



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

EMERGING SPACE PROGRAMS IN SUB-SAHARAN AFRICA

by

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March 2021

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REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC, 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 2021	3. REPORT TYPE AND DATES COVERED Master's thesis	
4. TITLE AND SUBTITLE EMERGING SPACE PROGRAMS IN SUB-SAHARAN AFRICA			5. FUNDING NUMBERS	
6. AUTHOR(S) Tyler J. Barker				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			12b. DISTRIBUTION CODE A	
13. ABSTRACT (maximum 200 words) Sub-Saharan African countries with established space programs have pursued a variety of different space policies, some focusing on national security, some focusing on socioeconomic development, or some on a mix of the two. Which factors—foreign partners, domestic politics, bureaucratic institutions, or economic capacity—are the strongest drivers of these policy decisions in African space programs? This thesis uses a qualitative case study analysis of the two most advanced space programs in sub-Saharan Africa, South Africa and Nigeria, to address the research question. Each case study provides a brief history of the country's space program before analyzing the roles each factor plays in space policy decisions. In both South Africa and Nigeria, only domestic political priorities had a strong impact on the space programs' trajectories, while the remaining factors exhibited either weak influence or no influence. The strength of the political priorities hypothesis suggests a high-degree of political agency and national pride in each country's space program, which contrasts with typical "Afro-pessimist" approaches to African studies. If U.S. leaders desire to improve geopolitical relationships with strategic partners in Africa, thereby counterbalancing great power competition on the continent, the U.S. should assist African countries in implementing their political priorities by increasing space cooperation with African countries across the commercial, civil, and military sectors.				
14. SUBJECT TERMS space policy, South Africa, Nigeria, developing countries, emerging space actors, sub-Saharan Africa, space programs			15. NUMBER OF PAGES 155	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU	

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EMERGING SPACE PROGRAMS IN SUB-SAHARAN AFRICA

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(MIDDLE EAST, SOUTH ASIA, SUB-SAHARAN AFRICA)**

from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

Sub-Saharan African countries with established space programs have pursued a variety of different space policies, some focusing on national security, some focusing on socioeconomic development, or some on a mix of the two. Which factors—foreign partners, domestic politics, bureaucratic institutions, or economic capacity—are the strongest drivers of these policy decisions in African space programs? This thesis uses a qualitative case study analysis of the two most advanced space programs in sub-Saharan Africa, South Africa and Nigeria, to address the research question. Each case study provides a brief history of the country’s space program before analyzing the roles each factor plays in space policy decisions. In both South Africa and Nigeria, only domestic political priorities had a strong impact on the space programs’ trajectories, while the remaining factors exhibited either weak influence or no influence. The strength of the political priorities hypothesis suggests a high-degree of political agency and national pride in each country’s space program, which contrasts with typical “Afro-pessimist” approaches to African studies. If U.S. leaders desire to improve geopolitical relationships with strategic partners in Africa, thereby counterbalancing great power competition on the continent, the U.S. should assist African countries in implementing their political priorities by increasing space cooperation with African countries across the commercial, civil, and military sectors.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIS	automatic identification system
ANC	African National Congress
ARMS-C	African Resource Management Satellite Constellation
AU	African Union
CGWIC	China Great Wall Industry Corporation
CSTP	Centre for Space Transport and Propulsion
DMC	Disaster Monitoring Constellation
DSA	Defence Space Administration
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EFCC	Economic and Financial Crimes Commission
EMSA	emerging space actor
EO	Earth observation
FIPEX	flux- Φ -probe experiment
GDP	gross domestic product
GEO	geostationary equatorial orbit
GLU	Government Lead Users' Group
GPC	great power competition
IMET	international military education and training
ISWAP	Islamic State's West Africa Province
KPI	key performance indicator
LEO	low Earth orbit
MSI	multispectral imager
MST	Minister of Science and Technology
MTCR	Missile Technology Control Regime
MTI	Minister of Trade and Industry
NASA	National Aeronautics and Space Administration
NASENI	National Agency for Science and Engineering Infrastructure

NASRDA	National Space Research and Development Agency
NCRS	National Centre for Remote Sensing
NIGCOMSAT	Nigerian Communications Satellite Limited
NWGSST	National Working Group on Space Science & Technology
PNT	position, navigation, and timing
SALT	South African Large Telescope
SANDEF	South African National Defence Force
SANSA	South African National Space Agency
SAP	structural adjustment program
SAR	synthetic aperture radar
SKA	Square Kilometre Array
SRF	solid rocket fuel
SSTL	Surrey Satellite Technology Limited
STEM	science, technology, engineering, and mathematics
SWG	Space Working Group

