

## **Analysis of US Hypersonic Spending**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## Introduction

International tensions are at their highest since the end of the cold war with some calling the relationship between China and the US the New Cold War (Howard, 2012). Military spending between both countries continues to increase year after year with the total military budgets of the United States and China totaling over one trillion dollars. Of this money, billions of dollars are allocated for research, development, and acquisition of new technologies. Hypersonic weapons are one of the key areas of cutting edge research both countries invest in. The US will spend 4.7 billion in 2023 on hypersonic research in 2023, up from 3.8 billion in 2022 (Congressional Research Service, 2022). There is no publicly available information on Chinese hypersonic spending, and any estimates made may be unreliable. Despite this spending, the US does not have an operational hypersonic weapon. The Chinese and Russians, on the other hand, already have an operational hypersonic weapon. Operational meaning a weapon that is passed research and development and is currently available to use by military forces.

In this paper I will determine if the US should spend more, less, or the same on hypersonic weapons considering the social construction of technology driven by deterrence theory. This will look at the importance of hypersonic weapons to China and the US, and to some extent Russia, in a militaristic sense balanced against the fiscal cost of these weapons. Although Russia already has hypersonic weapons in operation, their relatively small military budget and declining global power do not put them on a similar threat level with China (Dobbins et al., 2019). Because of this, this paper will mainly discuss China and the US with a few mentions of Russia.

Determining these two factors can help guide US policy decisions regarding military spending concerning hypersonic weapons. Spending too little can lead to China having a

technological edge during a time of heightened tensions, especially concerning Taiwan. Spending too much can leave other aspects of the DOD being underfunded. It can also lead to the US gaining a large technical edge over China and cause China to spend more leading to a hypersonic weapons arms race.

However, due to the relative size of the DOD budget compared to its spending on hypersonic weapons, as well as the technological deficit between the US and China, the US should increase its spending on hypersonic weapons to field an operational weapon.

### **Background and Significance**

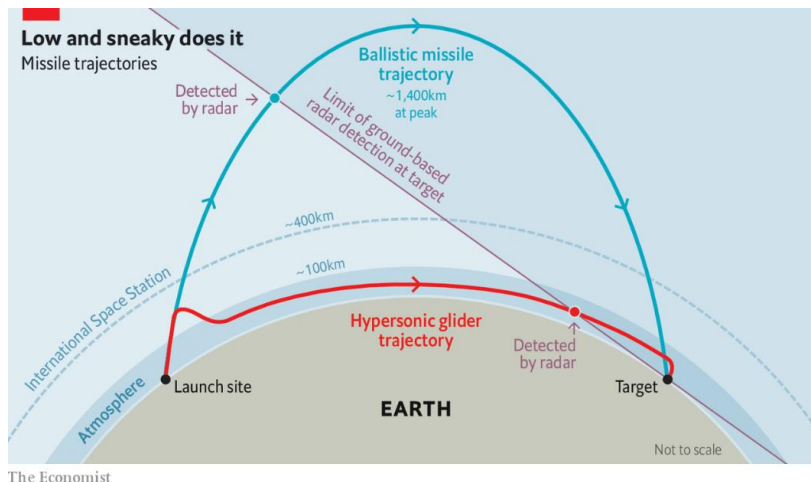
Tensions between the US and China have been rising for many years. China has massively expanded their military in several different ways. They have increased their budget and personnel, developed new technologies such as a fifth-generation fighter, and expanded their presence in the South China Sea. All these actions are putting pressure on the US and our allies in the region such as Taiwan, Korea, and Japan. China has stated that its military “will be capable of taking Taiwan by 2027.” (Mitchell, 2023) This military build up from China included investments into hypersonic weapons. This led to them unveiling their hypersonic weapon in 2019, the Dongfeng 17 (DF-17). Russia also has an operational hypersonic weapon, the Avangard, also entered into service in 2019. Four years later, the US still does not have an operational missile but is very close with its Air Air-Launched Rapid Response Weapon (ARRW), having already completed an All-Up-Round test in late 2022 even with setbacks (USAF, 2022). It also has plans to implement a scramjet powered hypersonic missile by 2027 (Keller, 2022).

