Nuclear Stockpiles and Arms Race Stability between the U.S. and China

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Strategic stability determines war and peace. As part of strategic stability, arms control stability significantly affects the overall relationship between rival states. In the years to come, a number of factors will influence nuclear arms race stability between the United States and China: the rising momentum for global nuclear disarmament, the development and deployment of missile defense systems in both countries, uncertainty with the introduction of conventional strategic weapon systems by one or both countries, and different nuclear strategies that the two countries might adopt. In order to understand the relative impact of the various factors on near- to mid- term arms race stability between the U.S. and China, this study uses quantitative modeling to reveal the complex bilateral interaction. Results of this analysis have implications for policy makers and analysts in both countries regarding the maintenance of arms race stability in the dynamic future.

Introduction

Since the beginning of the nuclear age, strategic stability between nuclear countries has been a critical component of great power interactions. Strategic stability is a concept in classical arms control theory which includes two elements of crisis stability and arms control stability. Arms race stability, widely seen as the foundation for regional and international security, is generally understood as "the condition wherein neither party to an arms competition will press military development or deployment in quest of major advantage, because such advantage is judged to be unattainable, however desirable".[2] During the late years of the Cold War, arms race stability between major nuclear powers was maintained through mutually assured destruction which was carried on into the post Cold War era.[3] Twenty years after the end of the Cold War, arms race stability between nuclear powers still rests on the concept of mutual vulnerability imposed by their nuclear forces.

The increasing momentum for global nuclear disarmament in recent years, however, requires us to reconsider the issue of arms race stability against the background of reduced nuclear arsenals. The question that deserves an answer is how global nuclear disarmament will affect arms race stability between nuclear weapons states in the process of reducing nuclear force levels and, if possible,

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[2] Gray, Colin S. 1980. Strategic Stability Reconsidered. *Daedalus* 109 (4):135-154.

[3] In comparison, the flexible response strategy adopted by Kennedy administration was not premised upon the idea of mutually assured destruction. Correspondingly, nuclear arsenals underwent significant increase during this period.

nuclear elimination. Speculation is already seen in academia, and scholars generally hold the view that strategic stability would probably decrease as the numbers of nuclear weapons in all nuclear weapons states go down, particularly when the numbers approach zero. No quantitative research has been done, nonetheless, to look at this process in detail and depict how exactly arms race stability will change over time as nuclear stockpiles decrease.

What makes the situation more complex is the introduction of missile defense systems. Countries including the United States have been developing and deploying midcourse missile interceptors for years. Latecomers like China have also embarked upon the path of developing missile defense systems and China tested its first midcourse missile interceptor in January 2010.[4] It is already known that in theory, missile defense systems of low effectiveness would undermine arms race stability between nuclear weapons states.[5] As a result, a legitimate question that follows is how the development of midcourse missile defense systems would affect arms race stability between the U.S. and China in the years to come, especially if both countries are to be involved in multilateral nuclear reductions in the future.

What further complicates the issue is the development of conventional strategic weapon systems by nuclear weapons states. At first glance, the development and deployment of conventional strategic weapons could help create a conventional deterrence capability which might play a supplementary role to existing nuclear deterrence and thereby reduces our reliance on nuclear weapons to deter military aggression. More importantly, the United States does not intend to develop a large scale non-nuclear long-range strike capability to compromise nuclear second strike capacities of other countries. The American Global Strike remains a niche capability including perhaps only a small number of long range weapon systems. However, because of deep-rooted mistrust between major nuclear weapon states, the introduction of conventional strategic weapon systems by one nuclear weapons state could still cause uneasiness in the mind of other nuclear weapons states because conventional strategic weapons have the potential to be used in a preemptive strike to disarm an adversary's nuclear forces. Conventional long-range strike vehicles might also trigger early warning systems and cause confusion and unnecessary reaction. As such, the introduction of conventional strategic weapons adds another layer of complexity to the issue of arms race stability between nuclear weapons countries.

Last but not least, nuclear weapons states' nuclear strategies could also significantly affect arms race stability between these countries. For example, if all nuclear weapons states stick to a nuclear strategy of minimum deterrence, it would be relatively easy to establish and maintain arms race stability because the role of nuclear weapons would become very limited and restrained under a minimum deterrence strategy – nuclear weapons states would only seek to maintain small but survivable nuclear retaliatory forces. However, the reality is that nuclear weapons

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[4] Jacobs, Andrew, and Jonathan Ansfield. 2010. With Defense Test, China Shows Displeasure of U.S. *The New York Times*, January 12.

[5] For a theoretic analysis on the impact of different types of missile defense systems on strategic stability, see, Li, Bin. 2006. *Arms Control Theories and Analysis*. Beijing: National Defense Industry Press.

states do have different nuclear strategies. The nuclear strategy of the U.S., for example, is different from that of China. Since the Cold War years, American nuclear strategy has been in favor of possessing the capacity to control escalation in a crisis, which means if the U.S. were attacked by nuclear weapons, the U.S. military should have the capacity to destroy the adversary's remaining nuclear weapons in order to prevent further nuclear attacks against America or its allies.[6] Such a strategy of escalation control is very different from a strategy of minimum deterrence and demands a larger and more formidable nuclear force than what is needed under a minimum deterrence strategy.

Accordingly, this research will analyze the possible evolution of arms race stability between the U.S. and China under a number of different scenarios. A series of models are established to help understand the impact of missile defense and conventional strategic weapons on arms race stability between the two countries, and the impact of different nuclear strategies will be incorporated into the models to reflect the complex reality of the issue under discussion.

