2002

The access deterrence scenario: A new approach to assessing national missile defenses

Franck, Raymond; Melese, Francois

Carfax Publishing

Raymond Franck & Francois Melese (2002) The access deterrence scenario: A new approach to assessing national missile defenses, Defense & Security Analysis, 18:3, 227-238, DOI: 10.1080/14751790220002334

https://hdl.handle.net/10945/71698

Defense & Security Analysis Vol. 18, No. 3, pp. 227–238, 2002

Carfax Publishing
Taylor & Francis Group

The Access Deterrence Scenario: A New Approach to Assessing National Missile Defenses

Raymond E. Franck, Jr

Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA 93943, USA

Francois Melese

Defense Resources Management Institute, Naval Postgraduate School, Monterey, Monterey, CA 93943, USA

INTRODUCTION

This paper proposes a scenario called "Access Deterrence", for assessment of national missile defense (NMD) when non-peer competitors to the United States practice asymmetric warfare with Weapons of Mass Destruction (WMD). The "Access Deterrence" scenario postulates a hostile, non-peer, regional power (or "player"), Country X, with designs on one of its neighbors, Country Z. Left to its own devices, X can quickly defeat Z's military forces and occupy that country. The *status quo* powers, with US leadership, seek to deter X (or failing that, defeat any invasion of Z in a theater war using methods derived from the contemporary Revolution in Military Affairs). The scenario posits that X has ballistic missiles capable of striking the US homeland, and that X can threaten to use them should the US intervene on behalf of Z.

The next section describes the scenario in more detail, including a narrative description of the key components of the situation: the players (X and US), their possible actions and reactions (or strategies), and the outcomes (ranging from "Peace" to variants of "Homeland War"). A preliminary analysis of the scenario using standard tools of game theory is presented in the section following. A distinguishing feature of the model presented is consideration of different variants of US and Country X player types. The country types are differentiated through their preference orderings of the

This essay contains opinions and judgements of the authors. It does not necessarily reflect positions held by the US Departments of Navy or Defense.

ISSN 1475-1798 print; 1475-1801 online/02/030227-12 © 2002 Taylor & Francis Ltd
DOI: 10.1080/14751790220002334

possible outcomes of the game. Our intent is to explore the effects of (a) intensity of US interests involved, (b) X's preference ordering for the outcomes (X's player type), and (c) US defenses against homeland missile attack. A more complete categorization and explanation of player types is offered in the next section.

This variation of the Access Deterrence game is then solved with both players "looking ahead and reasoning back".[1] The sequential nature of the decisions in this particular model is readily captured using the extensive form as a game tree.[2] In some cases, NMD does not alter the expected outcome; in other cases, NMD can have a substantial impact. For instance, if X is a type we characterize as a "Patient Revisionist", the model's outcome is "Peace" – with or without NMD. In contrast, if Country Z is a "major" US interest and X is a Patient Revolutionary, then the outcome is X occupying Country Z – which changes to "Peace" if the US has NMD. In the former case the value of NMD is negligible; in the latter it can be substantial.

These preliminary results also suggest the US should be thinking in terms of influencing outcomes in a favorable direction through its various military investments, including NMD. Game theory is a valuable tool to focus this discussion. The last section discusses possible extensions of the analysis and offers some concluding remarks.

THE ACCESS DETERRENCE SCENARIO

Most analyses of theater conflict conclude that US forces, with or without coalition partners, are sufficient to win handily in a theater war against a regional power like X.[3] Hence, there is good reason to expect opponents like Country X to take actions intended to disrupt, delay or preclude deployment to the relevant theater. Accordingly, the "Access *Denial"* scenario has received considerable attention. Access Denial posits military actions designed to disrupt and delay deployment of US and allied forces. An interesting variant of the same general idea is to *deter* (or preclude) deployment using (asymmetric) threats of attack with Weapons of Mass Destruction (WMD) against the US homeland. We call this latter situation the "Access *Deterrence"* scenario.

