Space-Related Cooperation Agreements in Latin America

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Client

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Disclaimer

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Honor Pledge

On my honor as a student, I have neither given nor received unauthorized aid on this assignment.

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Acronyms

ABAE	Bolivarian Agency for Space Activities (Venezuela)
ALMA	Atacama Large Millimeter/submillimeter Array
APSCO	Asia Pacific Space Cooperation Organization
CBERS	China-Brazil Earth Resources Satellite
CONAE	Argentina National Space Activities Commission
DDTC	Directorate of Defense Trade Controls
DIA	Defense Intelligence Agency
DoD	Department of Defense
DoS	Department of State
EOP	Executive Office of the President
EXA	Ecuadorean Civilian Space Agency
GMT	Giant Magellan Telescope
ITAR	International Traffic in Arms Regulations
LAC	Latin American Countries
MOU	Memorandum of Understanding
MTCR	Missile Technology Control Regime
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
SAC	Scientific Applications Satellites
SAOCOM	Synthetic Aperture Radar Observation and Communication Satellites
SRCA	Space-Related Cooperation Agreements
SSA	Space Situational Awareness
TSA	Technology Safeguard Agreement
US	United States

Executive Summary

For decades, the United States (U.S.) has been an uncontested world hegemon. However, recently China has rocketed onto the world scene. They've rapidly increased their defense budget, initiated a $1 trillion infrastructure development plan called the Belt and Road Initiative, and have done so while maintaining an annual GDP growth rate of over 9% since 2000 (Broder, 2019; *GDP growth (annual %)*, 2019; Tweed, 2019). China's rise to power has also coincided with a souring of its bilateral relationship with the U.S. which has been marked by a trade war, tension in the South and East China Seas, and, more recently, vitriolic rhetoric surrounding COVID-19 (USTR, 2019).

As part of its rise, China has spent significant time fostering relationships both around the world and, particularly, in Latin America. These relations are intended to, among other things, help China gain influence and a geo-political foothold in the region (Koleski & Blivas, 2018). These goals conflict with U.S. interests in the area. While intensely involved in infrastructure development and loans, China has also sought to strengthen its relations with Latin American countries in the space cooperation realm. They've done so through the implementation of space infrastructure loans, satellite development projects, the provision of launching services, and educational exchanges (Klinger, 2018). This is important because, while the U.S. has historically held a large lead in space supremacy, the CCP has recently led a concerted effort to rapidly modernize its space sector (Pollpeter et al., 2015). Furthermore, the space sector plays a crucial role in the ability of the U.S. military to operate on a global scale (Colby, 2016). **China's newfound strength, increasingly adversarial relationship with the U.S., and interests in the region in space policy make it important that the U.S. understand the nature and effects of China's actions in Latin America.**

To better understand China's efforts in Latin America, I first identified five nations with varying levels of economic heft and space development: Argentina, Brazil, Ecuador, Chile, and Venezuela. I then created timelines of space-related cooperation between each country and China and each country and the U.S. Based on my analysis of this research, I came to two main findings and their relevant implications.

> **Finding 1:** It is unlikely that cooperation between China and LAC negatively affects the ability of the U.S. to cooperate with LAC. Similarly, the prior existence of extensive space cooperation relationships between China and LAC does not prevent the establishment of U.S.-LAC space situational awareness agreements (SSA).
> **Implication 1:** While there may be a competitive aspect to the efforts of the U.S. and China to create and consummate international cooperation agreements, this is not obvious in the space cooperation/SSA arena. It is not a zero-sum game.
>
> **Finding 2:** China has deeper and more extensive space cooperation ties with LAC than the U.S.
> **Implication 2:** The increased presence of China and static presence of the U.S. in LAC increasingly paints China as a leader in the region.

Implication 2 is particularly concerning as being perceived as a leader improves China's ability to pursue its interests in the region. Given the Defense Intelligence Agency's (DIA) core mission of ensuring the U.S. is in a position to avoid or win future wars, I then considered three alternatives according to four different criteria in order to identify the option that best responds to China's efforts in Latin America and, in doing so, improves the international situation of the U.S. (DIA, 2018). Each alternative was formulated with the goal of increasing U.S. space-related cooperation in Latin America and, in doing so, limiting China's leadership in this sphere. The alternatives are as follows.

> **Alternative 1:** Recommend Adjusting U.S. Export Controls and Encouraging Cooperation with South America.
> **Alternative 2:** Recommend the National Science Foundation (NSF) Fund the Giant Magellan Telescope (GMT)**.**
> **Alternative 3:** Recommend the Establishment of a U.S.-Venezuelan Bilateral Astronomy Science Meeting.

These alternatives were then evaluated based on five distinct criteria and ranked on a scale of low, medium, and high. The following criteria were used: *effectiveness*, *monetary cost*, *diplomatic cost*, *ease of implementation*, and *sustainability*.

Based on my analysis, it is recommended that the DIA pursue *Alternative 1: Recommend Adjusting U.S. Export Controls for Space-Related Technology.* This alternative ranked low for *monetary cost* and *diplomatic cost* and moderate for *effectiveness*, as good or better than the other alternatives for each of these criteria. It did score lower on *ease of implementation* than *Alternative 2: Recommend the NSF Fund the GMT* however, *Alternative 2* also has a much higher monetary cost at close to $500 million (Foust, 2019). The recommended alternative also has the most comprehensive effect as, by removing bureaucratic restrictions that currently saddle U.S. space industries, U.S. companies will be able to cooperate more fully with LAC on space-related cooperation agreements (SRCA). The full results of the analysis can be found below in Figure 1.

Figure 1: Decision Matrix of Proposed Alternatives According to the Chosen Criteria

	Alternative 1: Recommend Adjusting U.S. Export Controls for Space-Related Technology	*Alternative 2: Recommend the National Science Foundation (NSF) Fund the Giant Magellan Telescope (GMT)*	*Alternative 3: Recommend the Establishment of a U.S.-Venezuelan Bilateral Astronomy Science Meeting*
Effectiveness	Moderate	Moderate	Moderate
Monetary Cost	Low	High	Low
Diplomatic Cost	Low	Low	High
Ease of Implementation	Moderate	High	Low
Sustainability	High	Moderate	Low

As an information gathering institution, the DIA itself cannot adopt nor implement this policy. However, the agency does communicate with decision makers that do have this authority. In order to encourage adoption of this policy, it is recommended that the DIA message the importance and utility of this alternative to its customers in the executive branch such as the Secretary of Defense (DIA, 2018). In doing so, the DIA should also frame the issue as an anti-China, pro-business, and national security initiative in order to appeal to the sentiments of the current administration.

Introduction

The goal of this report is two-fold. The first section focuses on understanding the effect and nature of China's efforts to engage in space-related cooperation agreements (SRCA) with Latin American countries (LAC). The second section uses those findings to inform policy proposals that could improve the position of the U.S. on the world stage. Broadly speaking, the first section will identify **what is happening in Latin America** and **why this is a problem** while the second section will identify **how the U.S. can best respond** to the identified problem.

PART ONE

Background

In this background, I will first provide an overview of the changing power dynamics between the U.S. and China, their evolving relationship, and China's interests in Latin America. I will then provide a short history of space development in China and the U.S. before exploring the importance of space power generally. Finally, I will analyze the intersection of these two areas and discuss the relevance of China's efforts to encourage space-related cooperation in Latin America.

Diplomatic Relations

The Shifting Balance of World Power

The U.S. has long treasured and leveraged its role as a global leader. In fact, since the end of the Cold War the U.S. has been the lone superpower and has had the ability to pursue its interests around the world largely on its own terms. Much of this power has come from U.S. military strength and economic heft. However, a large part of the U.S.'s ability to lead on the world stage is due to its many global relationships and the diplomatic power they impart. This, in turn, allows the U.S. to wield international influence as a tool in pursuit of its goals.