Models and Comparison

Mutual Minimum Deterrence and Arms race stability

Model 1 (as shown in Figure 1) reflects the basic concept of mutual minimum deterrence between two nuclear weapons states (the U.S. and China in this model). The ultimate goal of nuclear forces of both countries is to make sure that their nuclear forces can survive a nuclear first strike from the other side and the number of survived nuclear weapons should be able to cause an unacceptable damage to the other country.

[6] It is necessary to note that the strategy of escalation control is different from the strategy of first strike. Escalation control is a reactive strategy to respond to an enemy's offense that has already happened, whereas first strike is a preventive or preemptive operation. Under a scenario of limited nuclear conflict, the objective of escalation control is to destroy the enemy's nuclear weapons that are deployed in the region of tension and that pose an imminent threat. It might not be necessary to destroy the entire nuclear stockpile of the enemy, which is the objective of first strike strategy. However, when fighting a nuclear enemy whose nuclear force is very small, the targets of escalation control and first strike might not look much different. In such cases, destroying an enemy's imminent nuclear threat is almost identical to destroying its entire nuclear capability.

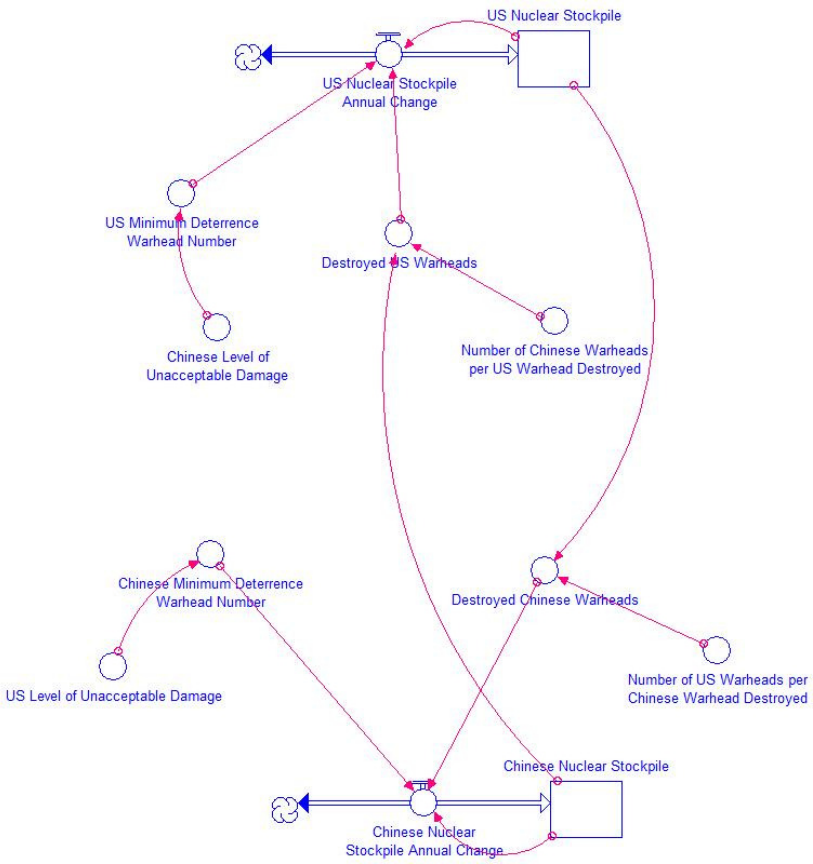

Figure 1: Model 1 - Simple Minimum Deterrence

The meaning of minimum deterrence is not as clear-cut as it should be. In the case of China, minimum deterrence refers to different nuclear strategies and nuclear postures in different historical eras. Before the mid 1990s, China's minimum nuclear deterrence was largely reliant upon geographical and numerical ambiguity of its nuclear forces. China's nuclear deterrence derived from the calculation that the U.S. would not be highly confident of its capability to destroy all Chinese nuclear forces and facilities in a first strike. Uncertainty played an important role in China's nuclear deterrence at that time. However, within the introduction of new strategic delivery systems, the foundation and meaning of China's minimum deterrence shifted from strategic uncertainty to assured retaliation. The land-mobile ballistic missile systems and the new generation of ballistic missile nuclear submarines are more survivable and resilient than older delivery systems. China has also made great efforts to reinforce its missile bastions, which raises the robustness of its nuclear retaliation capability. All these efforts have greatly increased the overall survivability of China's nuclear force, and it is reasonable to speculate that China has become increasingly confident about its nuclear retaliation capability. China's minimum nuclear deterrence nowadays, as a result, refers to an assured nuclear second strike capability, with the level of retaliation being kept at the lowest possible.

In this study, minimum deterrence refers to an assured nuclear retaliation capability that is kept at the lowest possible level. In current literature, however, there is no study that defines or explains what the lowest level means. Robert McNamara's criterion for unacceptable damage might reflective of the situation in the Cold War, but does not seem to be applicable any more. The consequences of 9/11 attack demonstrate that nowadays people and governments have a lower threshold of acceptable damage than before. It is therefore hard to believe that any government could accept the possibility of several major cities being hit by nuclear weapons. In this sense, this study sets the level of unacceptable damage as the damage caused by several survived nuclear warheads. Furthermore, China's level of unacceptable damage is set a little higher than that of the U.S., due to the generally believed Chinese tradition of pain tolerance and the lower level of China's economic development. Nonetheless, there is currently no consensus with regard to the levels of unacceptable damage in different societies and how to compare them. More research needs to be done to understand how the levels of unacceptable damage have evolved over time.