Hypersonic weapons are vehicles, normally missiles, that fly five times the speed of sound or more (>1 mile per second). There are two main types of hypersonic weapons underdevelopment or in operation today. The first, and less complex, are hypersonic boost glide vehicles. These weapons fly up briefly into space at extremely high speeds and release the hypersonic glide vehicle. This vehicle flies at hypersonic speeds at low altitudes within the atmosphere until it impacts the target. It can maneuver and change trajectories unpredictably. This coupled with its extremely high speed makes it very challenging to shoot down. The second, and more advanced type of hypersonic is a scramjet powered hypersonic cruise missile. This type of missile uses an incredibly advanced scramjet engine to power it. It works by letting the high speed of the vehicle compress the incoming air before igniting it and powering the engine, all while the air remains hypersonic. Russia, China, and the US are testing these missiles; however, no country has them operational at the moment.

Hypersonic weapons present unique strategic advantages over traditional and ballistic missiles. As seen in the graphic below, traditional ballistic missiles take a large predictable trajectory, allowing them to be detected early and shot down easily as it is easy to track where it will be.

## Figure One

### *Trajectory of Hypersonic Glider versus Ballistic Missile*



*Note.* (Adapted By Carroll (2023) from The Economist, (2019))

Hypersonic glide vehicles have a later detection window, faster speed, and unpredictable trajectory greatly increasing their effectiveness. These weapons also have the ability to carry a nuclear warhead. While none are currently deployed with nuclear payloads, the ability to have a nuclear missile with a low likelihood of being shot down becomes a large strategic advantage.

This brings in the concept of deterrence. Deterrence is using a threat of force to stop an actor from taking action. Nuclear deterrence explains this concept well. Countries build up their nuclear arsenal to deter other countries from attacking with their nuclear arsenal. Basically, a side is deterred from attacking because they know they will be attacked. Two important concepts of deterrence are the concepts of a second strike and mutually assured destruction. A second strike means that after the initial aggressor attacks, the attacked party can launch a full scale second strike. Countries often take this into account, building survivable nuclear forces that can withstand a full scale first strike. Mutually assured destruction is the concept that if one side

attacks, due to the second-strike principle, the other side attacks and both sides are destroyed and worse off. Together these two concepts are what makes deterrence such an effective tool for governments and militaries today. Deterrence applies to hypersonic missiles because they can render missile defense systems useless. Therefore, instead of countries relying on their missile defense systems to defend them, they must rely on deterrence, the second strike principle and mutually assured destruction, to stop incoming attacks. For hypersonic weapons, the best defense is a good offense.

The social construction of technology will also be analyzed in this paper. This theory argues that human actions, or society, shape technology and technology development and not technology shaping society. This can be clearly seen with the Apollo space missions where President Kennedy's speech, the government's massive investments, and the space race caused massive leaps and bounds in the space industries development. Clearly society and humans shaped this technology. Because without the investments and desire from the US to move into space, this technology would not be invented.

## **Methodology**

To determine how much the US should spend on hypersonic weapons, evidence will be collected, then analyzed under different theoretical frameworks. Evidence collection will be a literature review consisting of three different types of documents. Research papers on hypersonic weapons and their impacts. This will analyze budget estimates as well as hypersonic effectiveness. The second type will be a policy review, from big picture national objectives considering adversaries and deterrence, to small policies considering limited goals such as technological advancement and budgets. Finally, the third and smallest aspect will be anecdotal evidence or news stories depicting one singular hypersonic event or technological update.

The evidence analysis will be mostly a qualitative analysis of the various sources to obtain a whole picture concept of hypersonic weapons. I will determine how society and policy influence the development of hypersonic weapons under the guide of deterrence theory. This is because society and policy are driving change in the hypersonic industry because of a hypersonic race with adversaries such as China. It would be ignorant to explore how society and policy effect hypersonic weapons without considering that deterrence is driving this societal and political change. After qualitatively reviewing the evidence, I will determine based on the entire picture if the budget is justified or should be changed.

I will use three different frameworks when writing. I will use the social construction of technology and deterrence theory. I will also use, with the idea coming from chat gpt, a cost benefit analysis framework to determining if the cost of hypersonic weapons does or does not outweigh the benefits. Using these three frameworks together, I will be able to explore the social and fiscal factors pushing advancement in the hypersonic industry.