The main players

We posit "Country X" as a regional power seeking major changes to the *status quo*, including regional hegemony for itself. It has sufficient military power to defeat and occupy its neighbor (Country Z), barring significant forces deployed from outside the region. X would therefore find it highly advantageous to preclude outside intervention. To that end, X has developed a small, long-range ballistic missile force (perhaps a dozen warheads) capable of threatening significant parts of the Continental United States. However, that force is at least moderately vulnerable to a first strike using (precision) Weapons of Selective Destruction (WSD).[4]

The United States is the clear leader of the *status quo* powers. For that group, continued independence of Country Z is an interest of some importance. In particular, the US has planned for deployment of expeditionary forces to the region if needed, and made preparations in theater that facilitate deployment. While X likely assumes the

United States will bring a coalition force, this does not affect the essential calculations. In this scenario, the center of gravity of the opposing coalition is the United States. The United States alone can, with timely deployment of forces, defeat X. Without the United States, it is unlikely the coalition has either the means or political impetus to prevent X's occupation of Z. Therefore, any threats of homeland strike with WMD by X are most useful if directed against the United States.

A preliminary net assessment

The United States has military capabilities significantly greater than X. In any conflict with "conventional" weapons only, the US (especially with allies) is a strong favorite to defeat X. However, it is also reasonable to suppose that X may well have a stronger interest in occupying Country Z than the US has in Z's continued independence. Further, it is likely the United States would form a coalition against X – to facilitate access to the region if nothing else. The need not to offend coalition partners would likely restrict the options available to American decision-makers. It is also likely the coalition formed for military action disavows any hostile intentions toward the general population of X. Therefore, in most variants of the Access Deterrence scenario, this consideration limits both target selection and weapons choice for strikes against Country X. We therefore postulate the US "cares" more about potential civilian casualties and collateral damage in X than that country's political establishment does – a seemingly paradoxical view.

Our purpose

We engage in a preliminary exploration of the Access Deterrence scenario, highlighting variability of expected results with respect to the following:

1. the nature of Country X – "revisionist", "revolutionary" or "fanatic"; "patient" or "impatient";
2. the intensity of US interests in Country Z's independence – "major" or "vital"; and
3. the state of defenses against ballistic missile attacks targeted against the US homeland:
   (a) no significant change to current programs: Theater Ballistic Missile (TBM) defense plus long precision strike capabilities (which, among other things, provide significant pre-emptive options against Country X's long-range missile force); or,
   (b) NMD against a small-scale attack, the sort X might undertake.

The basic narrative

The basic narrative for the Access Deterrence scenario is as follows. Country X invades Country Z and quickly threatens to overrun Z's defenses, causing a serious problem for the US and its allies. In response, the US commences military deployments to aid Z. Observing this, X can threaten a WMD homeland attack against the United States (and

conceivably one of its allies). The US then chooses either to cease deployment, continue the deployment, or to undertake a pre-emptive first strike against X's long-range missile force while continuing to deploy its forces. If the US chooses to continue deployment, then X must decide whether or not to carry out its threat of a homeland strike.

The narrative is readily summarized in the decision tree illustrated in Figure 1. At each node, one party (US or X) makes a decision. At the end of each branch of the tree is an outcome. That is, the sequence of decisions determines which of several outcomes Country X and the United States reach. In this scenario, the possible outcomes are Peace (no disturbance of the *status quo*); Theater War; X occupying Z; and Homeland War in two variations (US strikes first or X strikes first).

Scenario outcomes

The "outcomes" are best described as follow-on chapters to the basic scenario. (They might also be considered the results of truncating the full decision tree.) The "Peace" outcome is simplest. X decides not to move now, perhaps waiting for a more favorable time. If the outcome is "Theater War" the US-led coalition deploys forces and engages in high-intensity conventional combat with X – with the US and allies being odds-on favorites to win. Without outside intervention, however, it is common knowledge that X occupying Z is an almost certain outcome – with everything this entails for X, Z and *status quo* powers such as the US.[5]

Outcomes featuring homeland strikes in our model come in two variants. On one hand, should the US strike first, initial operations would feature precision strikes intended to destroy X's missiles, and also disrupt the supporting command, control and communications structures. Any surviving X missiles could be (but not necessarily would be) launched in retaliation against the US homeland. On the other hand, should X strike first, the US would retaliate, probably in proportion to the damage received. With WMD strikes already undertaken, the US in all likelihood would be less selective in its choice of weapons and more willing to accept collateral damage in the X homeland – with attendant loss of life and property in X.