Another important figure in this model is the number of U.S. nuclear warheads that is needed to destroy one Chinese aimpoint, a concept that is introduced by Keir Lieber and Daryl Press.[7] Lieber and Press's study identifies 799 Russian aimpoints which they believe require 2890 U.S. nuclear warheads to destroy. In other words, in a scenario of a U.S. first strike against Russian nuclear forces, about four U.S. nuclear warheads are needed to destroy one Russian aimpoint on average, according to the 2006 study.[8] Accordingly, this study assumes that four U.S. nuclear warheads are needed in order to destroy one Chinese aimpoint.[9] To take into account China's nuclear offensive capability, the ratio for a Chinese first strike against the U.S. is set a little higher, e.g., five Chinese warheads are required to target one U.S. aimpoint. In practice, the exact ratios obviously are dependent on a series of factors, including the yields of attacking warheads, the height of detonation, the accuracy of attacking missiles, the robustness of attacked facilities, etc, but for the sake of calculation, it is fair to use the average ratios in the models of this study.

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[7] Lieber, Keir A., and Daryl G. Press. 2006. The End of MAD? The Nuclear Dimension of U.S. Primacy. *International Security* 30 (4):7-44.

[8] Although it might be true that it would probably take just one warhead to destroy an aimpoint, the consequences of missing the aimpoint is so devastating that war planners need to be absolutely sure that they destroy the aimpoint. Therefore, in order to reduce the uncertainty, as many as four warheads will be needed in practice to destroy one aimpoint, based on calculation in their study.

[9] This is a relatively general assumption. On the one hand, Chinese ICBM silos might not be as robust as Russian ones since Russian silos are mostly well hardened. On the other hand, Chinese mobile ICBMs make up a higher percentage in China's entire nuclear force than Russia's, and the percentage is increasing over time as China is retiring ICBM silos and introducing more mobile launch vehicles. Usually, it is take more warheads to destroy one mobile aimpoint than to destroy a silo. Therefore, it is reasonable to assume that on average four warheads will be needed to destroy one Chinese aimpoint.

Mutual Minimum Deterrence under Missile Defense

Model 2 is built upon the basic structure of Model 1 but incorporates the impact of missile defense into the equation. In reality, both the U.S. and China are developing (and the U.S. is deploying) missile defense systems, so Model 2 better resembles the reality of strategic interaction between the two countries.

The principle of minimum deterrence requires that both countries adjust the number of their nuclear weapons according to the stockpile of the other's nuclear weapons and missile interceptors. One country's nuclear stockpile should be sufficient for penetrating the other's missile defense system and conducting an effective retaliatory strike after absorbing a first strike.

Therefore, Country A's nuclear stockpile equals its minimum deterrence warhead number plus its destroyed warheads in a first strike.[10]

Country A's destroyed warheads is determined by Country B's nuclear stockpile and how many warheads on average are needed to destroy one nuclear weapon in Country A.

Country A's minimum deterrence warheads number is determined by Country B's level of unacceptable damage and how many warheads from Country A would be intercepted by Country B in a second strike.

The number of Country A's intercepted warheads depends on County B's missile interceptor stockpile and how many interceptors are needed to successfully intercept one warhead from Country A.

The same rules apply to County B in exactly the same way, and as a result, the two countries' nuclear stockpiles become interrelated in a dynamic manner. Furthermore, the stockpiles of both countries' missile interceptors are assumed in this model to increase over time in a linear way, although the rates of increase are different according to their different economic capacity and levels of research and development. Thus, the overall relationships between different variables are displayed in Figure 2.

[10] In this paper, the terms "stockpile" and "arsenal" all refer to the entire set of nuclear warheads that are usable, including those that are actively deployed and those that are in reserve but can be put in use within a relatively short period of time when necessary.