## **Literature Review**

After years of relative world peace after the Cold War, global tensions are rising once again. However, this time they are between China and the US. Examining the National Security Strategy, our two main competitors are China and Russia. However, the focus is on maintaining “an enduring competitive edge” over China and “constraining” Russia (Executive Office of the President, 2022). This shows how the United States views these countries with China as a peer or near-peer and Russia as less of a threat. When looking at the national defense strategy summary, with the entire document being classified, the threat China poses becomes more evident. Our number one defense priority is “Defending the homeland, paced to the growing multi-domain

threat posed by the PRC” (Department of Defense, 2022). The national defense strategy also mentions that China is our largest “strategic competitor and the pacing challenging for the department” and that another priority is “deterring strategic attacks against the US” (Department of Defense, 2022). This shows the massive emphasis that the DOD as a whole is placing on combating and deterring China.

This threat is evident to the government with rare bi-partisan support for increasing the total military spending. In fact, the bill approved by the house for 2023 authorized \$37 billion more dollars in spending than President Biden’s pentagon sought. However, once it was all said and done the final defense budget was \$858 billion dollars, \$55 billion more than requested (O’Brian & Ukenye, 2022). Looking at the total breakdown of the 2021 budget, and assuming a similar percentage breakdown for 2023, 40 percent is operations, 24 percent is personnel, 20 percent in procurement, and 15 percent is research, development, test, and evaluation. This means with a budget of \$858 billion, about \$128 billion will be spend across the entire DOD for research and development (*Budget Basics: National Defense*, 2022). Of this roughly \$128 billion, \$4.7 billion is spent purely on hypersonic weapons research, up from \$3.8 billion in 2022 demonstrating the United States emphasis on hypersonic development (Congressional Research Service, 2022).

As previously mentioned, the United States does not have an operational hypersonic missile. However, it has multiple programs close to operational status. The Navy, Air Force, and Army all have programs to develop hypersonic missiles. The Navy and Army have a joint program developing the Long Range Hypersonic Weapon (LRHW) a land launched hypersonic glide vehicle expected to enter service in 2023. Lockheed Martin is also developing a separate



ship based launching mechanism for the Navy expected to become operational in 2025 (Eckstein, 2023). The Air Force is developing the Air-Launched Rapid Response Weapon (ARRW) for use in air to ground combat. It is also a hypersonic glide vehicle. The missile is expected to enter service as early as 2023 (McFadden, 2022), but has faced some recent set backs. It has been criticized for having a lack of test plans and modeling and simulation needed to evaluate the weapon among other things (Tirpak, 2023). This could delay the project a push back the operation date.

According to Secretary of State Antony Blinken (2022), “China is the only country with both the intent [and ability] to reshape the international order”. China has increased its military budget on average about 7 percent each year the past decade, out pacing the US (Funaiolo et al., 2021). This increase is made most likely to ready for a potential war with Taiwan in the near future. Looking more closely into their military abilities, China has the “largest infantry and biggest navy, and continues to build its [military] stockpile.” (Davidson, 2023). It also has, as previously mentioned, operational hypersonic missiles in conjunction with continued research and development into other hypersonic technologies. Air Universities Geoffrey Chambers (2022) deduced that China’s hypersonic focus was on Scramjet engine technology. Moreover, China has greatly increased its ability to teach and train scientists on hypersonic weapons with the next generation of hypersonic scientists trained domestically in China rather than internationally.

## **Discussion/Results**

The social construction of technology often applies to military technology. In times of war, great advancements are seen such as the first jet engine, space faring vehicle, and nuclear bomb being invented during WWII. It is unlikely these technologies would have been invented

as quickly without the human need for them. This same concept can be applied to hypersonic weapons in today's world. This technology will not naturally come about without a large push from the government, specifically financially. The DOD recognizes this and increased their budget by about 25 percent for hypersonic weapons research in 2023. However, it is clear that throwing money at research and development does not always fix problems as seen with the Navy's Zumwalt class destroyer. Originally planned for 32 ships the ships went outrageously overbudget and ended up costing over 3 times more than planned and the program ended with only three completed ships. This shows that sometimes money is not always the answer for military technologies. However, if the navy could get the cost down to the original cost per ship the program would have gotten more overall funding and completed all 32 ships because the total gain would have been far higher per dollar (LaGrone, 2016).

For hypersonic weapons, it is important to look at the cost versus the benefit of increasing spending. Despite budgets increases year over year, by far more than the total DOD budget percentage increase, the US has still not fielded a hypersonic weapon and programs such as ARRW continue to have setbacks. However, with the current budget, hypersonic weapons can be reasonably expected to become operational by late 2023 and early 2024 with the LRHW and ARRW. To determine how much the US should spend two things must be analyzed. First, does the US need hypersonic weapons? Second, if so, should we continue to invest and develop them or stick to the current programs?

