4-2019

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Citation

KIM, Inwook, & PARK, Soul.(2019). Deterrence under nuclear asymmetry: THAAD and the prospects for missile defense on the Korean peninsula. *Contemporary Security Policy, 20(2)*, 165-192.
Available at: https://ink.library.smu.edu.sg/soss_research/2751

Deterrence under nuclear asymmetry: THAAD and the prospects for missile defense on the Korean peninsula

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Published in Contemporary Security Policy, 2018 December, Advance online

https://doi.org/10.1080/13523260.2018.1558750

Abstract: The 2016 decision to deploy Terminal High Altitude Area Defense (THAAD) to South Korea has generated multitude of intensely politicized issues and has proved highly controversial. This has made it challenging to alleviate, let alone clarify, points of analytical and policy tensions. We instead disaggregate and revisit two fundamental questions. One is whether THAAD could really defend South Korea from North Korean missiles. We challenge the conventional "qualified optimism" by giving analytical primacy to three countermeasures available to defeat THAAD–use of decoys, tumbling and spiral motion, and outnumbering. These countermeasures are relatively inexpensive to create but exceedingly difficult to offset. Second, we assess the optimal way to ensure South Korean national security against North Korean missiles. By examining the balance of capability and issues of credibility/commitment, we show that the US extended deterrence by punishment remains plentiful and sufficiently credible even without enhancing the current defense capability.

Keywords: Security dilemma, ballistic missile defense (BMD), terminal high altitude area defense (THAAD), extended deterrence, North Korea

In July 2016, the United States and Republic of Korea (ROK) announced the long-anticipated deployment of the Terminal High Altitude Area Defense (THAAD) to the Korean peninsula.[1] The decision immediately created huge uproar in the region, most conspicuously with China. While Washington and Seoul justified the deployment on the grounds of additional defense requirements against Pyongyang's growing nuclear and missile capabilities, Beijing, and to a lesser extent Moscow, perceived THAAD to be "not a simple technical issue, but an out-and-out strategic one" aimed at altering the regional strategic balance in favor of the United States (Wang Yi as cited in Kim J, 2016).

The competing interpretations proved to be highly escalatory and destabilizing, as evidenced by a series of diplomatic confrontations, retaliatory economic measures, and even led to talks of potential military strikes in the following months. The THAAD debate also became exceedingly complicated and intensely politicized, for it involved diverse sets of actors in the region whose competing strategic preferences collided at multiple levels. Unsurprisingly, this presented huge challenges for analysts and scholars who struggled to alleviate, let alone clarify, points of analytical tensions and policy disagreements.

Rather than confronting these debates as a whole, the discussions would be better served by disaggregating and revisiting two fundamental questions that underlie the entire issue. One is whether THAAD can really defend South Korea from North Korean missiles, the most immediate and critical objective behind the deployment. We contend that the widely shared "qualified optimism" on the defense capability of THAAD is overstated. To illustrate this point, we formulate a novel framework of "dynamic analysis," informed by a long-held axiom in the security studies literature that "how much security is gained by the acquisition of more weapons depend on how others respond" (Schweller, 2010, p. 289). This accordingly gives analytical primacy to the availability, costs, and effectiveness of the countermeasures that North Korea can adopt to defeat the THAAD system. We explain three readily available countermeasures–the use of decoys, tumbling and spiral motions, and outnumbering–which are relatively easy to create but exceedingly difficult to offset. Their availability essentially reduces the defense value of THAAD to a limited period. This assessment conforms to the conventional wisdom that missile technology decisively favors offense over defense, and casts deep doubts on the technical viability of defending against North Korean missiles through the construction of a missile defense system (Glaser & Fetter, 2016; Pifer, 2015).

This leads to a second question of this paper: how best to ensure South Korea's national security in the face of growing North Korean nuclear and missile threats, particularly given the diminishing marginal value of the missile defense system. Drawing on existing literature differentiating denial from punishment deterrence (Snyder, 1961, pp. 9–39), we, somewhat counterintuitively, argue that the U.S.-ROK alliance currently is not in need of any additional major defense systems. Examination of the current and projected balance of capability, and issues of credibility and commitment shows that the U.S. extended deterrence by punishment remains plentiful and sufficiently credible in dissuading Pyongyang from launching a nuclear strike or conventional missiles in the first place. As it stands, the Korean peninsula does not face a "deterrence gap" and the missile defense adds little to the existing U.S. nuclear umbrella: "Denial deterrence adds to reprisal deterrence like tying an extra cotton string adds to the strength of an aircraft carrier's anchor chain" (Butt, 2010). While our analysis of THAAD on the Korean peninsula as being defensively ineffective and potentially militarily counterproductive broadly contributes to the BMD literature (Futter, 2013; Peoples, 2010), we do not, however, outright reject deployment itself. Instead, our analysis, at minimum, suggests that the justification of THAAD must be sought outside the missile defense needs and that the U.S.-ROK alliance must caution against overconfidence in THAAD's interception capability.

We begin by justifying our choice to narrow the analytical scope strictly to a military analysis and sketch the current debate on its defense capability. After defining the "dynamic analysis" framework, a section that analyzes varieties of countermeasures available to North Korea follows. We then discuss extended nuclear deterrence and evaluate its practice on the Korean Peninsula. We conclude with broad policy and theoretical implications from our findings.

Setting the analytical scope

Ever since the United States first floated the idea of deploying THAAD in South Korea,[2] multiple points of domestic and regional disagreements emerged and subsequently intensified around different sets of actors, interests, and issues. For instance, South Korea witnessed a fierce domestic debate and local protests over possible harmful electromagnetic radiation to the surrounding areas (The Economist, 2016), while the United States and ROK debated the intra-alliance issue on which country should bear the costs of deployment.[3] More substantive and consequential controversy came with the Chinese, and to a lesser extent Russian, denunciation of the deployment (Suh, 2017). China's opposition was particularly vehement, arguing that THAAD sharpens two areas of its strategic vulnerabilities–an exposure of its second-strike missile launch sites by highly penetrative X-Band radar (Riqiang, 2013; Li, 2016) and South Korea's perceived realignment with the United States under the "Pivot to Asia" strategy (Denmark, 2017; Teng, 2015). China followed up its opposition by undertaking allegedly retaliatory measures on trade, tourism, and investment linkages against South Korean companies (Glaser, Sofio, & Parker, 2017).