However, China's recent rise to power has adjusted this dynamic. Militarily, China has increased its budget over the last 11 years from $59 to $178 billion and has used these funds to rapidly modernize its forces (Tweed, 2019). Economically, it has maintained an average annual GDP growth of over 9% since 2000. Over this same period, the U.S. has maintained a growth rate of just over 2% (*GDP growth (annual %)*, 2019). Lastly, China has increasingly dedicated time and effort to improving its diplomatic influence around the world. One example of this is the Belt and Road Initiative, a $1 trillion infrastructure development program, which China is using to invest in nations across the globe (Broder, 2019).

The Evolving Relationship

This rebalancing of global power is particularly salient given the changing nature of the US-China relationship. Simply put, it is becoming increasingly adversarial. Economically, China has consistently engaged in illegal trading practices, such as intellectual property theft, which costs the US economy several hundred billion dollars each year (Pham, 2018; USTR, 2019). Militarily, China has committed to massively increasing the capabilities of its forces. This is an effort that, the U.S. believes, has been undertaken with the intention of "…[eroding] America's military advantages on land, at sea, in the air, and in space" (Tweed, 2019). Lastly, China's aggressive efforts to claim territory in the disputed South and East China Seas have led to political concerns about China's continued commitment to established norms and the current world order.

These factors led the Trump Administration to label China the biggest threat to the U.S. in two important national security documents and to take aggressive moves of its own (Sutter, 2018). For example, the U.S. has placed tariffs on $550 billions of Chinese goods, increased defense spending, strengthened efforts to restrict China's acquisition of advanced foreign technology, and uses increasingly vitriolic rhetoric when discussing the relationship (Albert, 2016; Sutter, 2018; Wong & Chipman Koty, 2019).

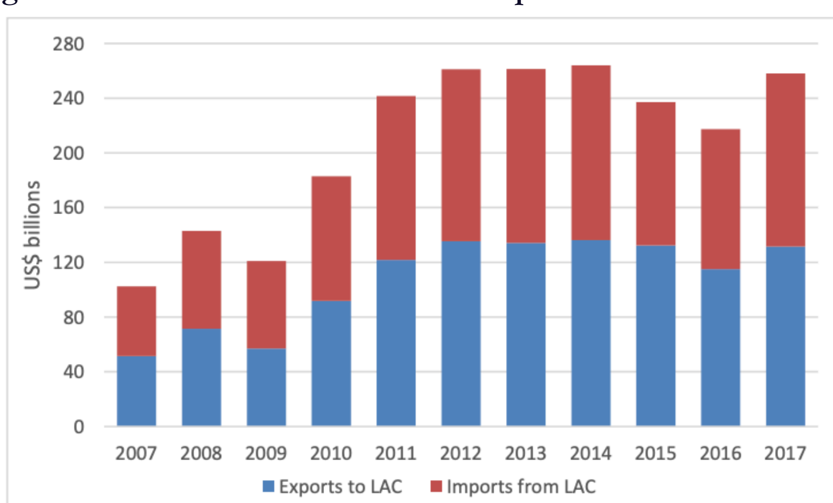
Latin America and Why it Matters

While China has been active all over the world stage as it works to curry influence, this study will focus on Latin America, a region where China has recently increased its footprint. For example, in 2018, China became Latin America's largest creditor, investing nearly $150 billion over the previous 13 years (Nathanson, 2018). As demonstrated by Figure 2 it has also become a large trading partner for the region (Koleski & Blivas, 2018). This effort is also reflected in other spheres. For example, the president of China, Xi Jinping, has developed close relationships with several Latin American leaders and Chinese leadership manages the China Community of Latin American and Caribbean States Forum (Koleski & Blivas, 2018; Nathanson, 2018). Through this organization, China is able to coordinate relations with many LAC at once (Koleski & Blivas, 2018).

China has undertaken these efforts to secure access to natural resources, influence international discussion, win backing for its policies abroad, and secure a foothold near the U.S. (Koleski & Blivas, 2018). These interests are not inherently negative but, when viewed with an eye to the arc of the China-US relationship, each becomes more concerning. The U.S. and China are each striving for natural resources, global support, and to engender positive discussion of their respective nations. Most obviously dangerous though, is China's desire to gain a foothold in the western hemisphere, an effort that conflicts with the position espoused in the Monroe Doctrine that powers should steer clear of the area.

In short, China's increasing level of influence in the region has begun to take effect and this concerns U.S. policy makers. The former Secretary of State Rex Tillerson made it clear that the U.S. was taking notice when he said in 2018 that "…China is getting a foothold in Latin America. It is using economic statecraft to pull the region into its orbit…" (Nathanson, 2018). The former Ambassador to Panama John Feeley went one step further when he expressed that China is "[increasing its] diplomatic throw weight throughout the region… where previously the United States was very clearly the partner of choice" (Kahn, 2018). China has become extremely active in Latin America which has forced the U.S. to consider, for the first time in decades, how it should behave in order to counteract the actions of potential competitors within its own hemisphere.

Figure 2: China's Economic Relationship with LAC from 2007-2017



Source: Koleski, K., & Blivas, A. (2018). *China's Engagement with Latin America and the Caribbean.* U.S.-China Economic and Security Review Commission.

The Space Realm

The U.S. and China in Space

The U.S. and China have both been active in space for decades though their trajectories differ substantially. A longtime leader in space, the U.S. landed a man on the moon in 1969, and in the 1970's implemented the Global Positioning System which consists of 24 satellites that provide location services (Marshall, 2017). As of March 31, 2019 the U.S. had 901 satellites in orbit and currently has extensive anti-satellite weapon capabilities (Mazareanu, 2019; Pollpeter et al., 2015; Wood, 2019). Though China began space development in the 1950s, much of its space sector has developed more recently (Marshall, 2017). For example, it wasn't until 1994 that China launched the BeiDou navigation system, China's version of GPS (Zhu, 2019). As of March 31, 2019, China had 299 satellites in space (Mazareanu, 2019).

Recently though, China has been building momentum. The government has made the modernization of the space sector part of its long term plan and President Xi Jinping touted Chin's "space dream" as being "… an important component of realizing the Chinese people's mighty dream of national rejuvenation" (Pollpeter et al., 2015, p. 7). Furthermore, China launched 38 satellites last year, more than any other country, and recently became the first country to successfully land a rover on the dark side of the moon, a technically difficult achievement (Campbell, 2019). Meanwhile, the U.S. space program has fumbled through the last 20 years. The shuttle program was cancelled in 2004 and the National Aeronautics and Space Administration (NASA) has constantly changed direction as Presidents Bush, Obama, and Trump implemented their different visions for the organization (Marshall, 2017). More recently however, President Trump has renewed focus on the U.S. military establishment and has also taken note of the increasing importance of space.

These changing dynamics of space capability are particularly important in the context of one key fact: the U.S. relies heavily on space technology in order to operate its global military presence. In fact, the position, navigation, timing, intelligence, surveillance, and reconnaissance provided by U.S. space infrastructure "…[is] actually the stuff of which American global military primacy is made" (Colby, 2016). For decades, the U.S. could rely on this technology without considering the space capabilities of competing nations. This is no longer the case.

The Nexus of Space and Diplomatic Relations

It is crucial to consider the question of diplomatic relations as well as the importance of space technology when considering China's efforts in Latin America. As mentioned, China is actively making loans and otherwise supporting development in LAC (Koleski & Blivas, 2018). However, it is also working to implement space-related cooperation agreements (SRCA) with countries in the region. To determine the effect of these agreements, this study will first consider the relationships the U.S. has maintained with Argentina, Brazil, Chile, Ecuador, and Venezuela over the past 20-30 years. It will then consider the relationships China has maintained with these same five nations during the same time period to determine patterns and trends in cooperation.

While focused on SRCA generally, this study will also pay special attention to agreements related to space situational awareness (SSA). This term refers to the ability of a nation to discover, track, and predict the location of objects in space (*Challenges to Security in Space*, 2019). SSA is key for countries that want to operate in space.

The Five Nations

Figure 3 below shows the location of the five nations chosen to provide a varied sample for this study while Table 1 displays basic information about them. Some nations have large economies and more advanced space industries (Brazil) while others have smaller economies and less advanced space industries (Ecuador). Also included is their debt to China and the year they recognized China in lieu of Taiwan.