AN OVERLY TIDY FIRST LOOK AT ACCESS DETERRENCE

As indicated, this section uses standard game theory methods to explore one version of the scenario outlined above. Our intent is to examine the effect of US and X types reflected in ordinal preference orderings on the outcomes. This first model makes standard, but strong, assumptions about the game tree laid out in Figure 1. Most notable are the following: (a) the game tree structure is fixed and a matter of common knowledge;[6] (b) preference orderings are likewise common knowledge; and (c) as the game is played, both players know precisely their location in the game tree whenever it's their turn to make a decision.

This is a finite game of perfect information. As such, it always has a well-defined Nash Equilibrium in pure strategies.[7] We can find the equilibrium by "looking ahead and reasoning back".[8] It is also worth noting that we can solve any variation (by player

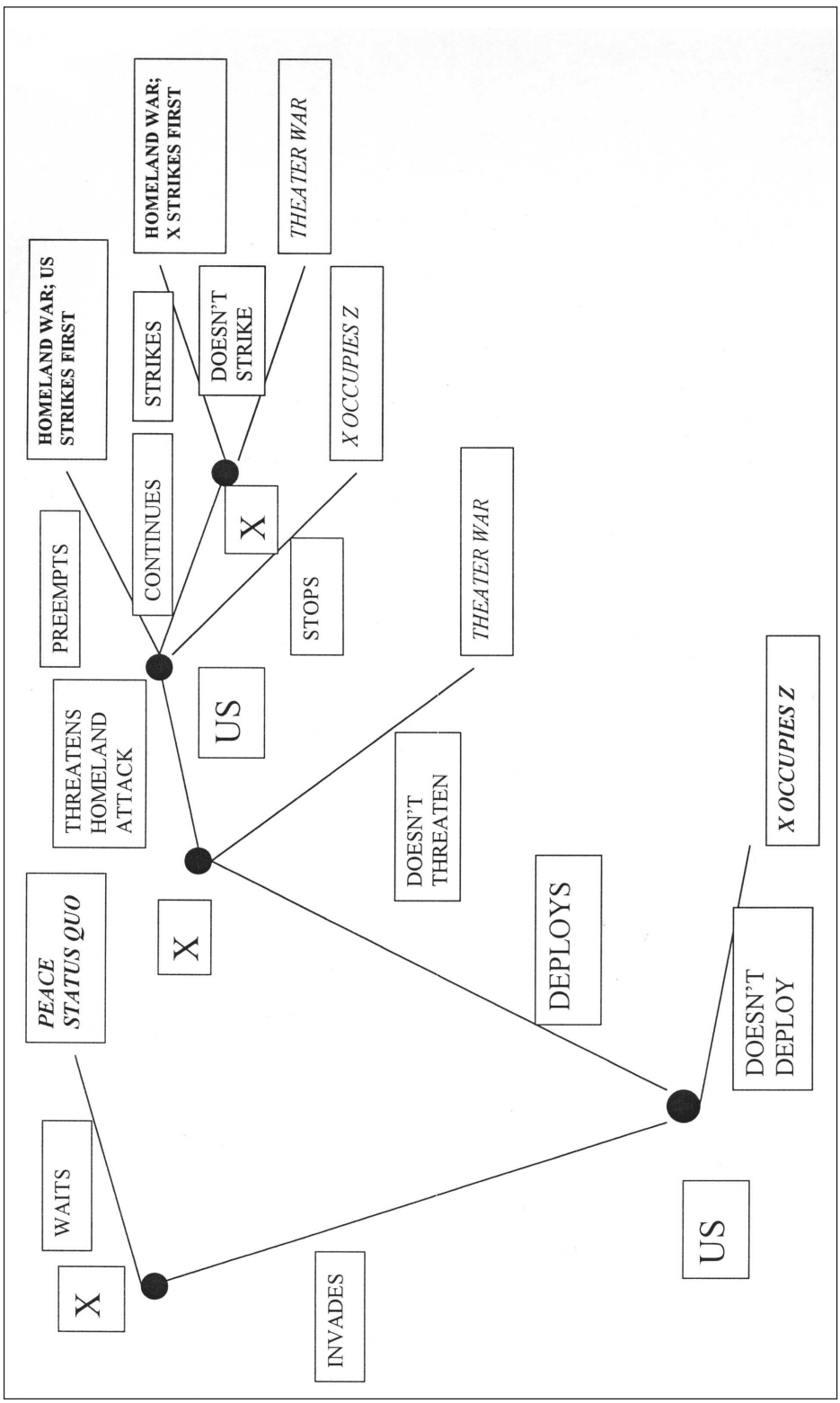

Figure 1: Access deterrence narrative

types) of the game in Figure 1 simply by knowing the players' preference orderings for the outcomes.