Given the diverse consequences of THAAD, calculating the cost and benefit of its deployment is likely to require complex and subjective evaluations, making an aggregation of those values into a single framework impractical and barely meaningful. Indeed, the debate thus far is hardly settled and has become increasingly politicized, while its divisive nature is likely to continue dominating the domestic and regional political landscapes in Northeast Asia.

Instead, we choose to restrict the analytical scope strictly to the military rationale of deployment–whether the THAAD can really provide an effective defense capability against North Korea's growing nuclear and missile threats. We justify this analytical choice for two reasons. First, the United States and ROK officially justify the deployment predominantly in terms of the THAAD's defense value and, therefore, whether it could really deliver the promised defense determines its legitimacy. If equipped with sufficient defense capability, for instance, its deployment may well be rationalized as an appropriate response to Pyongyang's growing missile capability. Seoul may even argue that it is worth some deterioration in its relations with China on the ground of national security requirements. On the other hand, if the THAAD is not what it promises to be, military rationale to deploy THAAD consequently weakens, opening up room for criticisms of making suboptimal military policy choices or of possibly pursuing other hidden agendas.

Second, despite its centrality in the overall controversy, the nature of THAAD's technical capability tends to be assumed away rather than put under close scrutiny in the literature (for exception, Sankaran & Fearey, 2017). The reasons behind this neglect are beyond the scope of this study, but likely to include but not limited to political scientists' general unfamiliarity with missile technology, a lack of information about specifics of THAAD and its X-Band radar system, or quick spillover of the controversy onto the larger political and economic dimensions that diverted attention away from the military aspect. Regardless, an absence of proper technical analysis is unwarranted, as what THAAD can and cannot do is a key to reliable and conclusive assessment on the desirability of its deployment.

THAAD defense capability: What advocates and critics say

There is a sizable volume written on technical specifications, defense capability, and deterrence value of THAAD. While advocates are optimistic about the added defense and deterrence value, critics point out that the system is still unproven, unreliable, and limited in defense capability. The two camps have converged onto a "qualified optimism" position, or that THAAD is not perfect but net positive to South Korea's overall missile defense.

The THAAD advocates

The advocates base their support for THAAD on two related but distinct dimensions. First, THAAD boasts one of the most advanced BMD technologies available, proven through 100% success ratio in all of the 14 successful intercepts since 2005, including the first and the latest test against an intermediate-range ballistic missile (IRBM) in July 2017 (Missile Defense Agency, 2017; Mostlymissiledefense, 2016). Most importantly, the addition of THAAD creates "a layered defense" by covering high-altitude that other BMD systems such as PAC-3 cannot, and, subsequently, enhances the chance of successful missile interception. For instance, one study estimated that in order to achieve 0.9 probability that none of the hypothetical 20 or 50 attacking missiles leak through the defense, "single-shot probability of kill (SSPk)"[4] needs to be 0.928 and 0.954 for one-layer defense, whereas SSPk can be as low as 0.731 and 0.786 for two-layer defense (Elleman & Zagurek, 2016, p. 6; Klingner, 2015, pp. 28–30). In other words, under the two-layer defense, SSPk is less demanding and require fewer interceptors to achieve the needed missile defense probability.

Second, due to the increased missile interception capability, advocates contend that THAAD enhances U.S.-ROK alliance's deterrence by denial. A primary purpose of THAAD arguably does not lie in missile interception itself in times of actual wars. Rather, a reduced chance of successful nuclear strike is expected to prevent Pyongyang from even contemplating such an option in the first place. Some go even further and argue that despite being purely defensive, THAAD can enhance U.S.-ROK alliance's deterrence by punishment capacity by reducing cost to pay in war (Glaser & Fetter, 2016, p. 84). Consequently, should North Korea launch a limited nuclear or conventional strike, the credibility that United States engages in retaliatory attack increases in tandem with better missile defense capability and reduced cost of fighting a nuclear war.

The critics

Critics point out that its deterrence effects are not as warranted as posited by the advocates, mainly due to technical inadequacies and unknowns in the THAAD system. First of all, experts doubt whether successful test records, given the highly controlled environment under which it took place, can translate to effective performance in real combat situations because "things that work well at home on the test range don't always go as smoothly when deployed" (Klug, 2017). For instance, tests were conducted only under clear weather conditions, as THAAD currently cannot withstand "temperature shock, humidity, rain, ice, snow, sand, and dust" (Gilmore, 2015). The prospect of correcting them is further impaired by the reported budget constraints to finance pricey missile tests today (Karako, 2016).

Second, even if one accepts THAAD technical descriptions at face value, there are still significant gaps remaining. A size of area covered, for instance, is limited by 200 km from the battery location. The Seongju battery covers major U.S. bases such as Camp Walker in Daegu, Kunsan Air Base, or those in Pyeongtaek and Osan as well as the headquarters of ROK army, navy, and air force. On the other hand, Seoul, a capital with population of 10 million, is out of the interception range, as well as most of ROK forces stationed near the DMZ. Furthermore, it was reported that missiles fired from Hwangju in North Korea to Busan, the second largest city and an important hub for military logistics, would fly well over 150 km in altitude over Seongju, which is above the THAAD interception range (Kim H, 2016).

Third, geographical reality makes low-altitude missiles more favorable to Pyongyang, which THAAD is not designed to intercept. The short distance between North Korea's missile sites and major South Korean cities shortens missile flight time, leaving insufficient time for PAC-3 to intercept low-altitude incoming missiles aimed at Seoul, for instance, which is only 40 km away from the DMZ (Park, 2013; Kim, 2010). Low-altitude missiles are also advantageous for their greater accuracy and lower technical challenges (no travel in and out of the atmosphere). Launching high-altitude missiles at South Korea is likely of a low probability, and critics view THAAD unlikely to be used in actual crises.[5]

Qualified optimism

While the disagreements are still substantial, advocates and critics tend to agree on two basic commonalities on the THAAD defense capability. One is "the more missile defense, the better it is for national security" stance. Critics recognize that high-altitude would be left completely undefended without THAAD and therefore constructing an additional shield could offer both an additional defense layer and psychological comfort to South Korean defense. Another shared view is that THAAD is far from a complete system against North Korea's missiles. Advocates accept technical limitations of THAAD, and that achieving a complete missile-proof is not viable. The difference between advocates and critics is on the marginal value of adding this imperfect but net positive BMD system–the former is more favorable to it than the latter.