Figure 3: Map of the Five Nations

Source: *The Americas*. (n.d.). [Custom Map Creator]. MapChart. Retrieved April 17, 2020, from https://mapchart.net/americas.html

Table 1: Summary of the Five Nations

Country	Size of Economy Relative to Latin America	Money Owed China	Year of China Recognition	Year of Space Agency Creation
Argentina	**3rd** (*GDP - Latin America*, 2019)	**$17.1 billion** (Gallagher & Myers, 2020)	**1972** (Shixue, 2006)	**1991** (Colazo, 2017)
Brazil	**1st** (*GDP - Latin America*, 2019)	**$28.9 billion** (Gallagher & Myers, 2020)	**1974** (Shixue, 2006)	**1994** (Sarli et al., 2018)
Chile	**5th** (*GDP - Latin America*, 2019)	**$0** (Gallagher & Myers, 2020)	**1970** (Shixue, 2006)	**2001 (shuttered in 2011)** (Sarli et al., 2018)
Ecuador	**7th** (*GDP - Latin America*, 2019)	**$18.4 billion** (Gallagher & Myers, 2020)	**1980** (Shixue, 2006)	**2007** (*The History of Ecuador and Space*, n.d.)
Venezuela	**10th** (*GDP - Latin America*, 2019)	**$62.2 billion** (Gallagher & Myers, 2020)	**1974** (Shixue, 2006)	**2007** (Sarli et al., 2018)

Problem Statement

China's rise has caused a shift in the economic, political, and military dynamics in the world. Latin America, in particular, has become a region of focus and China's interests there conflict with those of the U.S. Meanwhile, sustained and committed efforts by the Chinese have led to a rapid narrowing of the gap between U.S. and Chinese space capabilities (Pollpeter et al., 2015). Given China's efforts to expand its diplomatic influence as well as its desire to expand its space capabilities, China has become focused on enacting SRCA with LAC (Pollpeter et al., 2015). However, while it is clear these efforts conflict with U.S. interests, the effect of Chinese cooperative activities with LAC remains uncertain. That question is the focus of the first part of this report.

Research and Commentary

China has become very active in Latin America in pursuit of its interests but it is unclear what effect their efforts are having (Koleski & Blivas, 2018). To investigate possible trends of cooperation, this section will investigate and compare the quantity and nature of space-related agreements between China and LAC to the quantity and nature of space-related agreements between the U.S. and LAC. To compile these timelines, this report utilized open source information that was drawn from scholarly articles, the news media, and government websites, among other sources.

The following timelines help provide insight on trends of space cooperation by allowing for the identification and analysis of both the scale and type of cooperation between China, the U.S., and associated LAC. The timelines are also helpful in identifying possible inflection points in these relationships.

Argentina

China and Argentina

Commentary

The first instance of space-related cooperation between China and Argentina took place in 1989 and two years later, in 1991, Argentina created the Argentina National Space Activities Commission (CONAE) (*Argentina National Space Activities Commission (CONAE)*, 2020; *CART and SLR at South America Observing Station in Argentina*, n.d.; Colazo, 2017). However, more sustained cooperation did not gain momentum until the mid-2000s when China and Argentina agreed to a bilateral agreement that provided for the exchange of space technology and services (Hulse, 2007; Klinger, 2018). Since that agreement, China has provided further support, involved Argentina in APSCO, facilitated cooperation between Argentinian universities and Chinese national institutions, and built several facilities in Argentina (*CART and SLR at South America Observing Station in Argentina*, n.d.; Hulse, 2007; Klinger, 2018). Most notably, China has built a satellite monitoring station that is controlled by China's military and is "dual use", meaning the station can be used for both military and civilian purposes (Lee, 2016; Londoño, 2018).

Table 2: Timeline of SRCA Between China and Argentina

1989	China sent space observation hardware to the National University of San Juan (*CART and SLR at South America Observing Station in Argentina*, n.d.).
2004	China agreed to provide satellite components, launch services, and other technology for Argentina (Klinger, 2018).
2005	Argentina joined the China-run organization APSCO (Asia Pacific Space Cooperation Organization) as an observer state (Klinger, 2018).
2005	China agreed to contribute "technical support and equipment" to the Argentinian satellite manufacturing company INVAP (Hulse, 2007, p. 20).
2005	The China National Academy of Science, the China National Astronomical Observatories, and the National University of San Juan agreed to cooperate on a satellite laser ranging station (*CART and SLR at South America Observing Station in Argentina*, n.d.; Klinger, 2018).
2005	China delivered a "third generation" satellite laser ranger (SLR) to the National University of San Juan (*CART and SLR at South America Observing Station in Argentina*, n.d.; Hulse, 2007).
2010	China's National Astronomical Observatories created the South American Station in Argentina. This led to an agreement regarding the planned construction of the China-Argentina Radio Telescope (*CART and SLR at South America Observing Station in Argentina*, n.d.).
2012	China built and opened an antenna in Mendoza, Argentina (*Advances in China – Latin America Space Cooperation*, 2010; *CART and SLR at South America Observing Station in Argentina*, n.d.; Klinger, 2018).
2015	China and Argentina agreed on a defense deal which also allowed for the construction of a Chinese satellite tracking station in Argentina (Klinger, 2018).

The U.S. and Argentina

Commentary

During the 1980s, space cooperation between Argentina and the U.S. took a steep nosedive due to Argentina's commitment to developing ballistic missiles and participation in the Falkland War, each of which conflicted with U.S. interests (Serna, 2018). However, once the ballistic missile program was abandoned and the war resolved, cooperation slowly ratcheted up again (Serna, 2018). By the early 2000s, the U.S. had become firmly involved in the development of Argentina's SAC satellites and this effort has continued throughout the 21st century (Serna, 2018). It is worth noting that Argentina and the U.S. have been able to develop and maintain a significant cooperative relationship despite anti-American rhetoric from Argentina's leaders and the establishment of a Chinese satellite monitoring station in Argentina (Lee, 2016; Serna, 2018).

Table 3: Timeline of SRCA Between the U.S. and Argentina

Year	Event
1991	NASA and CONAE signed a cooperative agreement focused on space research and cooperation, launching satellites, exchanges, and cooperation on the Gemini and Auger projects (Hulse, 2007).
1996	NASA and CONAE cooperated to launch Scientific Application Satellite-B (SAC-B) from Vandenberg Air Force Base in the U.S. (Hulse, 2007; Serna, 2018; "U.S. Relations With Argentina," 2019).
1997	NASA and CONAE cooperated to hold a space conference (Hulse, 2007).
1997	The U.S. and Argentina agreed to a Memorandum of Understanding (MOU) regarding the X-33 project which was later discontinued (Serna, 2018).
1998	NASA and CONAE cooperated to launch the SAC-A satellite (Serna, 2018).
2000	NASA and CONAE cooperated to launch the SAC-C satellite (Hulse, 2007).
2005	The U.S. and Argentina agreed to collaborate on the development of the SAC-D/Aquarius satellite (*Agreement between the United States of America and Argentina*, 2005).
2011	NASA and CONAE cooperated to launch the SAC-D satellite (Serna, 2018).
2017	NASA and CONAE cooperated to hold a Disaster Risk Reduction Seminar ("U.S. Relations With Argentina," 2019).
2017	NASA and CONAE cooperated to observe New Horizons ("U.S. Relations With Argentina," 2019).
2018	NASA and CONAE cooperated to launch the SAOCOM 1A satellite on a SpaceX rocket from Vandenberg Air Force Base in the U.S. ("U.S. Relations With Argentina," 2019; Wilson, 2018).
2018	NASA and CONAE cooperated to conduct a thunderstorm study ("U.S. Relations With Argentina," 2019).
Unclear	GE invested in the Argentinian satellite communication company Nahuelsat (Hulse, 2007).

Brazil

China and Brazil

Commentary

Brazil has been active in the space sphere for decades and began cooperating with China in this area as early as 1984 (Klinger, 2018). Notably, the experience of Brazil and China models a "peer-to-peer" relationship in which both nations benefit from the cooperation (Klinger, 2018, p. 58). This has led to an active and strong space cooperation relationship. China and Brazil continue to work on the China-Brazil Earth Resources Satellite (CBERS) series to this day and just last year the 6th satellite of the program was launched (Barbosa, 2019; Klinger, 2018). Furthermore, China and Brazil recently strengthened their relationship with the creation of the Joint Laboratory for Space Weather (Chauvin & Fraser, 2019). Lastly, it is worth considering that Brazil has been removed from the European Space Organization due to funding issues and its lack of affiliation may push Brazil towards further alignment with China (Barbosa, 2019).