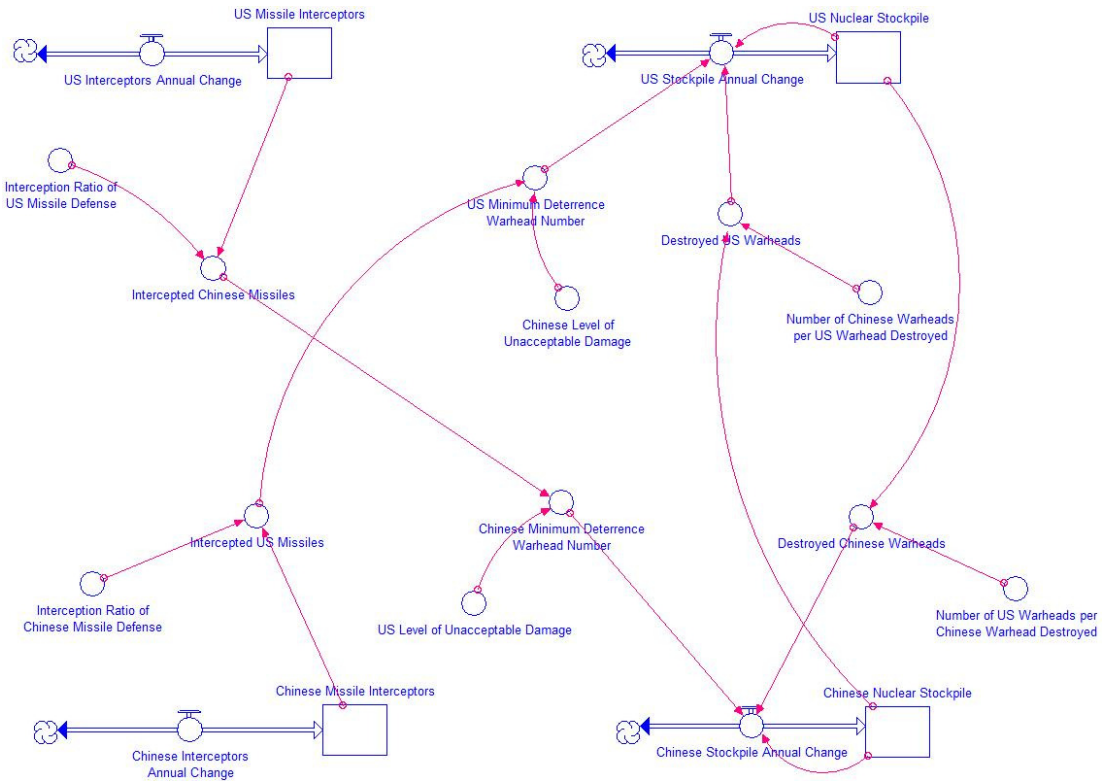

Figure 2: Model 2 - Mutual Minimum Deterrence under Missile Defense

This model assumes that more than one missile interceptor is required to destroy one incoming enemy warhead. This assumption is certainly subject to discussion. In practice, the ratio between incoming warheads and interceptors could be affected by the specific capabilities of deployed missile defense systems. Boost phase interception, for example, could be more effective than mid-course or re-entry phase interception because the enemy missile would not have released the multiple warheads that it might carry during the boost phase. It could become more difficult to intercept the warheads after they (and possibly together with decoys) have been released in mid-course or re-entry phase of the flight. Therefore, the interception ratio for Standard Missile defense systems might be higher than ground based mid-course missile defense systems. This study does not claim the interception ratio used in its calculation applies to different missile defense systems, but it does reflect the average estimated performance of current missile interceptors and meets the needs of this research.

In addition, this study assumes that both the U.S. and China will be deploying missile interceptors at relatively constant rates. This is a simplification of future development. In practice, the future deployment of missile defense systems may not resemble a linear increase. On the part of the U.S., the pace of the deployment of ground based interceptors may slow down, and the number of Standard Missile interceptors may increase very rapidly. As for China, it is not even clear whether China might be able to deploy missile defense systems in the near future, or has decided to deploy missile defense systems in a significant amount over the long term. It is hard to accurately predict the future development of missile

defense systems on both sides, but a pattern of linear increase is used in this study in order to facilitate calculation.

Escalation Control Strategy vs. Minimum Deterrence Strategy

As stated above, the current nuclear strategy of the U.S. is crisis escalation control, whereas the Chinese nuclear strategy is believed to be based on minimum deterrence. As a result, Model 3 is developed to reflect different strategies of the two countries (see Figure 3).

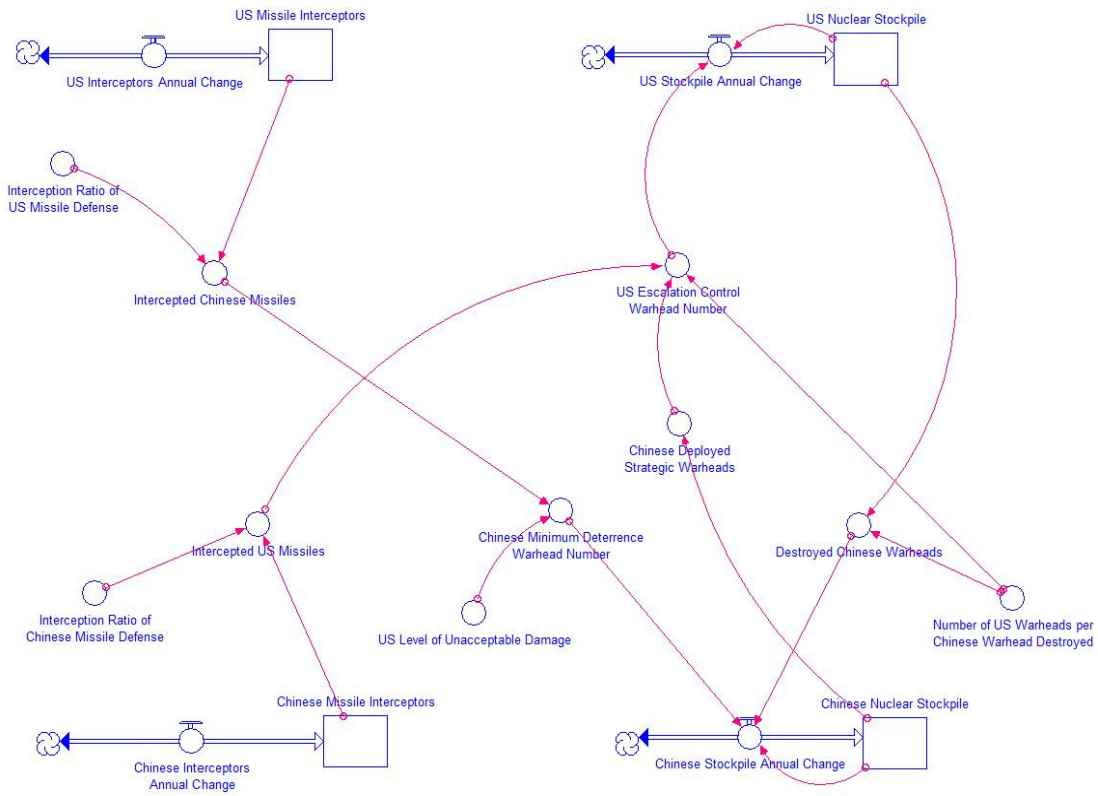

Figure 3: Model 3 - Escalation Control Strategy vs. Minimum Deterrence Strategy

Under crisis escalation control strategy, the U.S. nuclear forces should be able to launch a disarming strike and destroy Chinese deployed strategic nuclear weapons as soon as the U.S. detects that China is about to use its nuclear weapons or has already used nuclear weapons in an attack against the U.S., particularly in a crisis over Taiwan Strait. It is necessary to point out that, for the purpose of escalation control, the U.S. does not need to destroy all Chinese nuclear weapons but only those that are actually deployed and have a range long enough to threaten U.S. territory or oversea military bases. Short range nuclear missiles that cannot threaten the U.S. or nuclear weapons in storage are not included as targets in such escalation control strikes. Therefore, the number of U.S. nuclear weapons is defined as such that after penetrating China's missile defense system, the U.S. still has enough nuclear weapons to target and destroy all Chinese deployed strategic nuclear weapons. In the meantime, the Chinese nuclear strategy is still minimum deterrence.