We also add that Pyongyang arguably would be compelled to assume the best of THAAD interception capability in its missile offense strategy planning and implementation. It means that the noted flaws and limitations of THAAD may not be as problematic for deterrence purposes as it is for actual defense capability. If Pyongyang assumes that THAAD could intercept high angle missiles, it would then try to avoid launching missiles that fall under the THAAD interception range thereby achieving limited deterrence.

In short, the THAAD debate assumes "qualified optimism" about its defense capability–not perfect but net positive to South Korea's missile defense. A more irreconcilable difference lies in issues outside the Korean Peninsula–most notably, its impact on U.S.–China strategic balance, US-ROK burden sharing, ROK's economic vulnerability to China, and so on. Advocates contend that the THAAD deployment is a sovereign decision out of national security concern, while critics view that the strategic cost are greater than defense benefit. A focal point in the debate has now shifted to gauging, evaluating, and managing these costs in the equation, and away from THAAD's military defense and deterrence value.

Dynamic analysis: Asking the right questions

The "qualified optimism" offers a balanced and accurate description of what THAAD is and is not capable of. However, because it represents the current offense-defense balance of missiles, its validity can stand only for one static period, or a period while North Korea's missile launch system remains unchanged. This is a demanding and unrealistic assumption given that the THAAD deployment would almost certainly prompt North Korea to undertake countermeasures to offset the new BMD system. The technical assumption that underlies this debate then changes, often fundamentally, with the type of military countermeasures North Korea develops.

To account for this action-reaction nature of arms acquisition, we formulate a dynamic analysis that systematically considers the interactive nature of the security competition (Jervis, 1978). We move beyond the conventional emphasis on current distribution of military technology and capability, and instead examine North Korea's possible responses to the THAAD deployment.[6] More specifically, what are the countermeasures available to North Korea? How readily available and costly are they? Lastly, how effective are their technological specifications in defeating THAAD?

The dynamic analysis of new weapons system assumes two distinct sequential periods–time t and $t + 1$. The former, t, begins with new weapons acquisition and lasts as long as the adversary's weapon system remains unchanged. The latter, $t + 1$, on the other hand, denotes a period that begins after the adversary acquires the desired countermeasures. Each period therefore uses different criteria to measure the effectiveness of new weapons system.

In t, the criteria are the adversary's current military posture, capability, and technological specifications of the defense. If the new weapons system lowers costs to defeat or defend the adversary's existing system, then it is deemed effective in period t. The added military value continues until the adversary acquires necessary countermeasures, or $t + 1$.

On the other hand, in t + 1, the effectiveness is judged not by what the adversary is capable of today but what the adversary can do in the future to neutralize the new weapons system. The key criteria are therefore the availability, cost, and effectiveness of countermeasures. New weapons system still remains robust and valuable in t + 1, if either no effective countermeasure exists with the current technology or they come at a prohibitively expensive cost. In such a case, the new system adds strategic advantage over the adversary's capacity or imposes a disproportionately larger cost on the adversary at t + 1, respectively. The deployment of new system today therefore ensures greater strategic advantage tomorrow. Conversely, if countermeasures that can defeat the new weapon system are readily available at a relatively low price (or bearable by the target state), then the added value of new weapon system would be promptly be offset by the target's adoption of such countermeasures.

The dynamic analysis prioritizes t + 1 period. The temporal variation has an important implication–a state's security at t needs not necessarily match the one at t + 1. It is possible, for instance, while one's action enhances its security for t, the adversary's adoption of countermeasures nullifies or even undermines its security at t + 1. It is therefore critical to examine how quickly and at what cost effective countermeasures can be acquired. This emphasis on action-reaction is in alignment with the security dilemma and arm race literature that says security is a product of interactions between two or more states and therefore the optimality of weapons acquisition can only be calculated after incorporating the adversary's response to it (Glaser, 2000). Giving analytical primacy to the dynamic nature of arms race is common practice in much academic analysis about defense policy. And yet, this analytical approach garners attention precisely because actual policy often lacks a proper appreciation of the availability, cost, and effectiveness of countermeasures that the adversary can adopt. Our analysis addresses this shortcoming by systematically taking into consideration the strategic, technical, and financial perimeters of available countermeasures.

Countermeasures against THAAD

In both theory and practice, many countermeasures against THAAD do exist (Gompert & Isaacson, 1999; Sessler et al., 2000; Wilkening, 2000). However, within them exists marked variations and only a handful is within technical and financial reach for Pyongyang. Unfortunately for the U.S.-ROK alliance, though, these handful countermeasures are effective to sufficiently confuse and defeat the THAAD system without much added technological requirement or financial burden.

Avoidance countermeasures

Countermeasures against THAAD take two forms: avoidance and manipulation.[7] First, avoidance countermeasures refer to missiles that fly outside the THAAD altitude or radar coverage. The missing altitude, however, is covered by the already existing PAC-3 system, designed to intercept missiles flying at low-altitude (up to 25 km). The radar coverage, in contrast, presents a problem. Missiles launched at sites outside the X-Band radar coverage are simply undetectable and THAAD, therefore, will not be able to intercept them. The X-Band radar covers around 600 km under the Terminal Mode (TM) which is long enough to cover most of North Korea.[8] However, X-Band covers only 120 degrees and the radar in Seongju is reportedly to face north, exposing the remaining 240 degree totally undetected. Given the geography of the Korean Peninsula, this makes the avoidance countermeasure possible with submarine-launched ballistic missile (SLBM) (Elleman & Zagurek, 2016; Lewis, 2016; Postol & Schiller, 2016). Submarines with SLBMs are extremely difficult to detect by conventional technology too—oceans are vast and missile launching submarines need not be nearby targets (Postol & Schiller, 2016, pp. 763–765). Hypothetically, if all nuclear warheads are launched as SLBMs, the entirety of South Korea has no way to prevent them from reaching its territories.

However, technology for SLBMs is complex and not readily available. Indeed, the conventional assessment is that North Korean SLBMs are still underdeveloped and many years away from successfully developing and deploying them (Lewis, 2015; Schilling, 2016; Wallerstein, 2015). The current balance of technology and finance is such that as far as SLBMs are concerned, the THAAD is arguably a defensible course of action to take even from the dynamic analysis' point of view due to a considerably distant prospect of Pyongyang acquiring reliable and sufficient SLBMs capabilities.