Table 4: Timeline of SRCA Between China and Brazil

Year	Event
1984	China and Brazil agreed to cooperate on developing China-Brazil Earth Resource Satellites (CBERS) (Klinger, 2018).
1988	China and Brazil agreed to cooperate on developing the first two satellites of the CBERS project. China agreed to fund 70% of the program and Brazil took on the other 30% (Klinger, 2018; Pollpeter et al., 2015).
1989	China provided technology to Brazil in hopes Brazil would choose China to launch a satellite. The move failed (*Advances in China – Latin America Space Cooperation*, 2010).
1999	CBERS-1 was launched by China from the Taiyuan Satellite Launch Center (Klinger, 2018).
2002	China and Brazil agreed to develop CBERS-3 and CBERS-4 with a 50%-50% cost share (Pollpeter et al., 2015).
2003	CBERS-2 was launched by China from the Taiyuan Satellite Launch Center (Klinger, 2018).
2005	Brazil received an invitation to join the China-based APSCO as an observer (Klinger, 2018).
2007	CBERS-2B was launched (Sarli et al., 2018).
2013	CBERS-3 was launched (Sarli et al., 2018).
2014	CBERS-4 was launched (Sarli et al., 2018).
2014	The Chinese Academy of Sciences and Brazil's National Institute for Space Weather opened the China-Brazil Joint Laboratory for Space Weather (Chauvin & Fraser, 2019).
2019	CBERS-4A was launched. It was developed with a 50%-50% cost share (Barbosa, 2019).

The U.S. and Brazil

<u>Commentary</u>

While Brazil has one of the more developed space programs in Latin America, the country's cooperative relationship with the U.S. over the last 20 years has been minimal (Sarli et al., 2018). In 2003, the U.S. and Brazil attempted to put a TSA in place that would have protected U.S. technology and, in turn, allowed for the U.S. to launch satellites from Brazil (Boadle, 2019). However, this effort failed and the relationship remained inconsequential for about the next 15 years (Serna, 2018). This lapse in the relationship may have been due to an effort by Brazil to minimize its relationship with the U.S. (Serna, 2018). More recently however, the U.S. and Brazil agreed to a SSA agreement and have put in place a TSA that ensures U.S. technology remains secure and safe from adversaries that may want to steal it (Boadle, 2019). This uptick in activity seems like an effort to lay the foundation for more space cooperation in the future.

Table 5: Timeline of SRCA Between the U.S. and Brazil

Year	Event
1997	President Clinton invited Brazil to join the International Space Station in return for joining the Missile Technology Control Regime (MTCR) (Serna, 2018).
2003	Efforts to implement a Technology Safeguard Agreement (TSA) with the U.S. failed after facing opposition from Brazil's government (Boadle, 2019).
2018	The U.S. and Brazil signed a SSA agreement (Boadle, 2019).
2019	The U.S. and Brazil signed a TSA, making launches by U.S. companies from Brazil's Alcantara Base possible (Boadle, 2019).

Chile

China and Chile

Commentary

Until the mid 2000s, cooperation between China and Chile was fairly limited. However, since Chile received an invitation to join APSCO as an observer state in 2005, the two countries have developed a robust space cooperation relationship (Klinger, 2018). However, this relationship is not focused on satellite development or launches but rather on other aspects of space cooperation. For example, China has invested in observation infrastructure, gained access to satellite tracking stations in Chile, opened a South American Center for Astronomy in Santiago, welcomed Chilean astronomers to China to study, and facilitates a yearly China-Chile astronomy science meeting (Chauvin & Fraser, 2019; "China has plans for huge telescope in Chile," 2011; Pollpeter et al., 2015). This high level of space cooperation and integration is not unexpected as Chile's clear skies and low humidity make it ideal for high powered observation equipment (Long, 2011).

Table 6: Timeline of SRCA Between China and Chile

Year	Event
2005	Chile received an invitation to join the China-run APSCO as an observer (Klinger, 2018).
2010	The Chilean-Santiago Control Station sent satellite tracking data to the Xi'an Center (*Santiago Satellite Station - Chinese Space Facilities*, n.d.).
2010	A delegation from APSCO visited Chile to discuss inviting Chile to join the organization as a full member (*Introduction of the Organization and It's Space Cooperative Activities*, n.d.).
2011	China failed to secure a contract to develop a Chilean earth observation satellite (Klinger, 2018).
2011	After an earthquake, Chinese officials visited Chile and offered to donate $750 million of equipment to replace scientific gear that had been damaged ("China has plans for huge telescope in Chile," 2011).
2011	Chinese astronomers visited Chile and discussed the possibility of investing in a $34 million telescope ("China has plans for huge telescope in Chile," 2011).
2012	China and Chile signed an agreement that gives China the ability to apply for Chile's apportioned time at its international telescopes (Chauvin & Fraser, 2019).
2013	The NAOC and the University of Chile collaborated to open the Chinese Academy of Sciences' South America Center for Astronomy (CASSACA) in Santiago (Chauvin & Fraser, 2019).
2016	The Catholic University of the North and the NAOC signed an MOU regarding the development of an "Astronomical Observational base" in Chile (*China-Chile to Collaborate on Astronomical Observatories*, 2016).
2019	CASSACA considered two projects in Chile (an observatory at the Catholic University of the North and an "Astroscience park" in Central Chile) that would have amounted to over $320 million (InvestChile, n.d.).
2019	China held the Fifth China-Chile Bilateral Astronomy Meeting in Kunming, China (*China-Chile Bi-lateral Astronomy Science Meeting*, 2019).
Unclear	A satellite tracking station operated by China opened in Chile (Pollpeter et al., 2015).
Unclear	Chile sent astronomers to study in China ("China has plans for huge telescope in Chile," 2011).

The U.S. and Chile

<u>Commentary</u>

Since the 1960s, U.S. institutions have recognized the advantage that Chile's low humidity and clear skies provide when it comes to space observation (*About Us*, 2020; Long, 2011). As such, the National Radio Astronomy Observatory, the National Optical Astronomy Observatory, and private universities have all consistently chosen Chilean sites when deciding where to build their most advanced observatories (*About NOAO*, n.d.; *About Us*, 2020; *CTIO History | CTIO*, 1993). Most of the U.S.'s cooperation with Chile is somewhat transactional in nature and is focused exclusively on utilizing Chilean land rather than truly working collaboratively with Chilean institutions.

Table 7: Timeline of SRCA Between the U.S. and Chile

Year	Event
1974	The Cerro Tololo Inter-American Observatory in Chile began operating. It was created by the National Optical Astronomy Observatory (*CTIO History | CTIO*, 1993).
2000	Along with an international coalition, the NOAO completed the Gemini South Observatory in Chile (*About NOAO*, n.d.; *Gemini Telescopes, Science and Technologies*, 2016).
2000	The Las Campanas Observatory contains several different telescopes and, most recently in 2000, began operating the Magellan telescopes which it operates for a consortium of U.S. universities (*About Us*, 2020).
2004	The National Radio Astronomy Observatory cooperated with other stakeholders to begin constructing the Atacama Large Millimeter/submillimeter array (ALMA) telescopes in Chile (*Origins | ALMA*, n.d.).
2015	Construction on the Giant Magellan Telescope began (*FAQ | GMT*, 2020).

Ecuador

China and Ecuador

<u>Commentary</u>

China and Ecuador have a very short history of cooperation. The Ecuadorean Civilian Space Agency (EXA) was established recently, in 2007 (*The History of Ecuador and Space*, n.d.). Furthermore, since that time Ecuador has focused on domestically expanding EXA's space capabilities and technology rather than looking to foreign partners in order to achieve progress (*The History of Ecuador and Space*, n.d.). While Ecuador did utilize a Chinese rocket to launch a satellite in 2013, this was organized through the Dutch company ISIS and only after original plans to launch the satellite on a Russian rocket were delayed (Klinger, 2018; *The History of Ecuador and Space*, n.d.).