Mutual Minimum Deterrence with both Missile Defense and Conventional Strategic Weapons

In order to study the impact of the introduction of conventional strategic weapons on arms race stability, Model 4 is created to bring conventional strategic weapons into the equation (as shown in Figure 4).

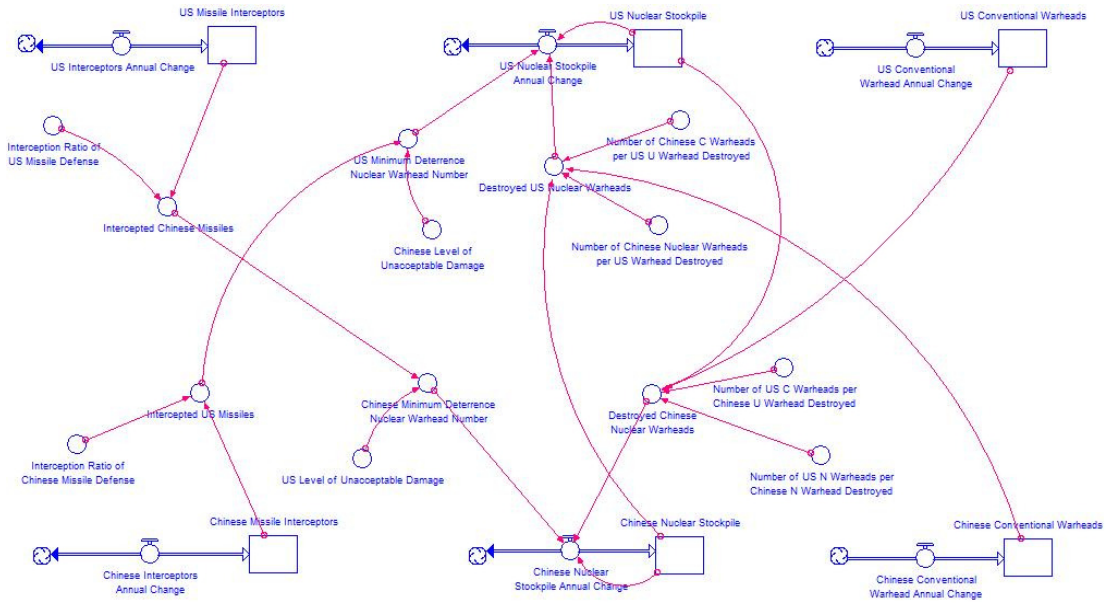

Figure 4: Model 4 - Mutual Minimum Deterrence incorporating both Missile Defense and Conventional Strategic Weapons

In Model 4, both countries are developing conventional strategic weapons (such as intercontinental ballistic missiles with conventional warheads) and are deploying these weapons in a gradual and incremental manner. Suppose both countries still stick to strategies of minimum deterrence. The logic and relationship of mutual minimum deterrence still applies, but the meaning of minimum deterrence is different after conventional weapons are introduced. Under current scenario, a country's nuclear force should be capable of not only surviving a nuclear first strike but surviving a first strike by a combination of both nuclear and conventional weapons.

Escalation Control Strategy vs. Minimum Deterrence Strategy (Incorporating both Missile Defense and Conventional Strategic Weapons)

The last model – Model 5 – takes into consideration both the impact of missile defense and conventional strategic weapons and looks into the scenario under which the U.S. adopts a nuclear strategy of escalation control whereas China sticks to a minimum deterrence strategy. This model incorporates all the main elements that might impact arms race stability and best resembles the complex situation that we are facing and probably will face in the near future (see Figure 5). Under the

scenario of this model, China maintains a nuclear force that is survivable to a first strike by a combination of U.S. nuclear and conventional strategic weapons, whereas the U.S. is dedicated to keeping its strategic force (a combination of nuclear forces and non-nuclear long-range strike forces) capable of destroying all Chinese deployed strategic weapons (both nuclear and conventional) at a time of crisis when a first strike is believed necessary to prevent further escalation.