ACKNOWLEDGMENTS

Most difficult projects require a collective effort to complete them successfully. This thesis was no exception. I am beyond grateful for the countless hours of support and guidance that my advisors, Dr. Rachel Sigman and Dr. Clay Moltz, contributed in helping me realize this project. I am certain that your knowledge, insights, and critiques substantially improved the final product. I would also like to thank Ms. Alison Scharmota of the Graduate Writing Center for helping me develop my writing abilities and confidence by patiently explaining even the most basic writing concepts. Moreover, I want to acknowledge the tireless work of the Thesis Processing Office and Dudley Knox Library staff members, who assisted in my research and final production efforts.

During my time at the Naval Postgraduate School, several professors stand out for enriching the classroom experience, even if much of it was virtual. Specifically, Dr. Baylouny, Dr. Glosny, Dr. Hafez, Dr. Looney, Dr. Meierding, Dr. Moltz, Dr. Ostovar, and Dr. Sigman each fostered exceptional learning environments that broadened my horizons and challenged my thinking. Furthermore, I am indebted to both senior intelligence officers, Captain (Retired) Clark Bone and Captain Robert Hight, for serving as mentors and advocating for my personal interests.

Finally, I could not have completed this thesis without my family. To my wife, Tatum, thank you for your unconditional love, relentless support, and unstoppable optimism. To my newborn twin daughters, Cora and Isolde, thank you for providing the motivation I needed to push through this thesis. You all inspire me to do my best. Lastly, thank you to my parents, siblings, extended family, and in-laws for creating such a strong support network. This thesis truly was a collective effort.

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I. INTRODUCTION

A. RESEARCH QUESTION

From science fiction to scientific journal articles, outer space is represented as humanity's final frontier. Space is an incredibly inhospitable environment with a plethora of hazards to both humans and spacecraft, including high radiation, extreme thermal variations, potential high-speed collisions, solar flares, microgravity, and almost no atmospheric pressure. Furthermore, rocket launches to orbit are jarring and expensive, even with the recent emergence of commercial rocket reusability. With the many challenges and risks that space presents, why would a developing country, with earthlier domestic and international concerns, commit scarce capital and resources towards creating space capacity and institutions?

Sub-Saharan Africa is widely recognized as a region with many developing countries that face countless obstacles. Fewer people realize that sub-Saharan Africa has an emerging space sector with a growing number of emerging space actors (EMSAs).¹ These EMSAs appear to create varied space programs, with some countries developing space programs to advance their national security goals while others pursue programs geared toward socioeconomic development. This thesis addresses why EMSAs in Africa have pursued different space policies, focusing on security, development, or some mix of the two. It also examines the foreign partnerships involved in different types of African space programs and the implications of these partnerships for influencing space policy.

B. SIGNIFICANCE

African space programs are rapidly expanding in scope and number. Every African country is now “involved in at least some capacity in the space sector, apart from being a user of space data.”² The level of involvement greatly varies between countries. Fourteen

¹ Hereafter, I will use “Africa” to mean “sub-Saharan Africa” for the sake of concision.

² Annette Froehlich and André Siebrits, *Space Supporting Africa: A Primary Needs Approach and Africa's Emerging Space Middle Powers* (Cham, Switzerland: Springer International Publishing, 2019), 145, <https://doi.org/10.1007/978-3-030-12173-0>.

countries in Africa have an emerging space program in the form of ground facilities or satellites.³ The remaining countries in Africa have not developed space technology but are involved in intergovernmental organizations or interact with non-governmental organizations focused on space programs.⁴ In short, Africa is experiencing a surge in space activity.

The growth in African EMSAs presents both an opportunity and threat to U.S. global interests. EMSAs present opportunities because they almost always need partners to develop space technology and access space.⁵ The U.S. might be able to strengthen partnerships with African countries by supporting their emerging space programs. On the other hand, U.S. interests could be threatened if EMSAs partner with countries seeking to limit U.S. power. For example, orbital trajectories, with the exception of geostationary equatorial orbit (GEO), eventually pass over all of Earth's longitudes, allowing military or dual-use satellites to collect information on U.S. national security interests globally. By understanding what factors influence the objectives of an African EMSA's space policies, the U.S. can identify potential partners and position itself to respond to future threats. With the growth in African EMSAs and great power competition (GPC) in Africa, this research is more relevant than ever.