Table 8: Timeline of SRCA Between China and Ecuador

Year	Event
2013	China launches the Ecuadorean satellite NEE-1 from Inner Mongolia after Russia failed to launch the satellite on time (Klinger, 2018).

The U.S. and Ecuador

<u>Commentary</u>

Early on, the U.S. and Ecuador maintained a minimal space relationship. This is likely due, in part, to the fact that Ecuador has a relatively new space program as the Ecuadorean Civilian Space Agency (EXA) was only created in 2007 (*The History of Ecuador and Space*, n.d.). Furthermore, since that time EXA has focused on developing Ecuador's space program and technology domestically, though the agency has looked to foreign companies to launch its satellites (*The History of Ecuador and Space*, n.d.). With that being said, cooperation has begun to pick up as the U.S. has recognized the quality of Ecuador's space material manufacturing. Over the last few years, American high schools have begun purchasing Ecuadorean satellite components for the Irvine CubeSat Stem Program (*The History of Ecuador and Space*, n.d.).

Table 9: Timeline of SRCA Between the U.S. and Ecuador

Year	Event
2016	High schools in California purchased satellite components from the Ecuadorean Civilian Space Agency (EXA) (*The History of Ecuador and Space*, n.d.).
2018	The Irvine CubeSat Stem Program purchased a laser transmitter from EXA (*The History of Ecuador and Space*, n.d.).
2018	The U.S. satellite IRVINE01 was launched. It is made of 50% Ecuadorean parts. (*The History of Ecuador and Space*, n.d.).
2018	The U.S. satellite IRVINE02 was launched. It is made of 60% Ecuadorean parts (*The History of Ecuador and Space*, n.d.).
2020	NASA chose EXA as a component provider for the IRVINE04 satellite (*The History of Ecuador and Space*, n.d.).

Venezuela

China and Venezuela

Commentary

Though the Bolivarian Agency for Space Activities (ABAE) was only created in 2007, the China-Venezuela space relationship has already reached an advanced level (Sarli et al., 2018). China has helped Venezuela develop and launch numerous satellites while also providing 180 Venezuelan scientists the opportunity to study satellite design, manufacturing, and operations (Klinger, 2018; Pollpeter et al., 2015; Sarli et al., 2018). To date, Venezuela has relied on international partners to bolster its space program and facilitate technology transfer (Sarli et al., 2018). In fact, Venezuela's space program has relied extensively on international cooperation with China for each of its major accomplishments (Sarli et al., 2018).

Table 10: Timeline of SRCA Between China and Venezuela

Year	Event
2004	China agreed to produce the Venezuelan satellite Venesat-1 (Serna, 2018).
2005	The China Great Wall Industry Corporation and the Venezuela Science and Technology Ministry agreed to cooperate on satellite launches (Klinger, 2018).
Before 2008	Venezuela sent 70 scientists to China to study satellite design, operations, and manufacturing (Sarli et al., 2018).
2008	Venesat-1 was launched by China (Klinger, 2018).
Before 2011	Venezuela sent 50 scientists to China to study manufacturing and how to operate spacecraft (Sarli et al., 2018).
2011	China agreed to develop and launch the satellite VRSS-1 (Klinger, 2018).
2012	China launched VRSS-1 from a base in Inner Mongolia (Klinger, 2018; Sarli et al., 2018).
2013	60 Venezuelan scientists went to China to learn about satellite design (Pollpeter et al., 2015).
2014	China agreed to develop and launch VRSS-2 (Klinger, 2018).
2017	China launched VRSS-2 from a base in Inner Mongolia (Klinger, 2018).

The U.S. and Venezuela

Commentary

The U.S. and Venezuela have taken part in little to no space-related cooperation. It is possible that this is due, in part, to the youth of Venezuela's space program. The Venezuela Space Center was created in 2005 and their space agency was created in 2007 (Sarli et al., 2018). However, Venezuela has successfully undertaken space-related cooperation with Argentina, Bolivia, Brazil, China, India, and Uruguay (Sarli et al., 2018). As such, the short history of the ABAE has not precluded its ability to cooperate internationally.

It seems more likely that this lack of cooperation between Venezuela and the U.S. is the result of a conscious decision on Venezuela's part. Since the beginning of the Bolivarian revolution, Venezuelan leaders have consistently maintained negative attitudes towards the U.S. (Serna, 2018). This has made space-related cooperation unlikely. Venezuela's decision to work towards domestic competency and its ability to find a willing (and more ideologically aligned) partner in China have likely also played a role in the minimal development of the relationship between Venezuela and the U.S. (Serna, 2018).

Table 11: Timeline of SRCA Between the U.S. and Venezuela

Year	Event
N/A	No relevant cooperation to speak of with the U.S. (Sarli et al., 2018; Serna, 2018).

Research Findings

China has increasingly worked to foster connections with countries in Latin American, particularly in the space realm. Based on an analysis of China's relationships with Argentina, Brazil, Chile, Ecuador, and Venezuela and an analysis of the U.S.' relationships with these countries, two findings and implications have become clear.

Finding 1

It is unlikely that cooperation between China and LAC negatively affects the ability of the U.S. to cooperate with LAC. Similarly, the prior existence of extensive space cooperation relationships between China and LAC does not prevent the establishment of U.S.-LAC SSA agreements.

The U.S. and China each maintain extensive space-related agreements with Argentina and Chile. Over the last 20 years, the U.S. has cooperated with Argentina on the development and launch of the SAC-C, SAC-D, and SAOCOM satellites (Hulse, 2007; Serna, 2018; "U.S. Relations With Argentina," 2019). Over the same time period, China signed an agreement to provide support and equipment to an Argentinian satellite manufacturing company; San Juan University cooperated with the China National Astronomical Observatories and the China National Academy of Sciences on a satellite laser ranging station; and China built a satellite monitoring station on Argentinian land (*CART and SLR at South America Observing Station in Argentina*, n.d.; Klinger, 2018).

Similarly, China and the U.S. each have extensive relationships with Chile. Over the last 20 years, the U.S. has continued to manage and develop several observatories such as Gemini South, the Atacama Large Millimeter/ submillimeter Array (ALMA), and The Las Campanas Observatory (*Gemini Telescopes, Science and Technologies*, 2016; *Las Campanas Observatory [LCO] — Las Campanas Observatory*, n.d.; *Origins | ALMA*, n.d.). During this same time period, China opened the Chinese Academy of Sciences' South America Center for Astronomy in the capital, has welcomed Chilean astronomers to study in China, and recently considered investing over $320 million in an astronomical observatory and Astro Science Park in the country (Chauvin & Fraser, 2019; "China has plans for huge telescope in Chile," 2011; InvestChile, n.d.). In both Argentina and Chile, the U.S. and China have been able to simultaneously expand their space cooperation relationships.

Lastly, it is worth noting that this finding holds true even when one nation has an established relationship. For example, China has a long-established space relationship with Brazil that includes cooperation on the CBERS series of satellites (Sarli et al., 2018). Despite this long-established relationship and the relatively sparse relationship between the U.S. and Brazil, they recently signed a SSA agreement and agreed on a TSA in 2019 (Boadle, 2019).

Implication 1

While there may be a competitive aspect to the efforts of the U.S. and China to create and consummate international cooperation agreements, this is not obvious in the space cooperation/SSA arena. It is not a zero-sum game.

Finding 2

China has deeper and more extensive space cooperation ties with LAC than the U.S.

When analyzed comprehensively, it is clear that China has established stronger space-related ties to LAC than the U.S. Consider each nation's role in the development and launching of satellites over the last 20 years. During this time period, the U.S. has extensively cooperated with Argentina on three satellites and used Ecuadorean parts to build two others (Hulse, 2007; Serna, 2018; *The History of Ecuador and Space*, n.d.; "U.S. Relations With Argentina," 2019). Meanwhile, China has cooperated extensively to develop and launch three satellites with Venezuela, five satellites with Brazil, and launched an Ecuadorean satellite (Barbosa, 2019; Klinger, 2018; Sarli et al., 2018). Furthermore, within the last 20 years Venezuela has sent approximately 180 scientists to study satellite design and manufacturing in China (Pollpeter et al., 2015; Sarli et al., 2018). During this time, Chile has also sent astronomers to study in China ("China has plans for huge telescope in Chile," 2011). Meanwhile, there is little evidence to suggest LAC have sent scientists to study space-related technology in the U.S. during the last 20 years.