Plausible player types

As indicated in Figure 1, there are five possible outcomes in this Access Deterrence scenario:

1. Peace;
2. Theater War;
3. X occupies Z;
4. Homeland War, with a US first strike; and,
5. Homeland War, with an X first strike.

This yields 120 (5!) different possible preference orderings. While one may, with sufficient thought and ingenuity, build a reasonable case for many of these preference orderings, we believe some rankings are clearly more plausible than others.

Accordingly, we assume the following about US preferences:

1. Peace is always most preferred;
2. Theater War is second most preferred; and,
3. Homeland War with a US first strike is always preferred to Homeland War with a first strike from X.

These US types are summarized, with brief verbal characterizations, in Table 1.

We assume the following for Country X preferences:

1. X occupying Z is always most preferred; and,
2. Homeland War with a US first strike is always least preferred.

These Country X types are summarized, with brief verbal characterizations, in Table 2.

Six candidate Country X types and three different US types satisfy these assumptions. The different plausible US types (Table 1) are characterized by the intensity of interest in Country Z and the state of NMD defenses. We characterize intensity as "major" or "vital", drawing on Neuchterlein's classification.[9] If the intensity of US interest is "major", then X occupying Z would be regarded as a serious threat, and would be worth fighting for if combat against X does not entail major risks. If the intensity of interest is "vital", then the threat is regarded as "dangerous" and clearly worth fighting for while accepting major risks to do so. For this particular variant of the Access Deterrence scenario, a US NMD is reliable and highly effective against an X attack; also, those NMD capabilities are a matter of common knowledge.

For example, if US interest in Z's independence is "major" and the US has no BMD, we can expect that the US would be highly averse to Homeland War. Hence, "X occupies Z" is third in the list of preferences, "Homeland War, US strikes first" is fourth; and "Homeland War, X strikes first" is last. We believe we can characterize a US player with the preferences "Homeland War, US strikes first" as third, "X occupies Z"

Table 1:
US player types

Characteristics		*Preferences*				
NMD?	*Intensity of interests*	*First*	*Second*	*Third*	*Fourth*	*Fifth*
NO	MAJOR	Peace	Theater war	X occupies Z	Homeland war, US strikes first	Homeland war, X strikes first
NO	VITAL	Peace	Theater war	Homeland war, US strikes first	X occupies Z	Homeland war, X strikes first
YES	MAJOR	Peace	Theater war	Homeland war, US strikes first	X occupies Z	Homeland war, X strikes first
YES	VITAL	Peace	Theater war	Homeland war, US strikes first	Homeland war, X strikes first	X occupies Z

Table 2:
Country X player types

Characteristics		*Preferences*				
		First	*Second*	*Third*	*Fourth*	*Fifth*
Revisionist	Patient	X occupies Z	Peace	Theater war	Homeland war, X strikes first	Homeland war, US strikes first
Revisionist	Impatient	X occupies Z	Theater war	Peace	Homeland war, X strikes first	Homeland war, US strikes first
Revolutionary	Patient	X occupies Z	Peace	Homeland war, X strikes first	Theater war	Homeland war, US strikes first
Revolutionary	Impatient	X occupies Z	Theater war	Homeland war, X strikes first	Peace	Homeland war, US strikes first
Fanatic	Patient	X occupies Z	Homeland war, X strikes first	Peace	Theater war	Homeland war, US strikes first
Fanatic	Impatient	X occupies Z	Homeland war, X strikes first	Theater war	Peace	Homeland war, US strikes first

as fourth, and "Homeland War, X strike first" as fifth in two ways. Either a US with *major* interests involved with a reliable NMD in place, or with *vital* interests and no NMD would seem to have preferences in that same order.[10] Finally, a US player with vital interests involved and reliable NMD in place would rate "Homeland War, US strikes first" as third, "Homeland War, X strikes first" as fourth, and "X occupies Z" as fifth – as shown in Table 1.