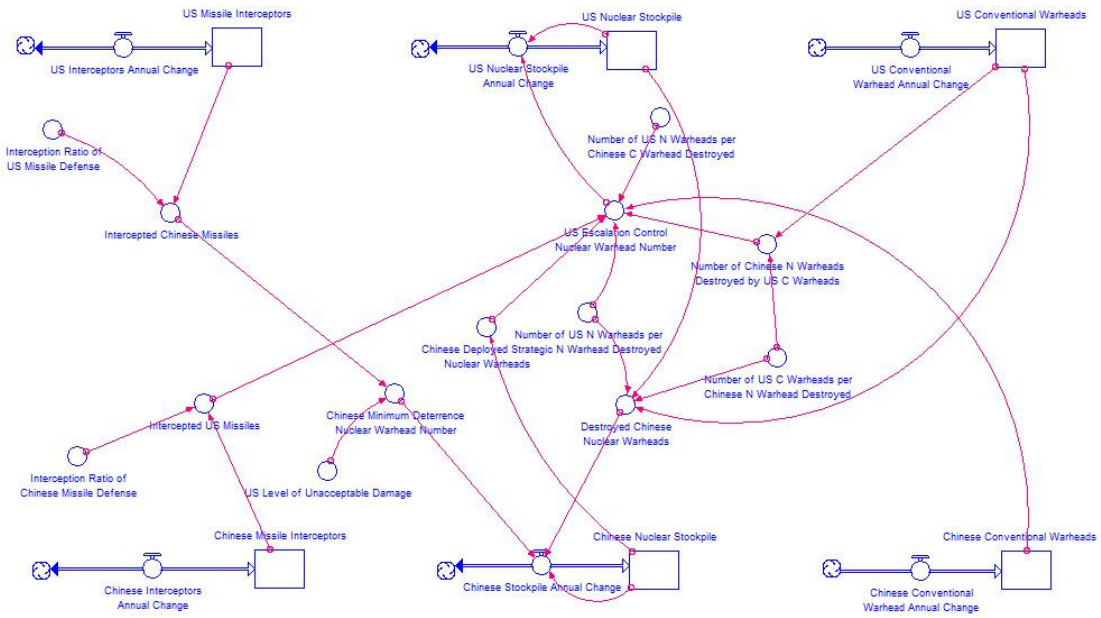

Figure 5: Model 5 - Escalation Control Strategy vs. Minimum Deterrence Strategy (Incorporating both Missile Defense and Conventional Strategic Weapons)

Results and Analysis

Current stockpiles of nuclear weapons and missile interceptors in the U.S. and China are reflected in this model.[11] All five models are run with the same initial values, so by comparing the results we can see the different impact of different factors on arms race stability between the two countries (see Figure 6 - 10).

[11] However, as discussed above, there is no readily available data with regard to variables such as the interception ratio and how many warheads are needed to destroy one nuclear weapon in a first strike. This is not an irresolvable problem, nonetheless, because reasonable estimations could be obtained from existing literature and open source military analysis. What is more important, the values of most of the variables in this model could change over time due to economic investment and technology development. As a result, by assigning different values to the variables, we can use this model to understand how different strategies of investment among different types of technologies and weapon systems could generate different results in the long run in terms of strategic stability between the U.S. and China.

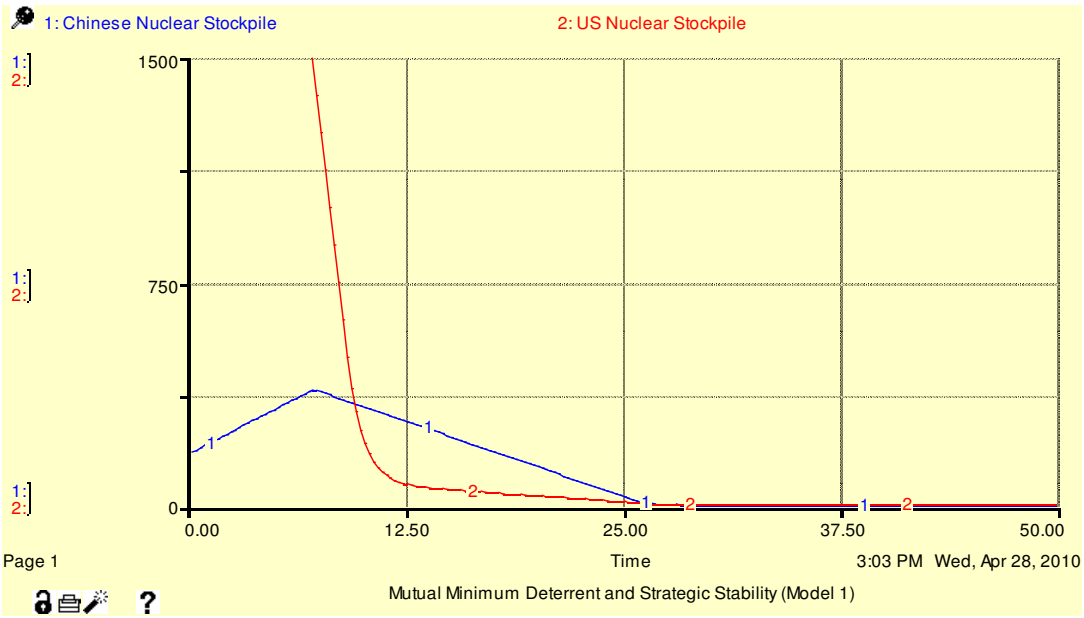

Figure 6: Mutual Minimum Deterrence and Arms race stability (Model 1)

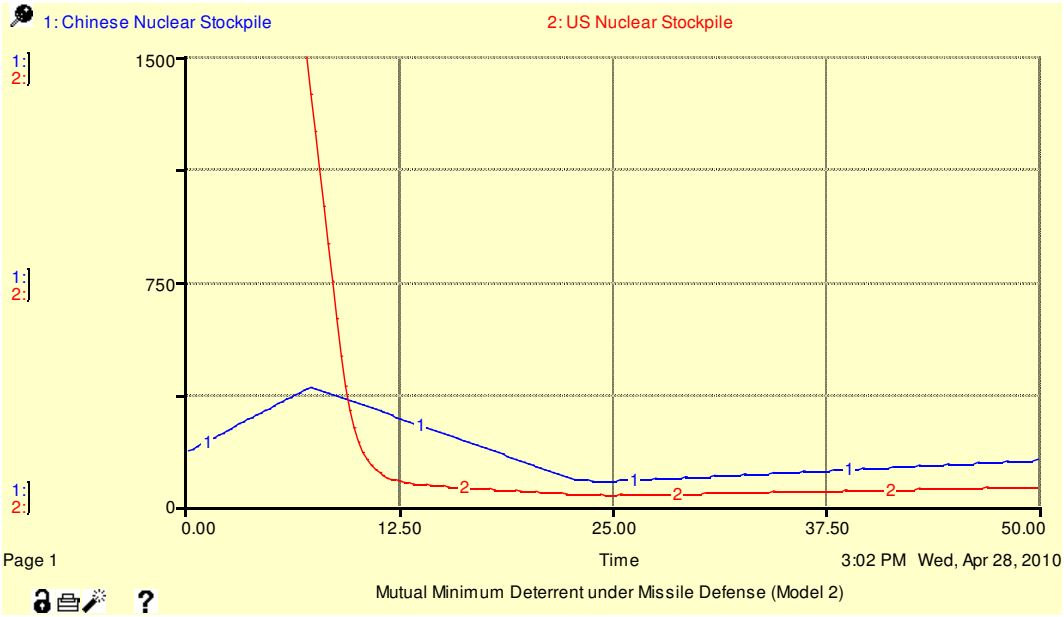

Figure 7: Mutual Minimum Deterrence under Missile Defense (Model 2)