In order to further understand this point, it is also worth considering direct country to country comparisons. For example, while both countries have relatively similar levels of cooperation with Argentina (extensive) and Ecuador (minimal), China has deeper relations with Brazil, Chile, and Venezuela. The U.S. has only recently begun cooperating with Brazil while China has opened the China-Brazil Joint Laboratory for Space Weather and cooperated extensively with Brazil on the CBERS series of satellites (Sarli et al., 2018).

The situation is relatively similar in Chile. The U.S. has built several different space observatories there over the last several decades but has not ventured into other types of SRCA (*Gemini Telescopes, Science and Technologies*, 2016; *Las Campanas Observatory [LCO] — Las Campanas Observatory*, n.d.; *Origins | ALMA*, n.d.). China, in comparison, has recently discussed plans to build its own telescopes, has opened the Chinese Academy of Sciences' South America Center for Astronomy, has held joint conferences such as the Fifth China-Chile Bilateral Astronomy Science Meeting in Kunming, and has negotiated with Chile in order to gain access to the ALMA telescope despite the fact it is not a member of the consortium (Chauvin & Fraser, 2019; "China has plans for huge telescope in Chile," 2011; *China-Chile Bi-lateral Astronomy Science Meeting*, 2019). As such, China's space relationship with Chile is both deep and broad.

Lastly, the U.S. has essentially no SRCA with Venezuela (Sarli et al., 2018; Serna, 2018). China, meanwhile, has cooperated extensively with Venezuela on the development and launch of three different satellites (Klinger, 2018; Sarli et al., 2018). China has also trained nearly 200 Venezuelan scientists on space-related activities (Pollpeter et al., 2015; Sarli et al., 2018).

Implication 2

The increased presence of China and static presence of the U.S. in LAC increasingly paints China as a leader in the region.

PART TWO

Responding to the Findings

The research and analysis of the previous section found that China's efforts to enact SRCA in Latin America increasingly identify it as a leader in the region. This is concerning because China's desire to secure a foothold in the western hemisphere conflicts with the interests of the U.S. (Koleski & Blivas, 2018). The second part of this study will propose and assess alternatives the U.S. could implement to ameliorate this problem.

Criteria

Each of the proposed alternatives will be assessed based on the following five criteria. Each criterion will be ranked on a scale of low, medium, and high

1. Effectiveness

The most important criterion when considering potential U.S. action is effectiveness. Given the complicated nature of this problem, I am focusing my definition of "effectiveness" on the vision statement of the DIA. As noted in the DIA's *Strategic Approach,* this vision is focused on "discover[ing] information, creat[ing] knowledge, provid[ing] warning, and identify[ing] opportunities in order to deliver overwhelming advantage to our warfighters, defense planners, and national security policy makers" (DIA, 2018, p. iii). Through these alternatives I hope to provide methods by which national security policy makers can improve the position of the U.S.

In short, I will judge the effectiveness of my alternatives by their ability to bring about an outcome that gives the U.S. an advantage on the international stage, particularly as compared to China. Based on the previously stated assumptions, this criterion will judge effectiveness by determining whether or not the proposed alternative will lead to more SRCA between the U.S. and LAC or fewer SRCA between China and LAC. If the proposals positively affect either of these fronts I will consider them effective and if not, I will consider them ineffective. I will then rank the effectiveness of the alternative on a scale of low, medium, and high.

2. Monetary Cost

I will also consider the cost of my project. While the U.S. military and defense apparatus has an enormous budget, the government is running a large deficit and the current administration has shown a low willingness to spend money and engage internationally. As such, this criterion is important to consider. To do so, I will consider both the direct costs of an alternative (such as the price of investing in infrastructure in LAC) as well as the indirect costs of an alternative (such as the economic activity foregone were an embargo to be implemented). I will consider these costs as measured by USD and will consider both when ranking the alternative on a scale of low, medium, and high.

3. Diplomatic Cost

The goal of the U.S. as related to this problem is to improve its international status in Latin America. However, depending on the chosen alternative, in doing so the U.S. could further damage an already acerbic relationship with China. This is, on its own merits, not a desirable outcome. As such, I will consider the diplomatic price a given alternative would require for the U.S. to engage in further cooperation in LAC or to push China out. This will be measured on a scale of low, medium, and high and will consider the nature of the alternative. For example, changing a procedure to encourage cooperation would have a low diplomatic cost while implementing an embargo would severely roil international relations and so exact a high diplomatic cost.

4. Ease of Implementation

As these alternatives are international in scale it is likely they will be difficult to implement effectively. Since effective implementation is key to overall effectiveness it is thus important to consider this criterion. This will be measured by considering the number of agencies that would need to be involved in creating and implementing the alternative, the complexity of the program, the number of international actors that would be involved, and the scale of the program. By considering the values associated with each of these categories, I will be able to assign a score of low, medium, or high. I will also research examples of similar strategies being employed in the region to further understand their potential ease of implementation.

5. Sustainability

Lastly, I will consider the sustainability of the policy options. This criterion is important for two reasons. First of all, the relationship between the U.S. and China is both conflictual and dynamic. As such, any action the U.S. takes in order to attempt to gain the upper hand will likely be countered in some manner by China. Secondly, this relationship is adversarial and is primed to remain so for decades. Thus, *external sustainability* is important as they should be able to withstand some degree of counter action from China. In order to determine the sustainability of my alternatives I will examine the methods and mechanisms by which they work and consider their relative vulnerability to Chinese counter-action. Doing so will grant me insight into the resilience of each alternative. I will also consider the flexibility of the alternatives in order to determine whether small changes could be made in order to retain the alternative's effect if exposed to counteraction. I will then measure this by assigning a score of low, medium, or high.

Alternatives

As the intelligence arm of the Department of Defense (DoD), the DIA provides information to military and acquisition leaders, warfighters, and Congress to ensure the U.S. wins or avoids wars (DIA, 2018). The findings of this report conclude that China's efforts in LAC have supported their pursuit of interests that conflict with those of the U.S. The following alternatives will help mitigate China's efforts by strengthening U.S. relations with LAC.

1. Recommend Adjusting U.S. Export Controls and Encouraging Cooperation with Latin America

This alternative recommends that the DIA advise policy makers to adjust U.S. export controls. More specifically, the Department of State (DoS), in conjunction with the DoD, should further amend the U.S. Traffic in Arms Regulations (ITAR). While changes were recently made in order to reclassify satellite and launch technology from a "munition" to a normal good, which placed important space technologies under the purview of the Department of Commerce rather than the DoD, they did not go far enough (Bryce Space and Technology & Aerospace Industries Association, 2017; Henry, 2018). The DoD and DoS should further amend the ITAR regulations related to thrusters and imaging technology, among other technologies, to remove bureaucratic hurdles for space companies (Bryce Space and Technology & Aerospace Industries Association, 2017; Wolf, 2012). The U.S. should also move to encourage cooperation between space companies and South American nations by publicizing the change in ITAR regulations. Doing so would require little monetary cost and could be implemented within a year (*A Guide to the Rulemaking Process*, 2011).

This tactic would not prevent China from engaging in further cooperation with LAC. However, it would have two other important effects. First of all, it would make cooperation with U.S. space industries more attractive. Reducing the burden of the current regulatory regime would attract companies that do not have the capital to manage compliance costs (Abbey & Lane, 2009). This increased freedom of operation could lead to more cooperation between the U.S. and South American countries and potentially displace China. This move would also reinvigorate the domestic space sector of the U.S. Current restrictions limit the ability of immigrants to work on important projects and have been otherwise shown to result in a weakened domestic space industry (Abbey & Lane, 2009). Making these changes could thus help reinforce U.S. space supremacy by giving its domestic industry a boost. It is worth noting that each of these changes would likely take years to realize as the regulatory changes filter down.