In Table 2, an X player that considers "Peace" preferable to "Theater War" is characterized as "Patient" – willing to wait for better circumstances. An X that prefers "Theater War" to "Peace" is considered "Impatient".[11] Moreover, an X player which has "Homeland War, X strikes first" fourth on its preference list is characterized as "Revisionist", third as "Revolutionary" and second as "Fanatic".

Outcomes of the game as a function of player types

With the assumptions embedded in this model, we can readily determine the outcome of the Access Deterrence scenario as a function of player types. An example is provided in Figure 2, in which a US player with major interests in Z and no NMD meets a Patient, Revolutionary X type. The game is solved by working backward through the nodes of the decision tree. Working through one example illustrates the process and illuminates the nature of the model's assumptions.

At Node E in Figure 2, X decides between "Homeland War, X strikes first" and "Theater War". Being a "Revolutionary" type, X chooses to strike the US homeland. At Node D, the US chooses from the menu of striking pre-emptively against the X nuclear threat, continuing deployment of forces (without a pre-emptive strike), or ceasing deployment. Knowing X's choice at Node E, US chooses to stop deploying and accept "X occupies Z" as the outcome – the least of the evils available. Similarly, at Node C, X (knowing the US decision at Node D)[12] chooses to threaten a WMD attack against the US homeland. At Node B, the US (knowing what X would do at Node C and the US choice at Node D) perceives two paths that will end in X occupying Z.[13] Finally, at Node A, X (understanding the US quandary at Node B) chooses to invade Country Z. Therefore, when Player X is a "Patient Revolutionary" and Z is of "Major interest" to a US that has no NMD, the anticipated outcome is "X occupies Z".

We have found the outcomes associated with each of the 18 games associated with the three plausible US and six Country X preference orderings.[14] Those results are summarized in Table 3.[15] Examining the table reveals some interesting results. Against a Revisionist X (averse to a Homeland War in either variant), the US gets its best result (Peace), or next best (Theater War).[16] Against a Revolutionary or Fanatic X, a US with *either* a vital interest in X or NMD can expect a relatively good result (Peace or Theater War). A US with neither an intense (vital) interest in Country Z nor NMD will find itself permitting X to occupy Z.

More broadly, this first look indicates NMD can compensate for less intense interest on the part of the United States. That suggests the United States, and its allies, would have to be more selective about overseas commitments without NMD. It also suggests that a US without NMD might be more likely to find itself being tested and probed regarding its intensity of interest and degree of commitment in a variety of regions.