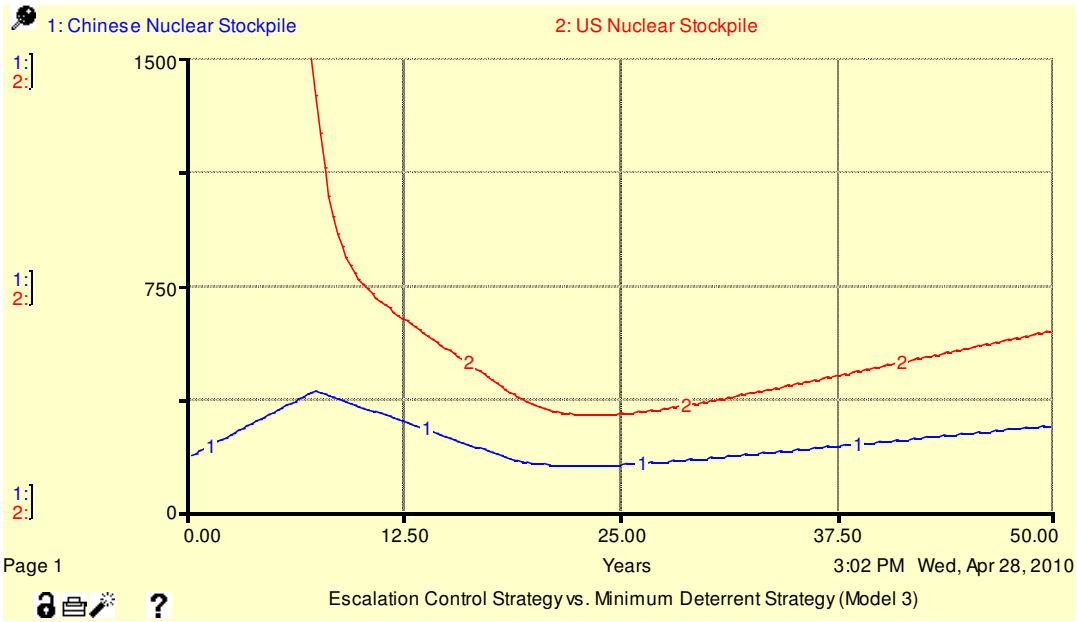

Figure 8: Escalation Control Strategy vs. Minimum Deterrence Strategy (Model 3)

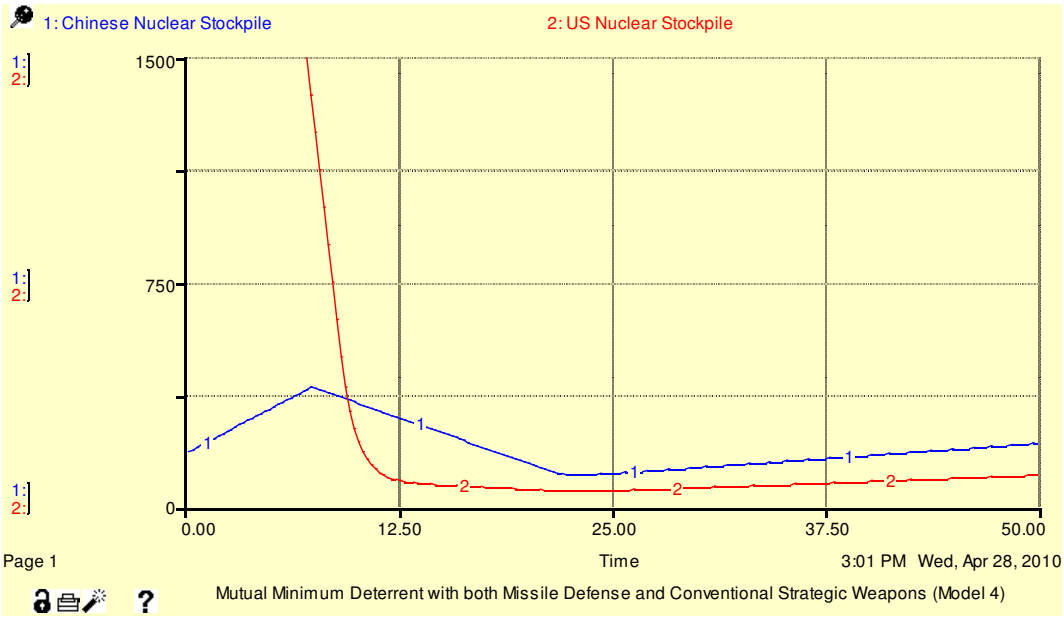

Figure 9: Mutual Minimum Deterrence with both Missile Defense and Conventional Strategic Weapons (Model 4)