2. Recommend the National Science Foundation (NSF) Fund the Giant Magellan Telescope (GMT)

The DIA should advise the NSF to fund the GMT in Chile. This telescope is currently supported by an assortment of organizations and universities in the U.S and abroad but is short on funding (Foust, 2019). The NSF should provide the roughly $500 million needed to fully fund the GMT (Foust, 2019). This will provide the consortium the necessary funding while also ensuring that all U.S. researchers have access to the installation regardless of their institutional association (Foust, 2019). As a private venture that is not entirely dependent on possible NSF funding, this telescope is already under construction and will be ready to begin operation by 2026 (*FAQ | GMT*, 2020). Upon completion it would immediately strengthen the U.S. position as the leader in the field (Foust, 2019).

This alternative would not restrict China's ability to pursue SRCA nor would it affect their current agreements. However, it is a relatively direct option that would ensure the U.S. continues to cooperate with LAC generally and with Chile in particular. Funding the GMT would signal that the U.S. remains committed to space-related cooperation in Latin America and would help counter the narrative of Chinese leadership in the area. Furthermore, given the present and future importance of space technology to both China and the U.S. It is also worth noting that, by providing federal funding, the U.S. would remain at the top of the field. The NSF funded ALMA in Chile and, since becoming operational in 2013, it has taken part in groundbreaking discoveries (Mountain & Cohen, 2018). The GMT will likely have similar results that will help counter narratives of Chinese leadership both in the region and in the technical space.

3. Recommend a U.S.-Venezuelan Bilateral Astronomy Science Meeting

The DIA should advise that NASA work to establish a Bilateral Astronomy Science Meeting with Venezuela. This meeting should take place in the U.S., invite academics and researchers from relevant universities such as the Central University of Venezuela, and center around their astronomical and space-related work (Acevedo et al., 2011). The conference should last 3-4 days and, though NASA will support its creation, should remain as apolitical and research-centric as possible given the tense U.S.-Venezuelan bilateral relationship. According to several different sources, about 12-18 months should normally be budgeted for planning an international research conference. However, given the political complexities of the proposed conference it would likely require about 18 months to execute. (*How To Organise An Academic Conference*, 2016; *Organising a Research Conference*, n.d.; Stark, 2015).

As is true for the other alternatives, this option would focus on strengthening U.S. relations in the region rather than obstructing Chinese efforts. Initiating an annual research conference would show a commitment to the region in general and Venezuela in particular. It would also lead to an increased level of interaction across institutions, researchers, and potential PhD candidates (Hansen, 2017). This is noteworthy due to the current dearth of cooperation between the U.S. and Venezuela. Of the five nations analyzed, Venezuela is the only one with which the U.S. has no space cooperation relationship. This reality not only allows China to take a leading role in Venezuela but also makes it more difficult for the U.S. to maintain an understanding of space-related developments in the country.

Assessing the Alternatives

Three alternatives have been proposed that could improve the position of the U.S. in LAC through increased engagement. To determine which alternative is best, I will consider them based the aforementioned criteria of *effectiveness*, *monetary cost*, *diplomatic cost*, *ease of implementation*, and *sustainability*. While some of these alternatives may impart technological advantages, the chief purpose of these alternatives is to increase the level of U.S. engagement within LAC as related to space cooperation with an aim to increase U.S. leadership in the space arena within the region.

Alternative 1: Recommend Adjusting U.S. Export Controls and Encouraging Cooperation with South America

Regarding **effectiveness** and the ability of this alternative to either encourage U.S.-LAC cooperation or limit China-LAC cooperation the outcome is unclear but likely **moderate**. This measure would make business cooperation with U.S. space industries more attractive as reducing the burden of the current regulatory regime would make it simpler to engage in business relationships. While it is difficult to know the real effectiveness of this option, it is plausible this could make the U.S. a better partner and thus lead to more cooperation between the U.S. and LAC. This adjustment could also potentially help displace China.

The **monetary cost** of this alternative is relatively light as it is not expensive to adjust regulations, particularly since these actions would lead to less bureaucracy (*A Guide to the Rulemaking Process*, 2011). In fact, this change may benefit the economy. It is estimated that from 2009 to 2012 between $1 and $2 billion was foregone in lost sales opportunities as a result of ITAR restrictions (Botwin, 2014). Though this number is not specific to Latin America, the expected economic benefit and low cost of adjusting regulation leads to a **low monetary cost.** Similarly, the **diplomatic cost would also be low.** Adjusting export regulations could have an impact on the international market. However, it is unlikely this would lead to hostile blowback as this change would open up U.S. technology for export and so would help rather than harm international partners. It is important to note that export restrictions can remain in place for high risk countries such as China.

Regarding **ease of implementation,** it is first important to consider that three agencies would be involved in the proposed export changes. The DoS, in conjunction with the DoD, would be responsible for removing items from the existing list and the Department of Commerce would add the items to its less restrictive Export Administration Regulations (*Tutorial 1: Introduction to ITAR and the U.S. Munitions List | SBIR.gov*, n.d.). It is also noteworthy that this alternative would not require the cooperation of any international actors. However, the change would require the approximately 1,000 U.S. companies that utilized space-related export controls from 2009-2012 to adjust their processes (Botwin, 2014). Lastly, the government would have to carefully manage the implementation of this alternative to reduce regulation while still protecting valuable U.S. technology. Though the new process would be less complex than the existing system, the high number of U.S. companies involved as well as the associated risk of advanced technology falling into the hands of bad actors leads to a **moderate ease of implementation**.

Finally, the **sustainability** of this alternative is **high**. While this alternative could be implemented unilaterally in order to make cooperation between the U.S. and LAC more appealing, China could make corresponding moves in order to increase the benefit of cooperating with their native businesses. However, China's private firms do not have the technological prowess to compete with U.S. firms despite the fact that the Chinese government has increasingly invested in them (Andrew, 2019). In fact, the first private Chinese company to launch a rocket that reached orbit did so just a year ago in 2019 (Clark, 2019). As such, U.S. companies retain a significant technological lead and the ability of Chinese companies to make jumps in their development is unclear. The **sustainability** of this alternative is **high.**

Alternative 2: Recommend the National Science Foundation (NSF) Fund the Giant Magellan Telescope (GMT)

The **effectiveness** of this alternative is **moderate.** It funds another U.S. telescope on Chilean soil and so furthers U.S.-Chile cooperation but has no effect on the development of cooperation between Chile and China. The majority of the value from this alternative comes from guaranteeing that the U.S. will maintain leadership in the field of astronomical observation. This will promote the image of the U.S. at a time when China is increasingly acting to seize that mantle in Latin America.

The **monetary cost** of this project is **high.** Not only does the telescope require approximately $500 million of initial funding, the installation would also require tens of millions of dollars a year to run. As a point of comparison, the ALMA telescopes require $40 million a year from the NSF (*Telescopes Could End Up Beyond the Reach*, 2018). The **diplomatic cost,** however, would be **low.** The U.S. has led the construction of several advanced telescopes before with little to no diplomatic problems. This effort would not harm any nations.

The **ease of implementation** is **high**. The federal government would play a role in this alternative solely through the provision of funds. The NSF has funded several large telescopes in Chile in the past so this procedure wouldn't be novel (Foust, 2019). In fact, the consortium of institutions leading the development of the GMT is a private venture of which the NSF would only be a partner (Foust, 2019). With that being said, the consortium must work with an international actor (Chile), complicating implementation, and the scale and complexity of this project inherently makes implementation more difficult. However, given that Chile is home to numerous international telescopes and the U.S. government need only provide funding, the **ease of implementation** for this alternative is **high**.

The **sustainability** of this alternative is **moderate**. Funding this telescope will ensure U.S. technical and intellectual leadership in the astronomical observation field until the 2040s (Foust, 2019). However, there is no guarantee that U.S. leadership will extend beyond this time frame. China could invest in larger and more advanced telescopes in order to claim leadership in the field. In fact, China's completion of the world's largest radio observatory in 2019 indicates an ambition to do just this (Gough, 2019).