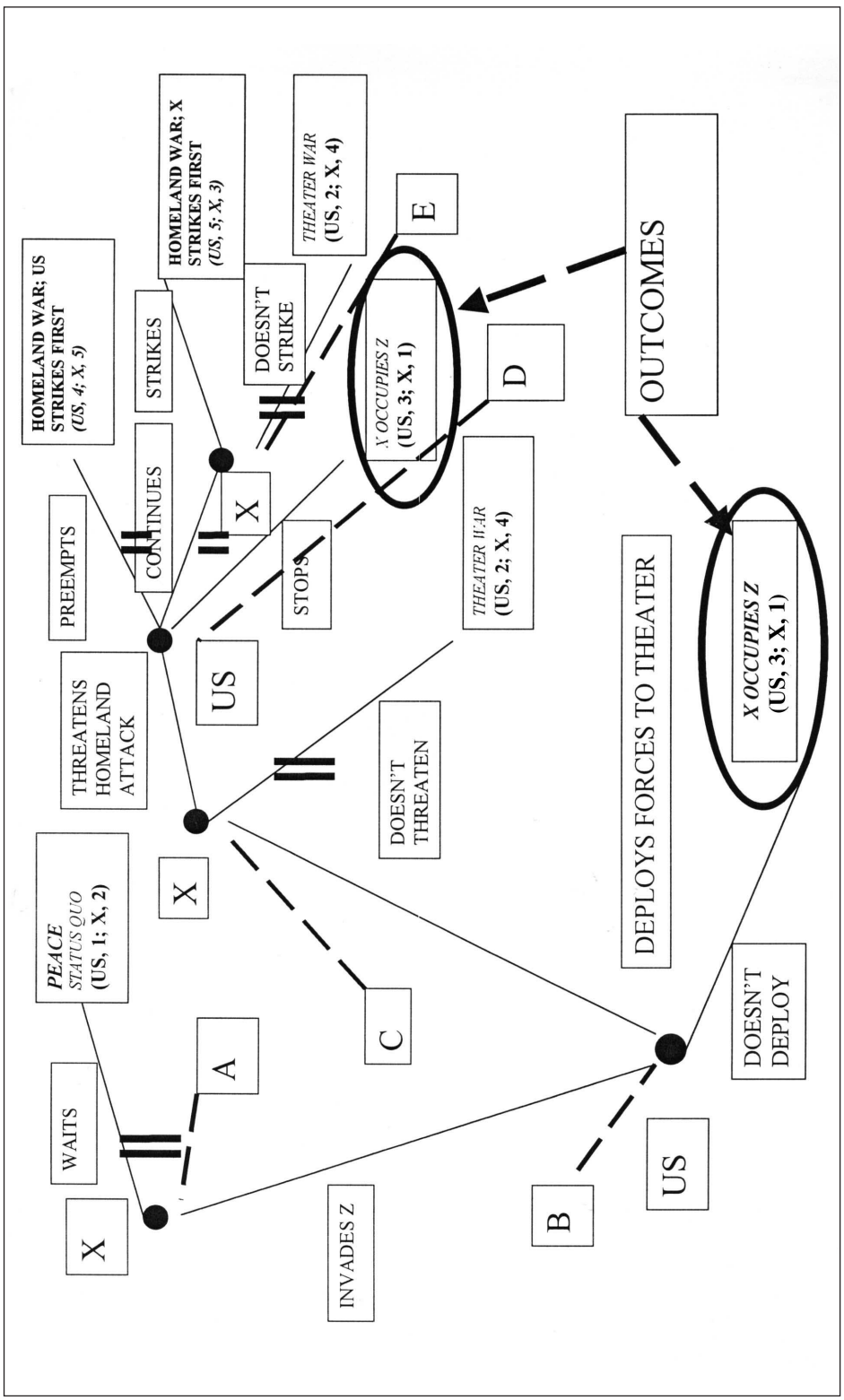

Figure 2: US with major interests in Z and no NMD against a patient revolutionary X

Table 3:
Outcomes vs. player types

	US type		
X type	*Major interest, no NMD*	*Major interest, NMD orVital interest, no NMD*	*Vital interest, NMD*
Patient Revisionist	Peace	Peace	Peace
Impatient Revisionist	Theater war	Theater war	Theater war
Patient Revolutionary	X occupies Z	Peace	Peace
Impatient Revolutionary	Theater war	Theater war	Theater war
Patient Fanatic	X occupies Z	Peace	Peace
Impatient Fanatic	X occupies Z	Theater war	Theater war

CONCLUDING REMARKS

While we believe the Access Deterrence scenario is of general and long-term interest, we hesitate to draw broad conclusions from the specific case we have examined here. As noted, the model specified in Section 3 is a simple, well-ordered situation. There are excellent reasons to believe life is more complex. If Country X should choose to threaten the US with homeland attack (Node C in Figure 2), then an acute international crisis would likely ensue.[17] Considerable experience demonstrates that such a crisis is not conducive to the orderly, rational deliberations assumed in Section 3. Furthermore, we know that errors, misperceptions, and analytical failures are common features of international affairs – especially in acute crises. Hence there seems to be considerable opportunity for further research.

One interesting extension of the model would be to introduce uncertainty as to player types and focus on the sub-game that would take place after X threatens homeland attack (Node C).[18] Another extension would analyze the same sub-game, but allow for "brinkmanship", or "threats that leave something to chance".[19] We believe this extension is also amenable to analysis using methods of political and behavioral sciences already applied to studies of acute international crises.

Another interesting possibility is the US developing a high-confidence "magnificent first strike" capability against X's nuclear force as a substitute for, or complement to, NMD. This first-strike capability could feature a combination of precision strikes with

Weapons of Selective Destruction and Weapons of Mass Effect (WME) to paralyze X's command control network. The WMEs themselves could be Electromagnetic Pulse (EMP) warheads and Information Warfare attacks intended to disrupt X's communications and data processing network.

Our dual objective has been, first, to present an initial draft of an interesting and relevant scenario for analyzing one part of the efficacy of NMDs,[20] and, second, to demonstrate that the Access Deterrence scenario is interesting, important, and amenable to analysis using game theory. This scenario is a useful stylization of military decisions in a conflict involving the US (plus coalition partners) against an aggressive regional power. The paper demonstrates that such a scenario can be used to assess the value of investment in NMD as well as the value of other alternatives.