Manipulation countermeasures

On the other hand, manipulation countermeasures, aimed at defeating the THAAD system by exploiting its technical vulnerabilities, are readily available, relatively inexpensive, and highly effective. Three such countermeasures are discussed here: use of decoy, spiral and tumbling motion, and outnumbering.[9]

First, North Korea can deceive the THAAD system by making discrimination of real warheads difficult. Discrimination arguably represents the most difficult technical challenge to BMD developers (Ruppe, 2004). Of multiple ways available to deceive a target radar system, decoys–"devices that try to mimic the appearance of real reentry vehicle when viewed by various optical or radar sensor" (Wilkening, 2014, p. 128)–poses the greatest technical challenge.[10] Decoys are usually generated in midcourse, or after the ballistic missiles leave the atmosphere. Decoys are particularly difficult to be discriminated in the "exoatmospheric" condition as all objects with the same initial velocity travel along identical paths and at the same speed, regardless of their mass (Glaser & Fetter, 2016). After the re-entry into the atmosphere, lightweight decoys and heavier real warheads follow different flying trajectories due to weight differences. At this point onwards, decoys therefore can no longer disguise themselves as warheads by their speed and trajectory. However, discrimination still could be made very difficult by covering the warheads with low infrared signatures and radar cross sections, radar jamming, camouflaging the decoys with clouds of thin wires or tinfoil strips known as chaffs to confuse the onboard sensors (Glaser & Fetter, 2016; He & Yong, 2003, pp. 176–184; The Economist, 2014) as most conventional radars identify real warheads by the exterior properties of the missile, most of which are largely manipulative by the missile designers.

The radar system that accompanies the THAAD is Army/Navy Transportable Radar Surveillance (AN/TPY-2), which operates in the X-band frequency. Raytheon, the developer, claims that AN/TPY-2 is capable of simultaneously tracking and identifying multiple small objects as small as a baseball and their movements at as far as hundreds mile away (Raytheon, n.d). This, according to Raytheon, gives THAAD an unprecedented level of discrimination capability. National Research Council similarly contends that the midcourse discrimination problem can be addressed by "the synergy between X-band radar observations and optical sensors onboard the interceptor with the proper shoot-look-shoot firing doctrine" (National Research Council, 2012, p. 102).

However, the claim reads more as a hopeful assertion than a proven assessment. Whether and to what extent the AN/TPY-2 achieved the discrimination capability is still unknown. There is no data published on it, and discrimination capability is still under development (National Research Council, 2012). The current perception in scientific and security communities appears that discrimination capabilities "will never be foolproof" (Karako, 2017a, p. 50) and the technology is still far away from developing satisfactory discrimination capabilities in the foreseeable future (Glaser & Fetter, 2016, p. 78; National Research Council, 2012 for cautiously optimistic assessment). The oft-neglected cost factor also favors countermeasures over THAAD as manufacturing countermeasures come at a cost much smaller than building an effective BMD system. As remarked by a U.S. Senator during the Senate Hearing for the Committee on Appropriations in 2003, “we are building a very complex, expensive missile defense system that can be foiled by inexpensive counter-measures such as simple balloon decoys or chaff?” (Inouye, 2002, p. 161; Zakheim, 2015).

A second source to thwart the THAAD system comes from a technical difficulty to project missile flight trajectory. THAAD suffers from a limitation that the current hit-to-kill interceptors can reliably and consistently intercept missiles only with stable and straight flight movement. The missiles must fly spin-stabilized so that it would not tumble or spiral. This is critical for hit-to-kill interception to succeed because only “a few tenths of seconds” is available for the interceptor to see details of the homing missiles’ motions, virtually making it impossible to redirect the missile at the last second (Lewis & Postol, 2010). Consequently, if the missile is traveling at an unpredictable speed and with erratic spiral or tumbling motions, interception stands virtually no chance of success. Tumbling can also cause the breakage of the reentry missiles into smaller and numerous pieces. The sudden creation of additional potential targets can confuse the intercepting missile, which does not have a luxury of time to re-identify its target during the terminal phase. It is worth noting that creation of spiral or tumbling comes at a cost, however. Due to the random movement, landing the missiles at an exact target also becomes impossible. This poses problems when accuracy is a key. For instance, when aiming at military targets, missing by mere tens of meters could be fatal for conventional missiles. However, when the missiles are loaded with nuclear warheads, this is lesser of a problem for a densely populated target like South Korea as opposed to sparsely populated vast lands like Russia.

This known difficulty incentivizes to create missile tumbling and spiral. Unfortunately for THAAD, tumbling is easy and cheap to create. Tumbling can allegedly be acquired by as a simple technique as “a hammer hit” or something comparable to twisting a warhead slightly (Suh, 2016). The bent warhead then simply cannot fly on a predictable course after being exposed to aerodynamics in the post-reentry, making the hit-to-kill interception technically infeasible. In fact, due to their design, the North Korea’s missiles that fall under the THAAD coverage—Scud-B, Scud-C, and Nodong—all follow irregular trajectory after its powered flight (Park, 2015). Lastly, tumbling or spiraling could be achieved by modifying the fins at the backend of missiles, or making it light, so that the missiles are subject to random aerodynamic forces. They then may act “like arrows that had no feathers” (Park, 2015). In short, technology to create random motion of the homing missiles is simple and readily available for states that already produce missiles.

Tumbling problem is hardly new, and the BMD developers have long tried to resolve it. Unfortunately, neither real combat experiences nor test records support such assertions. For instance, the tumbling of the Iraqi Al Hussain missile during the 1991 Gulf War caused huge embarrassment to the U.S. BDM system by penetrating the Patriotic missile defense (Lewis & Postol, 2010). While the tumbling issues are widely acknowledged, the following BDM tests were still conducted in highly controlled conditions. Five SM-3 tests were done “under nearly identical flight conditions,” for instance, which would almost never occur in real combat situations (Lewis & Postol, 2010, p. 17).

Last simple manipulation countermeasure is to outnumber THAAD interceptors. This strategy makes use of the fact that each battery of THAAD comes with only 48 ready-to-launch interceptors and that it takes about an hour to reload them (Elleman & Zagurek, 2016, p. 7). Assuming two interceptors are assigned to a single incoming warhead, it means that only about 20–24 missiles can be intercepted in the first strike (Elleman & Zagurek, 2016). A simple counter missile launch tactics would be then to launch 20–24 empty or non-nuclear warheads in the first round to vacate the THAAD interceptors, and then launch the second strike with nuclear warheads.