When looking at deterrence, it is important to look at the military as a whole. Hypersonic weapons do very little to deter large countries such as China from attacking the US outright. Economic and diplomatic deterrence as the first line of defense, and nuclear deterrence as the last line, are more than enough to deter large national conflicts. However, when viewing smaller

conflicts, such as a probable Chinese invasion of Taiwan, they become more valuable.

Hypersonic missiles are very hard to shoot down. This means in a conflict between China and Taiwan, with the US aiding Taiwan, Taiwan would have the direct ability to strike anything on the eastern Chinese coast with ease. This would add a strong level of deterrence to China attacking Taiwan. Slower cruise missiles are more likely to be shot down and would give China more security by attacking with bolstered air defenses. So, a successful hypersonic weapon would add a higher level of deterrence than without and cause China to think twice about a conflict with Taiwan as long as the US supports them.

Since these weapons are important in smaller regional conflicts, investing in their abilities will continue to be important. Scramjet hypersonic weapons, the expected next generation of hypersonic weapons after glide vehicles, are more maneuverable, have a longer range, and do not need the initial boost phase that increases detection probability. Even though this increased investment would hopefully bring about more effective hypersonic weapons, the gained deterrence value is limited. In regional conflicts, where hypersonic weapons can deter conflict, scramjet hypersonic weapons present very little benefit. The main benefit would be in larger peer to peer conflicts that are deterred by other factors.

But scramjet engines are the future of hypersonic flight and have more possible application than just hypersonic missile. They could be used for space flight, missile defense, and air to air combat. Because of these potential benefits, investing in their future maintains its importance. Since humans drive the advancement of technology, sitting idly by and not pursuing this advanced technology allows two things to happen. A strategic disadvantage with China if they develop them first. This would give them an edge in a regional conflict and potentially disrupt US support to Taiwan. Second, it means this technology, which requires a large monetary

and time investment to mature, may not be available if needed in a future conflict. During WWII, jet engines and ballistic missiles were not available to the German military until the very end of the war, when it was already lost. The US does not want to be in a position where it needs scramjet technology but did not invest in it in the past.

Finally, when examining the entire military budget of \$858 billion, and \$128 billion on research and development alone, \$4.7 billion seems relatively small. An increase in this budget to six or seven billion dollars will not cause other projects to be majorly underfunded as it is such a small percentage. Likewise, increasing the total budget by two or three billion is also possible as it is a drop in the bucket and congress is willing to give money to the military due to global tensions.

Because the current phase of hypersonic weapons provides a deterrent ability in small regional conflicts, and the next generation of hypersonic weapons with scramjets have potential benefits, it is important to get our current programs operational quickly and continue to invest in new hypersonic technology. These factors, combined with the relatively low cost of increasing the hypersonic budget by two or three billion, should persuade the United States government to increase their spending on hypersonic weapons with a focus on making our current programs operational and maturing scramjet technology.

## **Conclusion**

In this paper, I asked if the US should spend more, less, or the same on hypersonic weapons considering the social construction of technology driven by deterrence theory. After researching and analyzing the topic, I determined that an increase in US spending on hypersonic, in the range of two to three billion, would be the optimal choice for the US military.

When looking at the social construction of technology and deterrence theory, the two main arguments for raising the budget come forth. Since society, the government in this case, drives technological innovation if they choose not to invest in hypersonic technology, the US could fall behind China, our main adversary. Then, if this technology is ever needed, it will take a long time and large monetary investment to catch up and we might not be able to in time. Second, in small regional conflicts, such as a probable Taiwan conflict, hypersonic weapons offer a unique deterring factor because they represent the ability to bypass air defenses on the Chinese mainland. This makes China vulnerable to an attack against their own soil and makes an invasion riskier.

Looking forward, while a budgetary increase is needed, determining the exact amount is the next step. This requires a more in depth analysis of total US spending, the US government, and DOD spending. It will also require a cost benefit analysis for several factors depending on where the money actually comes from. Hypersonic weapons are the future of strike-oriented combat. Investing in this technology now allows the US to maintain its strategic advantage and stay ahead of its adversaries.

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