Alternative 3: Recommend the Establishment of a U.S.-Venezuelan Bilateral Astronomy Science Meeting

The **effectiveness** of this alternative is **moderate**. While it does not inhibit Chinese cooperation in Latin America, the alternative does provide for the beginning of cooperation between the U.S. and Venezuela. This is particularly important because the U.S. currently has little to no SRCA with Venezuela (Sarli et al., 2018; Serna, 2018). As such, this would provide the U.S. with an opportunity to begin working with a country that is currently unknown to NASA.

The **monetary cost** of this program is likely around $100,000. In 2019, the average cost of a conference hosted by the DoD was about $280,000 (*DoD Hosted Conference Annual Reports*, n.d.) However, the cost of a small conference with about 70 attendees, which would be appropriate for this purpose, is about $100,000 (Gabriel, 2019). As such, the **monetary cost** of this program is **low.** The **diplomatic cost** of this program is **high**. The U.S. doesn't currently maintain an Embassy in Venezuela and recognizes opposition leader Juan Guaidó as its rightful leader ("U.S. Relations With Venezuela," 2019). Furthermore, since 2017 the U.S. has implemented many different financial and economic sanctions on the economy of Venezuela ("U.S. Relations With Venezuela," 2019). As such, any effort to create a scientific conference between U.S. and Venezuelan researchers would be inconsistent with its present policy.

The **ease of implementation** of this alternative is **low.** Conferences are often planned and carried out across the country. In fact, in 2019 the DoD executed 147 conferences (*DoD Hosted Conference Annual Reports*, n.d.). Furthermore, this conference would be of limited scale and have less than 100 attendees. However, they are complicated to plan and this conference would require NASA to work with national universities as well as several international universities in Venezuela. Most pressing, this alternative would face significant logistical and political issues as a result of the poor U.S.-Venezuela relationship. As such, the **ease of implementation** is **low**.

The **sustainability** of this option is also **low.** There is value in kickstarting a cooperative U.S.-Venezuela space relationship with a conference, however, a single conference will have a limited effect in the long-term. Conferences must be held for several years or as part of a more comprehensive relationship in order to solidify their benefits. Put simply, one conference one year, particularly in light of the current relationship, will have limited influence.

Recommendation

It is recommended that the DIA implement *Alternative 1: Recommend Adjusting U.S. Export Controls for Space-Related Technology.* Critically, this alternative has the greatest potential effectiveness as it has the capacity to affect relationships across the region. In contrast, the other alternatives affect only one nation each. Furthermore, this strategy has a low monetary cost as the proposed changes are administrative in nature and, by reducing regulations, could have the added benefit of encouraging economic productivity (Botwin, 2014). In comparison, the other two alternatives require spending on outside projects. Adjusting export controls would have a low diplomatic cost as this alternative would loosen regulations the U.S. currently maintains without adversely affecting other nations and, in fact, could benefit them by granting foreign countries access to U.S. space industries (Wolf, 2012). Adjusting export controls is moderately difficult to implement however, funding the GMT, while simpler, is far more expensive (Foust, 2019). Lastly, as the only "policy change" among these alternatives as opposed to a single action, adjusting export controls is relatively sustainable. Reducing regulations will have a more lasting effect than a single conference with Venezuelan researchers and, depending on the time it takes Chinese corporations to catch up to the technological prowess of U.S. space corporations, the policies will likely also remain effective longer than the GMT will retain technological superiority (Foust, 2019).

With that being said, this alternative entails the highest level of risk. While the export control system is overly complicated and restrictive, it was implemented with the intent of protecting valuable and potentially dangerous U.S. technology (Botwin, 2014). Reform efforts must be managed in order to streamline the process while simultaneously ensuring the regulations effectively serve their purpose of protecting U.S. technology from falling into the hands of dangerous actors.

The low cost, high sustainability, and moderate effectiveness of this alternative make it the best option despite its moderate ease of implementation. If this alternative is implemented well, the U.S. may be able to expand its international cooperation with LAC in a method that benefits U.S. corporations while also exhibiting leadership in the region.

Figure 4: Decision Matrix of Proposed Alternatives According to the Chosen Criteria

	Alternative 1: Recommend Adjusting U.S. Export Controls for Space-Related Technology	*Alternative 2: Recommend the National Science Foundation (NSF) Fund the Giant Magellan Telescope (GMT)*	*Alternative 3: Recommend the Establishment of a U.S.-Venezuelan Bilateral Astronomy Science Meeting*
Effectiveness	Moderate	Moderate	Moderate
Monetary Cost	Low	High	Low
Diplomatic Cost	Low	Low	High
Ease of Implementation	Moderate	High	Low
Sustainability	High	Moderate	Low

*Green indicates a positive result while red indicates a negative result.

Adoption

The Recommendation

Based on the efforts of China in Latin America, its interests in the region, and the interests of the U.S. it is recommended that the DIA work to loosen export controls related to space components, satellites, and satellite launching technology. This will make it simpler for the U.S. space industry to work with international partners and thus make space-related cooperation agreements between the U.S. and LAC more attractive.

In order to adjust export controls, the Directorate of Defense Trade Controls (DDTC) of the DoS needs to alter the International Traffic in Arms Regulations (ITAR) (*Introduction to ITAR and the U.S. Munitions List*, n.d.). The DDTC often does this in conjunction with the Defense Technology Security Administration of the DoD (*Introduction to ITAR and the U.S. Munitions List*, n.d.). More specifically, these departments need to work together in order to adjust the items that are subject to ITAR and, within ITAR, subject to the United States Munitions List and the Missile Technology Control Regime (MTCR) (Part 121 - The United States Munitions List, n.d.).

The Position of Relevant Parties

This recommendation requires the cooperation of numerous government stakeholders. Namely, the DoS, the DoD, and the Executive Office of the President (EOP), which directs these agencies, all play a role. While not directly related to the process of reducing regulations, the producers of satellites, components, and launching technologies also have a large stake in moving this recommendation forward.

The DoS is willing to make these changes and as recently as 2017 made adjustments to ITAR with this goal in mind (*US State Department clarifies satellite thruster regulations*, 2018). However, by revising the process more aggressively on a shorter timeline the adjustments can have a more beneficial effect (*Recommendations for U.S. Space Industry Competitiveness*, 2017). As such, it is likely the DoS will support the substance of this initiative while resisting the timeline. The DoD, meanwhile, will likely resist the recommendation. The DoD is a conservative institution and this recommendation requires it to reduce controls on technology that was seen, at one point in time, as too dangerous to export. As such, the DoD would likely require a large amount of evidence to loosen regulations.

It is difficult to predict the position of the EOP. It will likely garner support if it is properly framed as a move designed to counter the increasing global influence of the CCP. However, it is also possible that specific export control adjustments could be seen as being "weak on China" and thus rejected. Private corporations, however, would support this alternative as it would free them from over-regulation and allow for more flexibility when negotiating international deals.

Moving Towards Policy Adoption

Notably, the DIA cannot directly affect the implementation of this recommendation as the agency is focused on information gathering rather than policy creation and implementation. However, the agency fulfills its mission by providing information to the Secretary of Defense, their deputies, the Chairman of the Joint Chiefs of Staff, combatant commanders, and members of Congress (DIA, 2018). Within this restricted role, the DIA has the capacity to inform important decision makers in the DoD and EOP about the importance of reforming U.S. export controls through reports, briefs, and other mediums. It is recommended the DIA utilize this path when pursuing implementation.

Given the likely positions of the DoD and the EOP, the DIA must be prepared to manage potential resistance to change. However, the nature of the DIA necessarily restricts strategies it can use. As a result, it is recommended the agency work passively to frame the issue and alternative in a way that aligns with the incentives of each of these branches. More specifically, the DIA should focus on framing this alternative as a crucial step to counter the influence of China on the world stage while also promoting the interests of U.S. businesses. If messaged successfully, the EOP will take the aggressive policy-making steps in the DoD and the DoS that the DIA cannot.

Potential Problems

The most likely problem in the implementation of this option is that it will be ineffective. The DIA is not a policy making agency and so cannot act directly. Rather, the organization must rely on its ability to convince those who can make policy to do so. While this is possible, it is not highly likely.

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