The use of numerical superiority is not without costs and risks. First of all, this tactic requires the loss of minimum 48 missiles during the first strike, of which numbers increase in tandem with THAAD batteries. Second, it loses any strategic advantage from a surprise first nuclear strike, giving South Korea and the U.S. time to launch counterattack promptly. On the former, Pyongyang may not like the idea of losing precious missiles but it already has plenty of missiles to fire (500 Scud-Bs and -Cs with a range of 300–500 km, and 200 Nodongs (1,000 km)) to outnumber more than several THAAD batteries. Only one battery is deployed in South Korea at the moment. The latter poses a larger problem, but this can be overcome by increasing the launch pads.[11]

Overall evaluation

The dynamic analysis paints a grim picture for proponents of THAAD. It is far from guaranteed that countermeasures could be successfully developed or costless to produce.[12] However, critics now note that countermeasure technology is readily available, and the mastery of them is often with the technical capability of an emerging missile state (Sessler et al., 2000, p. 59). In fact, because the effectiveness of countermeasures is built on "fundamental physical principles" and "not … potentially classified engineering details," it is much easier to build effective missiles that can penetrate missile defense systems than to build an effective ballistic missile defense system (Lewis, 2017; Sessler et al., 2000). Scholars and analysts tend to be suspicious of the THAAD capability to withstand possible countermeasures, which results in various negative assessments that range widely from "too limited, too modest, and insufficiently reliable" (Karako, 2017b, p. 165) to "to be very lower, probably zero or close to that" (Klug, 2017). Added deterrence value by the THAAD, therefore, is likely to be severely limited at $t + 1$. Unfortunately for the U.S.-ROK alliance, $t + 1$ is not a distant future either, as necessary technology is already or readily available and sufficient amount of countermeasures are relatively cheap.

Countermeasure is not an end of this iterative process, but it would motivate deployment of counter-countermeasures for the BMD system at period $t + 2$, and so on (For related arguments that countermeasures are neither easy nor cheap, see National Research Council, 2012; Stein, Little, Lewis, & Postol, 1997; Wilkening, 2014). While $t + 2$ and beyond remains outside the scope of this article, it is worth mentioning that the consensus on military technology and within the defense sector is still that "the defender is at a perpetual disadvantage" as "offensive ballistic technology is far more mature than that of missile defense, and cost considerations favor the offense" (Grego, Lewis, & Wright, 2016; Pifer, 2015; The Economist, 2014). For instance, one battery of THAAD, despite the technical vulnerabilities and unknowns, reportedly cost approximately $800 million or more (Ekman, 2014, p. 8; Manyin, Chanlett-Avery, Nikitin, Williams, & Corrado, 2017, p. 6). Furthermore, as many as seven interceptors are usually required to shoot a single basic missile, while it is a lot cheaper to manufacture manipulation countermeasures discussed in this section (The Economist, 2014). While we acknowledge a possibility of building a credible and affordable BMD system at some point in the future, the general consensus is such that the imbalance between missile offense and defense is likely to persist in the foreseeable future. Our doubt about the wisdom of deploying THAAD under the criteria set up by the dynamic analysis still holds.

Extended nuclear deterrence on the Korean peninsula

Given the relatively inexpensive countermeasures readily available to Pyongyang and the technical difficulties associated with the current THAAD system, we argue that the focus should be on strengthening the current extended nuclear deterrence framework in East Asia. Deterrence, a concept that is distinct from defense, is broadly defined as the act of dissuading the adversary from initiating a course of action through the threat of retaliation (Department of Defense, 2006; Huth, 1999, p. 26; Morgan, 1977, pp. 25–47; Snyder, 1961, pp. 3–51). The policy of deterrence aims to signal to the opposing side that the costs of using military force far outweigh the actual benefits. Unlike general deterrence, which aims to prevent an attack on its own territory, extended deterrence "aims to affect the cost calculations of adversaries, specifically dissuading them from attacking a U.S. ally" with the implicit or explicit threat of retaliation (Brooks & Rapp-Hooper, 2013, p. 268; Crawford, 2009; Huth, 1988, p. 424; Pifer et al., 2010, p. 1). In East Asia more specifically, extended deterrence based on bilateral security alliances (Cha, 2010) remains at the heart of U.S. security policy towards the Asia-Pacific region well into the post-Cold War era (Pifer et al., 2010, pp. 29–30).

Extended deterrence comes in two variants–by denial and by punishment (Schelling, 1966, pp. 78–80; Schwarz, 2005, p. 9; Snyder, 1961, pp. 14–16). Extended deterrence by denial is geared towards convincing an adversary that "if it attacks, it will not achieve its military goals" (Brooks & Rapp-Hooper, 2013, p. 269). The ground-based BMD system on the Korean peninsula is based on this variant of extended deterrence and serves as the backbone of regional missile defense cooperation (Trachtenberg, 2012, p. 81). The main aim of the THAAD system (and other similar defense capabilities) is to protect both U.S. troops and its allies from potential missile attacks and, in the process, prevent the aggressors from achieving its goals through the use of force. The second type–extended deterrence by punishment–is aimed towards dissuading an adversary from initiating an attack against its allies in the first place through threat of massive retaliation. Security guarantees and defense commitments to its allies, and U.S. nuclear declaratory policy all serve as tools of the second type.

Within the military rationale scope, we argue that deterrence by punishment, rather than by denial, presents a more viable and less expensive option against North Korean nuclear and missile threats moving forward. As it stands, deterrence by denial remains problematic for two interrelated reasons. First, as outlined above, the BMD structure in East Asia through the deployment of the THAAD is not a cost-efficient mechanism to deter North Korea given the technological limitations and the readily available manipulation countermeasures. As our dynamic analysis demonstrates, such moves to strengthen defense capabilities on the Korean peninsula in period t gives Pyongyang added incentives to try to overcome the defense capabilities against it at $t + 1$. Thus, aims to deter North Korea by denial will only lead to further arms racing and military provocations. Second, the deployment of THAAD has largely been perceived as a move away from the regional status quo and has the potential to ignite unnecessary escalatory and retaliatory policies in the region as critics have pointed out.

Consequently, rather than deploy the THAAD system to beef up defense capabilities, strategic stability on the Korean peninsula can be attained by extended deterrence by punishment. With the technological imbalance favoring the missile offense over the proposed defense capabilities, the credibility of the threat of retaliation via the current extended deterrence framework should continue to hold moving into $t + 1$. In the remainder of this section, we examine the viability of this type of extended deterrence against North Korea by analyzing two key components in further detail–the current and projected balance of capabilities, and issues of credibility and commitment.