This thesis also contributes to the theoretical understanding of African countries. There are not currently many tools to comprehend African governments' actions in the space sector, so there is abundant room for growth in this field. Understanding the factors that influence African space policy will further illuminate the behavior of African governments in their broader development and security programming. Furthermore, African space studies are especially interesting because the space sector is a potential point of national pride, which contrasts to common development concerns like poverty, food,

³ Samuel Oyewole, "Space Research and Development in Africa," *Astropolitics* 15, no. 2 (May 2017): 190–91, <https://doi.org/10.1080/14777622.2017.1339254>.

⁴ Froehlich and Siebrits, *Space Supporting Africa*, 144–45.

⁵ Danielle Wood and Annalisa Weigel, "Charting the Evolution of Satellite Programs in Developing Countries: The Space Technology Ladder," *Space Policy* 28, no. 1 (February 2012): 21–22, <https://doi.org/10.1016/j.spacepol.2011.11.001>.

and ungoverned spaces. Exploring an optimistic topic like space challenges common “Afropessimist” approaches to African studies.

C. LITERATURE REVIEW

The context in which African countries are developing their space programs today is considerably different from that in which more advanced space programs came about. Whereas the Cold War gave rise to a generation of space programs focused largely on the competitive pursuit of international power, there is now increasing importance on access to space for both national security and socioeconomic development.⁶ The space policy goals of most EMSAs fall on a spectrum between these security or development objectives.⁷ This research examines the motivations of EMSAs in Africa, and discovers what factors are most important in a country’s decision to favor either security or development in their nascent space programs.

EMSAs in Africa are exclusively what Harding classifies as second- or third-tier space actors, which means they rely on international collaboration in varying degrees to accomplish their space objectives.⁸ As African countries look to develop space capacity, they invest primarily in satellite programs and ground facilities, with several additional small sounding rocket programs.⁹ Host governments fully fund about 62% of these space programs, while private investors and external partners work with African countries to fund

⁶ Robert C. Harding, *Space Policy in Developing Countries: The Search for Security and Development on the Final Frontier* (New York: Routledge, 2013), 29–30, 71.

⁷ For example, the subtitle of Harding’s book emphasizes the importance of security and development as the primary policy goals for space programs in developing countries. Harding, *Space Policy in Developing Countries*.

⁸ Harding categorizes EMSAs into three groups: (1) first-tier EMSAs are the most advanced programs, with autonomous production, independent launch capacity, national space agencies, and a space history predominantly focused on ballistic missiles or nuclear weapons; (2) second-tier EMSAs have semi-independent technology production with international collaboration, basic rocketry capabilities, and national space agencies; and (3) third-tier EMSAs invest in space capacity by purchasing space technology, cooperating with more advanced space states, and, sometimes, making independent space contributions. Froehlich and Siebrits, *Space Supporting Africa*, 268–69; and Harding, *Space Policy in Developing Countries*, 78–79.

⁹ Oyewole, “Space Research and Development in Africa,” 193–94.

the remaining projects.¹⁰ Like other EMSAs, African countries use these space investments to solve countless security and development problems.

1. The Security-Development Space Policy Decision

Most of the existing literature on EMSAs focuses on why developing countries choose to develop a space program at all. Fewer studies address why EMSAs adopt different *types* of space policies. Nonetheless, this discussion draws on existing literature to highlight key factors driving space policy choices of EMSAs, and discusses how these explanations may or may not apply to African countries in establishing security- or development-focused space programs. I examine four broad groupings of factors: international relations, political priorities, bureaucratic institutions, and economic capacity.

From the international relations perspective, many EMSAs are dependent on international partners with more advanced space programs. In their study of space technology for eight EMSAs, for example, Wood and Weigel discover that all eight countries used international partnerships to help advance their space programs, and only one country has the technological capacity to independently launch to GEO.¹¹ EMSAs, therefore, broadly depend on international partnerships to access the benefits of space. It follows that the availability of space partners is likely to shape a country's space policy.

Another strand of the international relations perspective focuses on the extent to which a conflictual or cooperative international context shapes emerging space programs. For example, during the Cold War, the conflictual environment led to a security-focused space race aimed at international power between the U.S. and USSR.¹² In the post-Cold War era, where international cooperation is more common, space programs have focused to a larger extent on socioeconomic development.¹³ This does not indicate that competition

¹⁰ Oyewole, 194–95.

¹¹ Wood and Weigel, “Charting the Evolution of Satellite Programs in Developing Countries,” 21–22.

¹² Giorgio Petroni and Davide Gianluca Bianchi, “New Patterns of Space Policy in the Post-Cold War World,” *Space Policy* 37, no. 1 (August 2016): 12–13, <https://doi.org/10.1016/j.spacepol.2016.10.002>.