NOTES

1. A. Dixit and B. Nalebuff, *Thinking Strategically: the Competitive Edge in Business, Politics and Everyday Life*, New York: Norton, 1991.
2. E. Rasmussen, *Games and Information: an Introduction to Game Theory*, Oxford: Blackwell, 1989.
3. The European Union, the People's Republic of China, Russia and India seem to be exceptions – although all currently have at least civil relations with the United States.
4. The nature of X's missile force is very important. Degree of (a) robustness of the Command, Control and Communications (C3) system and (b) physical vulnerability of the missiles themselves to a pre-emptive first strike are matters of particular concern. However, those matters are largely beyond the scope of this essay.
5. The story attached to "X occupies Z" could include non-military actions to get X forces out of Country Z.
6. In game theory literature, an item of information is common knowledge if it is known to all players, with each player knowing that all players know it, each player knowing that all players know that all players know it, and so on. Rasmussen, *op. cit.*, pp. 50–1.
7. E. Rasmussen, *op. cit.*, p. 126.
8. A. Dixit and B. Nalebuff, *op. cit*, p. 34.
9. D. E. Neuchterlein, *America Recommitted: United States Interests in a Restructured World*, Manhattan: University Press of Kentucky, 1991, pp. 13–22.
10. There are undoubtedly differences between these two US types, but we believe they lie in willingness to take risks among the various outcomes – a matter beyond the scope of the discussion here, but not beyond the scope of the scenario.
11. An "impatient" X may perceive a unique window of opportunity in the current situation. Alternatively, expectation that the correlation of forces will progressively worsen could make X impatient – arguably a key factor in the Japanese Empire's decision for war against the United States in 1941.
12. This implies that X knows that the US knows what X will do at Node E.
13. Although our model is too coarse for its consideration, there may be an interesting timing issue. If X issues its homeland strike threat before the US is clearly committed to deploying forces, then it's a "deterrent" threat. If X issues the threat after the deployment is clearly under way, and requires the US to reverse actions already taken, then it's "compellance". Experience indicates it's generally easier to deter than to compel.
14. A spreadsheet model that can accomplish this task is available from the authors on request.
15. There seems to be one counterintuitive result. A "patient, revolutionary" X ends up occupying Z, while an "impatient, revolutionary" X ends up in a theater war it will almost certainly lose. Since theater war is second choice for both parties, it is not surprising the

players find their way to that outcome in this particular game. In a broader sense, we might take this as an illustration of patience as a virtue, or alternatively conclude that our characterization scheme leaves something to be desired.

16. This indicates a revisionist X does not gain any appreciable advantage in acquiring a capability for a missile attack against the US. That leads to an interesting wrinkle perhaps worth further consideration. Country X could choose to acquire that capability intending to signal that it is "Revolutionary" or "Fanatic".
17. McClelland's classic on the subject identifies the likelihood of war or violence as the essence of an "acute international crisis". C. A. McClelland, *The Acute International Crisis*, World Politics 14, 1961, pp. 182–204.
18. The basic methodology is developed by Harsanyi. An application of that method to armed confrontations is essayed in Franck. J. C. Harsanyi, "Games with Incomplete Information Played by Bayesian Players . . .", Parts I, II and III, *Management Science* 14 (1967–8), pp. 159–182, 320–334, and 486–502, rpt. in H. W. Kuhn (ed.), *Classics in Game Theory*, Princeton University Press, 1997, pp. 216–88. R. E. Franck, *The Option of War and Arms Race Behavior*, unpublished thesis, 1982.
19. "Threat leaving something to chance" comes from Schelling (Chs. 7, 8). Dixit and Skeath (Ch. 13) has a particularly interesting analysis of brinkmanship, using the Cuban missile crisis of 1962 as a case in point. T. C. Schelling, *The Strategy of Conflict*, Cambridge: Harvard University Press, 1960, rpt. Oxford: Oxford University Press, 1977. A. Dixit and S. Skeath, *Games of Strategy*, New York: Norton, 1999.
20. There is at least one other part: how will Country X react to a US National Missile Defense, especially if it is effective? There's a follow on question: would the US rather live with the problem of being vulnerable to attack from Country X, missiles or the problem that would likely replace it after Country X adapts?