Capabilities for extended deterrence

The balance of military capabilities gives us the first measure as to whether extended deterrence by punishment will hold against North Korea, an aspect that is especially critical against military provocations or other instances of short-term deterrence. Overall, the state of U.S. nuclear weapons remains unparalleled in the current unipolar international system (Lieber & Press, 2006). The nuclear balance as it stands and projections moving forward all remain highly favorable for the United States against regional nuclear states such as North Korea. In 2018, the United States deployed 1,550 strategic nuclear warheads and "an estimated 2,200 strategic and 300 non-strategic warheads in central storage" based on the projections made by the Federation of Atomic Scientists (FAS) (Cordesman & Linn, 2015, p. 507; Woolf, 2017, p. 8). While the United States continues to downsize its nuclear arsenal due to the New START Treaty, its delivery system is simultaneously undergoing a process of modernization. For instance, the U.S. Air Force is in the midst of "modernizing the Minuteman missiles, replacing and upgrading their rocket motors, guidance system, and other components" while the U.S. Navy is "designing a new Columbia class submarine that will replace the existing fleet beginning in 2031" (Woolf, 2017, summary). Furthermore, with the new non-strategic B61-12 bombs scheduled to replace and update the older variants (B61-3, B61-4, and B61-10), the U.S. is similarly modernizing its tactical nuclear arsenal (Montgomery, 2016, pp. 14–15).

As it stands, the overwhelming U.S. nuclear capabilities can easily overwhelm North Korea's small arsenal even in the most pessimistic of scenarios in $t + 1$ and without the added THAAD defense capability (Kristensen & Norris, 2018; Wit & Ahn, 2015). Though it is true that North Korea has made rapid progress on the ballistic missile technology the past few years, as evidenced in the latest tests in 2017, North Korea is yet to master and demonstrate the reentry technologies without which its ICBMs cannot strike the U.S. mainland (Kristensen & Norris, 2018, pp. 46–48). Such strategic nuclear arsenals are further supplemented with U.S. military commitment to the Asia-Pacific region at the conventional level; approximately 60% of Navy and Air Force assets and overseas-based processes have either been assigned to the U.S. Pacific Command (PACOM) or are scheduled for deployment to the region by 2020.[13] Thus, the nuclear gap along with the U.S. military commitment to the region prove to be more than enough for deterrence by punishment to remain credible to Pyongyang. As Dennis Blair, former commander of PACOM and director of national intelligence, succinctly noted in his testimony to the U.S. Senate in January 2018: "North Korea has not used nuclear weapons for … fear of retaliation" (Situation on the Korean Peninsula, 2018). Massive retaliation based on the current nuclear and conventional balance should serve as strong deterrence mechanism against any North Korean nuclear attacks or military provocations.

Credibility and commitment of extended deterrence

Credibility serves as another critical underpinning of extended deterrence for both allies and adversaries (O'Neil, 2011, p. 1445; Snyder, 1961, pp. 13–14). Or put it differently, for extended deterrence to hold the United States needs to persuade North Korea that it is "willing to accept high costs in defense of an ally even in situations where its national interests are not self-evident" (Smith, 2015; Huth, 1999, p. 34). The extent of the credibility of extended deterrence is a function of the perceived U.S. interests in the region and its nuclear posture it holds (Murdock & Yeats, 2009). While difficulties are certainly associated with the application of the term, credibility is not seriously challenged under the current extended deterrence framework as both components are firmly in place.

The United States continues to hold strong interests in the region in the post-Cold War era, a strategic shift that has been in the makings since the early years of the George W. Bush administration (Department of Defense, 2014). Strategic priorities have shifted towards Asia-Pacific under the American rebalancing strategy and its commitment to the region was captured by the policy of "three mores": "more interest, more engagement, and more quality assets" (Cordesman & Linn, 2015, pp. 29–30). Fundamental to the rebalancing strategy are the U.S. alliance with Japan and ROK, the lynchpin to regional security in the region, especially in dealing with a nuclear-armed North Korea (Smith, 2015, p. 11). As such, extended nuclear deterrence remains a viable option as long as the United States provides alliance-related assurance to South Korea against potential North Korean attacks even in the post-Cold War era (Knopf, 2012, pp. 381–382; Pifer et al., 2010, p. 32).

To this end, successive U.S. administrations and the official statements and documents of various government branches have continuously reaffirmed its security commitment to the U.S.-ROK alliance and to the maintenance of extended deterrence in East Asia. Immediately following North Korea's nuclear tests on October 9, 2006, then President Bush released a White House statement through which he "reaffirmed to our allies in the region, including South Korea and Japan, that the United States will meet the full range of our deterrent and security commitments" (New York Times, 2006). Under the Barack Obama administration, commitment to extended deterrence under the U.S. nuclear umbrella and security assurances towards South Korea has been continuously reinforced. ("Joint Vision," 2009). Similarly, the 2010 Nuclear Posture Review (NPR) reemphasized the credibility of the U.S. nuclear umbrella and its commitment in "strengthening bilateral and regional security ties and working with allies and partners to adapt these relationships to 21st century challenges" (Department of Defense, 2010, p. xii).

Such policy stance of extended deterrence and reassurance to South Korea has been strengthened and further stressed through diplomatic channels the past few years. After the Joint Statement of the 2016 U.S.-ROK Foreign and Defense Ministers' Meeting, mutual commitment to defend ROK was reaffirmed and "Secretaries [John] Kerry and [Ashton] Carter reiterated the ironclad and unwavering U.S. commitment to draw on the full range of its military capabilities, including the U.S. nuclear umbrella … to provide extended deterrence for the ROK" (Department of State, 2016). Commitment to extended deterrence would continue in the Donald Trump administration, as the United States reaffirmed security ties with close allies in East Asia in face of continuing North Korea's missile and nuclear tests. Key members of the Trump administration have stressed the importance of U.S.-ROK alliance as the key to extended deterrence. After speaking to his counterpart, Minister of National Defense Min Koo Han, Defense Secretary James Mattis reaffirmed that the United States remained "steadfast in its commitment to the defense of the ROK" and "emphasized that any attack on the United States or its allies will be defeated, and any use of nuclear weapons will be met with a response that is effective and overwhelming" (Department of Defense, 2017a). Following North Korea's sixth nuclear test on September 2017, Mattis again firmly signaled U.S. commitments to the defense of South Korea and emphasized any threats emanating from North Korea would be met "with a massive, effective, and overwhelming military response" (Department of Defense, 2017b). Similarly, Vice President Mike Pence and then-Secretary of State Rex Tillerson emphasized the alliance as serving the "linchpin of peace and security" while Mattis stressed the importance of the defense relationship between the two countries (Anderson, 2017, p. 155) Such U.S. commitment, both to the region and specifically the ROK, speaks directly to the strengths of extended deterrence in face of North Korean threats.