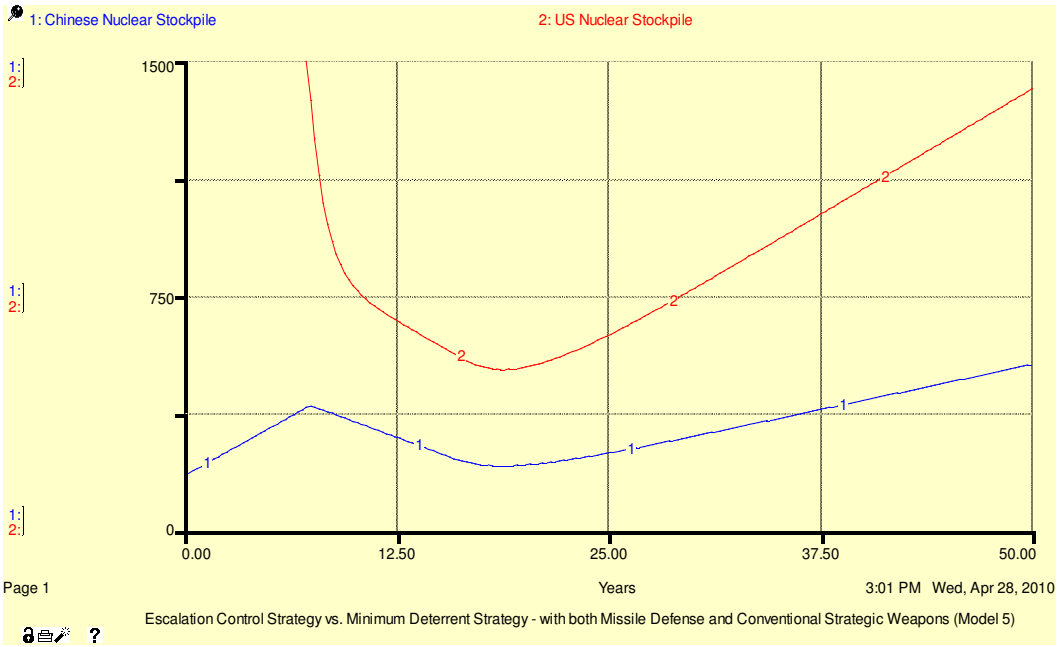

Figure 10: Escalation Control Strategy vs. Minimum Deterrence Strategy - with both Missile Defense and Conventional Strategic Weapons (Model 5)

These graphs show that arms race stability between the U.S. and China could be best maintained under a pure mutual minimum deterrence with no missile defense or conventional strategic weapon systems. Under such hypothetical scenario, both countries need only to keep very small nuclear arsenals to maintain the mutual minimum deterrence relationship (as is shown in Figure 6). Both countries will save significant amounts of money and resources as a result, and arms race stability could be maintained into the future. However, even under this scenario, the course of nuclear interaction between the two countries could create concerns in the short- to medium- term, because according to the modeling result China's nuclear stockpile will increase dramatically in the short term before it could ultimately go down in the long run. In reality, nonetheless, China's nuclear arsenal does not have to increase before a balance is reached as the model predicts. If both countries are convinced that the other side is genuinely pursuing a minimum deterrence strategy with no intention of introducing missile defense or conventional strategic weapons in a large scale, Chinese leadership might not feel pressed to build up its nuclear forces while the U.S. can take the time and gradually reduce its nuclear arsenal. Effective confidence building measures would be necessary for this to happen and would be critical for the ultimate success of bilateral (or multilateral, if other nuclear weapons states are taken into account) nuclear disarmament.

However, if missile defense systems are introduced, the long term arms race stability would be undermined – the degree of impact depends on the scale of missile defense systems. Figure 7 shows that after introducing missile defense systems, the number of both countries' nuclear weapons will have to keep increasing in the long term. The more missile interceptors are deployed, the more nuclear weapons both countries will need to maintain minimum deterrence capabilities.

Similarly, the introduction of conventional strategic weapons will also undermine arms race stability by a certain degree, as is in demonstrated in Figure 9. After conventional strategic weapons are deployed, the rates of nuclear build-up in both countries increase as a result. From the standpoint of long term arms race stability, it is necessary to keep conventional strategic weapons at low numbers in order to mitigate the negative impact.[12]

Although both missile defense and conventional strategic weapons build-up would have negative impact on arms race stability, the most influential factor seems to be the nuclear strategies to be adopted by countries. As Figure 8 shows, if one country – the U.S., for example – chooses to adopt a strategy of crisis escalation control, it could have tremendous impact on the long term arms race stability, even if the other country sticks to a minimum deterrence strategy. Under such a scenario, the nuclear stockpiles of both countries will increase rapidly after a short period of reduction. If this is the case, a nuclear arms race between the U.S. and China seems unavoidable and such an arms race probably will have very negative impact on the foundation of international security.

The worst scenario is the one that both countries will develop missile defense and conventional strategic weapons, and one country adopts a strategy of escalation control. The consequences of such a scenario are depicted in Figure 10: an intense nuclear arms race will be witnessed between the U.S. and China. Their nuclear arsenals will increase so rapidly under such scenario that the numbers could even approach the levels possessed by the two nuclear superpowers in the Cold War.

The key conclusion of this study is that the nuclear strategies to be adopted by the U.S and China in the future will have the most decisive impact on arms race stability between these countries. Minimum deterrence strategy is conducive to the maintenance of long term arms race stability, whereas a strategy of escalation control could undermine the stability. It would be beneficial for both countries to stick to minimum deterrence strategy and avoid taking the strategy of escalation control. To achieve this, it seems critical for the two sides to increase current channels of bilateral communication and to seek more transparence on strategic thinking and intention. Furthermore, both the introduction of missile defense systems and conventional strategic weapons will have a negative impact on arms race stability by a certain degree. It is important to keep the numbers of missile interceptors and conventional weapons small if they have to be deployed at all.

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[12] Further quantitative analysis is necessary for understanding the specific relationship between the number of conventional strategic weapons and its impact on arms race stability. For limit of space, such discussion is not covered in this paper.