theoretical debate of relative and absolute forces, as well as strategic interaction.

Methodology

The literature review has identified four broad theoretical categories determining nuclear arsenal size; practical, military, organizational, and political. Starting with the practical issues, technical and economic effects would be examined. China's apparent problems in maintaining nuclear submarines would be relevant, as well as technical obstacles for miniaturizing warheads and MIRV capability. Economically, budget estimates for nuclear and conventional forces would be juxtaposed with national economic performance to look for potential financial limitations. Militarily, China's ability to engage in counterforce and countervalue conflicts would be analyzed, as well as survivability, flexibility, and credibility. Hypothetical conflict scenarios would be proposed, and China's predicted behavior and performance would be evaluated in light of the current force structure. Analyzing China's publicly stated nuclear doctrines would follow, comparing stated doctrine with real military capability. Organizational factors would be next, looking for tendencies towards bureaucratic politics, effects of standard operating procedures, or the military-industrial complex. Last, domestic and international political effects would be analyzed. Arsenal size is unlikely to be significant domestically given China's centralized government, but international behavior could be analyzed for

real and perceptual consequences. This comprehensive approach would offer a detailed explanation of current force structure, as well as providing guidelines to predict future behavior. The arsenal will be evaluated over time, comparing prevailing conditions with intelligence estimates for that year, looking for consistency or change.

An emphasis on countervalue doctrine, combined with a degree of economic and technical limitation is expected to offer a fairly robust explanation of Chinese force structure. Historically, by the time China went nuclear in 1964, a credible counterforce doctrine was practically infeasible, given the large numerical and technological leads of the US and Soviet Union arsenals. While this gap remains impossibly large, China has taken few aggressive steps to attempt reduce it, such as a larger arsenal, highly accurate missiles, or MIRVs. Practical limitations cannot be ignored, but offer a very incomplete picture unless doctrine is highlighted. The countervalue doctrine explanation is also strengthened by China's longstanding no-first-use pledge regarding nuclear weapons.

A number of factors could potentially call these conclusions into question. Given the secrecy of the Chinese government, inaccurate intelligence may provide a flawed picture of the existing nuclear force size and structure. The warhead count as well as the quantity and quality of strategic delivery systems may be higher than previously estimated, which would point towards a more aggressive counterforce strategy. Shifting international conditions (such as US ABM deployment), or internal policy may result in changes to nuclear doctrine, which may or may not be publicly announced. Finally, Chinese nuclear forces may be found to be deployed differently for different potential opponents. For example, China may adopt a countervalue strategy of limited deterrence towards the US, but could simultaneously have a counterforce strategy towards India, a

smaller and more vulnerable target. While they are believed to be unlikely, any of these changes or discoveries would significantly alter assessments of the Chinese nuclear forces, suggesting alternative explanations and predicting alternative futures.

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