Extended deterrence by punishment continues to underpin the Trump administration's strategic logic against North Korean nuclear and missile threats. After reports of Pyongyang's success in producing miniaturized nuclear warheads for ballistic missile delivery and statements on plans to test four Hawsong-12 intermediate-range ballistic missiles in mid-August 2017, both Trump and Mattis spoke of massive retaliation and promised to rain "fire and fury" that could destroy much of North Korea (Baker & Choe, 2017; Baker & Harris, 2017). After additional ballistic missile tests by Pyongyang a month later, Trump sternly stated in his first United Nations General Assembly address that if the United States is "forced to defend ourselves or our allies, we will have no choice but to totally destroy North Korea" (Borger, 2017). Perhaps the extended deterrence by punishment logic is best captured in the administration's 2018 NPR: "Our deterrence strategy for North Korea makes clear that any North Korean nuclear attack against the United States or its allies and partners is unacceptable and will result in the end of that regime" (Department of Defense, 2018, p. 33). Such statements speak to the confidence in and effectiveness of the extended deterrence by punishment framework against North Korea that is already in place.

In addition, greater institutionalization of the alliance enhances the effectiveness of U.S. security guarantees to its allies and further strengthens the credibility of extended nuclear deterrence against a nuclear-armed North Korea (Montgomery, 2016, p. 15). Recently, more attempts have been made in this direction between the United States and ROK through the Extended Deterrence Policy Committee (EDPC) (Santoro & Warden, 2015, pp. 151–152). The 42nd U.S.-ROK Security Consultative Meeting in 2010 explicitly outlined the aim "to institutionalize an Extended Deterrence Policy Committee, which will serve as a cooperation mechanism to enhance the effectiveness of extended deterrence" ("Joint Communiqué," 2010). This was recently reaffirmed in the 50th U.S.-ROK Security Consultative Meeting (2018) in Washington, DC ("Joint Communiqué," 2018). Within this framework, a ROK-U.S. Counter-Provocation Plan was also signed in 2012 to develop a combined response system against North Korean provocations (Cordesman & Linn, 2015, p. 19; Smith, 2015, p. 16) and an Extended Deterrence Strategy and Consultation Group (EDSCG) was established in 2016 and regularized under the Trump and Moon Jae-in's administrations to "strengthen the Alliance's posture and reinforce the U.S. commitment to extended deterrence" (Department of State, 2017). Furthermore, these cooperative measures can potentially provide the basis for further discussions on matters of joint doctrine and practices between the two sides in enhancing the credibility of extended deterrence framework (Davis, Wilson, Kim, & Park, 2016, p. 16).

Some scholars and analysts, as part of the fourth wave of deterrence research, have questioned whether credibility can be sustained against rogue states in the post-Cold War era (Knopf, 2010, pp. 6–7; Payne, 2000). In response, they have called for a tailored deterrence posture against North Korea, of which BMD is part of (Roberts, 2016). While we do not outright reject the application of tailored deterrence, we argue that it is neither necessary nor feasible at this stage against North Korea. First, as critics have noted, it is very difficult to get detailed information about Pyongyang's decision-making process and intentions, without which the applicability of the tailored deterrence framework is undermined (Jackson, 201], pp. 291–292). Second, credibility does not necessarily have to operate with 100% assuredness for extended deterrence to hold. As scholars have pointed out, leaders in Pyongyang only need to believe that the United States might respond to an attack for extended deterrence to remain credible (Jervis, 2003, p. 321; Lebovic, 2007, p. 8). Moreover, 100% assured credibility is difficult to achieve and rather costly even with the implementation of the THAAD system given the above outlined countermeasures available to Pyongyang. As such, the missile defense system on the Korean peninsula only adds marginal value to the existing extended deterrence framework.

In sum, maintaining the status quo through extended deterrence by punishment seems to be an effective and relatively inexpensive means through which South Korea can overcome the problems posed by nuclear asymmetry. First, the threat of massive retaliation remains credible due to North Korea's limited nuclear arsenal and problematic delivery platform. Moreover, given recent technological developments in the post-Cold War era, such as weapons accuracy and remote sensing (for instance Lieber & Press, 2017), the existing U.S. extended deterrence by punishment should prove to be even more credible in period $t + 1$ against small states such as North Korea. With an effective counterforce system already in place through the US-ROK alliance structure and continuing American commitment to the region, it is redundant and needlessly costly to further pursue the THAAD option on the Korean peninsula.

Second, though Pyongyang's motivation is anyone's guess (or very difficult to determine), many suspect that its leadership is basing its pursuit of nuclear weapons on minimal deterrence (Park, 2013, p. 185). As such, theoretical and policy grounds for the implementation of THAAD may not be as strong as its advocates posit, particularly in the context of missile defense. Rather than overreacting to North Korea's growing nuclear and missile capability, therefore, decision-makers in Washington and Seoul should focus on enhancing the credibility of the existing extended deterrence framework through declaratory statements and further institutionalization of the alliance structure.

Conclusion

The deployment of the THAAD system to South Korea has been politically controversial and strategically contentious in the region to say the least. As such, we narrowed our analytical scope to the military aspect and tackled two foundational questions which, we believe, remains at the heart of this complex issue. The first question is on the defense capability of the THAAD system. We challenged the widely-held qualified optimism by showing that the readily available and relatively inexpensive countermeasures–decoys, tumbling and spiral motions, and outnumbering–make North Korean missiles difficult to offset and the defense value of the THAAD short-lived. Second, we argued that given the United States' overwhelming nuclear and conventional retaliatory capability, and continuing commitment in the current U.S.-ROK alliance structure, strategic stability on the Korean peninsula is best served by the extended nuclear deterrence by punishment already in place. Rather than adding a defense system that is technologically challenged with diminishing marginal value in return, the policy focus should be on the management and strengthening of the credibility of the existing extended deterrence framework.

While it is tempting to link the two aspects and argue that the THAAD deployment was strategically unwise and counterproductive, we caution against equating the low interception capability to an argument against deployment and for its outright withdrawal from the Korean peninsula. It should be reminded that even within the U.S.-ROK alliance, THAAD had never been a mere technical issue but increasingly become one about alliance credibility. Since THAAD deployment has been mutually agreed and already implemented, a push for withdrawal can be easily channeled to Washington's concerns about ROK's credibility and commitment as an ally. Subsequently, the U.S. commitment to the alliance and overall credibility of the extended deterrence may weaken.

Our pessimistic assessment, therefore, challenges but does not necessarily invalidate the overall rationale for deployment in South Korea. This is because the desirability of the THAAD deployment needs to be computed out of a more complex, long-term, and highly strategized equation, which includes other contentious dimensions such as the credibility of U.S. extended deterrence, a regional strategic balance between the United States and China, and security-trade linkages in the ROK-China relationship. In short, it is one matter to dismiss missile interception capability but quite another to deny its strategic value as a whole. Whether to deploy or withdraw THAAD, accordingly, must balance competing policy prescriptions out of the highly subjective and politicized components of the overall controversy. The analytical scope of this paper was limited to the technical viability, and therefore it cannot resolve the overall THAAD controversy alone, nor did it intend to.

Our assessment, however, contributes to the discussion in several more nuanced and significant ways. Most immediately, it suggests that THAAD deployment cannot be justified solely on the grounds of missile defense. This point needs to be highlighted because a creation of “additional shield” against “growing missile threats” has arguably been the most frequently cited line of rationalization for THAAD deployment and, similarly, against its possible withdrawal. Such line of argument is unwarranted. THAAD is particularly vulnerable to a range of cheap and readily available countermeasures against which no effective counter-countermeasures are found today. In general, both the costs and available technology distinctly favors missile offense over defense system.

Furthermore, the weak foundations of the defense argument warn against a danger of breeding overconfidence in defensively ineffective and unsustainable THAAD. The misguided optimism is a source of concern because states who believe in the possession of sufficient damage-limitation capabilities are more likely to opt for military solution than otherwise in times of heightened military tension. Our analysis shows that this assumption is far from plausible, and therefore any military action by the U.S.-ROK alliance entails a risk of nuclear retaliation that the THAAD is not equipped to handle to an extent conventionally believed. It also follows that deployment of additional THAAD batteries, as advocated by some policy circles, would be of little value to the defense capability, and thus not advisable.

Instead, THAAD only makes sense for both Seoul and Washington when it is viewed and employed primarily in the context of alliance credibility management. Seoul, for instance, is better advised to disregard the THAAD defense capability, and instead focus on weighing the benefit of demonstrating its commitment to the U.S.-ROK alliance and the current extended deterrence against strategic costs and risks, most notably with diplomatic and economic backlash from China. Washington, on the other hand, may view Seoul’s decision as a litmus test for Seoul’s credibility as an ally, but is ill-advised to treat it as a reliable defense system for South Korea and its troops stationed in the peninsula.

Lastly, THAAD case is a reminder for policymakers and analysts of an iterative nature of security competition which often gets lost in the policy and academic discussions. In evaluating military capability of new weapon system, the availability, cost, and effectiveness of countermeasures should be key criteria. Unfortunately, their technical vulnerabilities to countermeasures often succumb to other political and economic considerations. Overlooking the dynamics of security dilemma is deeply problematic. It does not only distort the focal point of debate and misrepresent the true cost and benefit of adopting weapons under consideration, but also can potentially result in making suboptimal choices.

Acknowledgements

The authors thank Paul Avey, Charles Glaser, Mike Mochizuki, Seung Joon Paik, Kimberly Peh, and two anonymous reviewers for their helpful comments. Previous drafts of this article were presented at the ISA Hong Kong and ISA ISSS-ISAC Washington, DC in 2017. For valuable research assistance, the authors thank Kian Yang Tan.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Notes

1 THAAD is a latest ballistic missile defense (BMD) system developed in the United States, designed to intercept short, medium, and intermediate range ballistic missiles at their terminal flight stage. While THAAD debate is shaped by North Korea's growing nuclear threats, the THAAD interception capability technically covers both missiles armed with conventional and nuclear warheads. For technical specifications, components, defense capability, and history of THAAD, see Center for Strategic and International Studies (2017). The U.S. Forces in Korea (USFK) deployed one battery of THAAD in March 2017 which became operational in May. It is stationed in Seongju, the southeastern region of the Korean Peninsula. See (Choe, 2017)

2 The debate intensified after North Korea fired a Nodong missile to high altitude on March 2014. This unprecedented launch pattern raised a suspicion that Pyongyang is seeking to exploit a technical gap in the existing PAC-3 system, which can intercept incoming missiles at lower altitude only (Chosun Ilbo, 2014).

3 The tension reached its peak when President Trump remarked, "why are we paying a billion dollars? So I informed South Korea if it could be appropriate if they paid … We're going to protect them. But they should pay that … " (Reuters, 2017).

4 SSPk is defined as "the probability an individual interceptor will collide with and destroy a missile or warhead" (Elleman & Zagurek, 2016, pp. 5–6).

5 Indeed, many critics contend that Pyongyang's ballistic missile program is eyeing at Alaska and the U.S. western coast, which requires missile flight out of the atmosphere and reentry technology.

6 Suh (2017) raises an action-reaction possibility but falls short in detailing countermeasures.

7 We exclude one other major countermeasure, preemptive strike on the BMD system. See Sessler et al. (2000, p. 48).

8 The X-Band radar has two modes – Terminal Mode (TM) and Forward Base Mode (FBM). TM operates a shorter range than FBM. It is reported that the X-Band in South Korea would operate on TM as the radar is expected to not only detect, but acquire, track, and discriminate ballistic missiles in the terminal phase of flight. (Raytheon, n.d.).

9 This is a slight variation from Wilkening (2000) which divides countermeasures into “circumvention,” “defense suppression,” “saturation,” and “qualitative improvement in the offense.”

10 Other countermeasures include cutting a rocket into multiple pieces creating potential alternative targets for interceptors. They are, however, more useful against the GMD. X-Band with TM (as set up in South Korea) is reportedly able to discriminate a real warhead.

11 It is estimated that North Korea has no less than 200 missile launchers (Office of the Secretary of Defense, 2017, p. 17.

12 The Chevaline Project, the British initiative in the 1970s to develop missile technology capable of penetrating the Moscow’s ABM, allegedly cost £1,000 million by 1980 (Baylis & Stoddart, 2003). The cost and technology have becoming less prohibitive over the years, however (Sessler et al., 2000, p. 39).

13 The U.S. Air Force will be committing 60% of combat F-22s to the region (Cordesman & Linn, 2015, pp. 29–30).

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