¹³ Petroni and Bianchi, 13; and Harding, *Space Policy in Developing Countries*, 196.

in the space domain has disappeared after the Cold War, but rather, that the dominance of the conflictual environment has waned.¹⁴ Development objectives have become a new focus of cooperation, especially in the economic, political, and institutional domains, but military cooperation, through alliances with more advanced space countries, remains an important influence on space policy for EMSAs.¹⁵ Thus, the broad nature of the international environment matters for understanding how EMSAs' develop their domestic space programs.

As the last element of the international relations perspective, Froehlich and Siebrits assert that an African EMSA's status as an "emerging middle power" shapes space policy decisions. They define an emerging middle power as a state with medium global international power, but regional dominance, and offer South Africa and Nigeria as primary examples.¹⁶ Froehlich and Siebrits expect that emerging middle powers will behave in ways that support the existing international order, maintain their regional privilege within the system, avoid threats to global powers, facilitate regional cooperation, and solidify their position as a broker between global powers and regional states.¹⁷ Put simply, the emerging middle powers argument expects African EMSAs to conform to international space laws and norms. Although this argument may help explain how African EMSAs interact with international space fora, it is not a useful explanation for influences on African security-development decisions in the space sector since international space institutions permit a wide variety of both security and development space applications.

A country's political priorities also shape its space program. Harding argues that "states have traditionally structured national space policies in ways that are not at all unlike

¹⁴ As an example of a post-Cold War conflictual environment, Moltz finds that competition for space capacity is strong in Asia, which creates security-focused space policies. James Clay Moltz, *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2012).

¹⁵ Stephen M. Walt, "International Relations: One World, Many Theories," *Foreign Policy*, no. 110 (Spring 1998): 32, <https://doi.org/10.2307/1149275>; and Harding, *Space Policy in Developing Countries*, 196.

¹⁶ Froehlich and Siebrits, *Space Supporting Africa*, 73.

¹⁷ Froehlich and Siebrits, 73–75.

their terrestrial national security and development priorities.”¹⁸ Many EMSAs create space policies that utilize satellite technology to gain information for both national security and socioeconomic development, which creates tangible political benefits.¹⁹ For example, satellite imagery can support national security objectives by tracking adversary force movement, while also contributing to development by providing information on crop yields.²⁰ The imagery provides information that politicians use to make more informed decisions about both security and development problems. In other words, space policy mirrors a country’s political priorities because of the real benefits that space technology can deliver to help achieve political objectives.

Several studies have focused on the role of bureaucratic institutions in shaping emerging space programs. Both Moltz and Martinez offer complementary examples of bureaucratic cooperation and its effects on space programs. Moltz finds that internal organizational competition over space priorities has slowed Brazil’s space progression.²¹ Likewise, Martinez cites broad bureaucratic cooperation as the driver of South Africa’s resurgent space program.²² These findings reveal the importance of bureaucratic actors in the success or failure of emerging space programs, and hint at the power that bureaucratic institutions hold.

Many scholars have also considered how an EMSA’s economic capacity may guide its space policy. As previously discussed, developing space capacity is difficult and expensive, especially independent launch capabilities. Wood and Weigel note that launch technologies require more substantial investments than satellite development alone.²³ The diverging technology requirements mean that EMSAs with less economic capacity can

¹⁸ Harding, *Space Policy in Developing Countries*, 13.

¹⁹ Harding, 75.

²⁰ Oyewole, “Space Research and Development in Africa,” 187.

²¹ James Clay Moltz, “Brazil’s Space Program: Dreaming with Its Feet on the Ground,” *Space Policy* 33, no. 1 (August 2015): 17, <https://doi.org/10.1016/j.spacepol.2015.05.001>.

²² Peter Martinez, “The Development and Initial Implementation of South Africa’s National Space Policy,” *Space Policy* 37, no. 1 (August 2016): 38, <https://doi.org/10.1016/j.spacepol.2016.10.003>.

²³ Wood and Weigel, “Charting the Evolution of Satellite Programs in Developing Countries,” 21.

generally only pursue satellite technology, rather than launch technology.²⁴ The technological difficulty of launch technology and its close connection with ballistic missiles means that EMSAs with less economic capacity may have difficulty pursuing security-focused space programs, with the notable exception of dual-use satellites.²⁵ A country's access to equatorial launch sites helps mitigate these launch costs, but the difference in technology requirements does not change.²⁶

Explanations based on economic capacity include an EMSA's economic diversity as well. Petroni suggests that EMSAs that rely heavily on one economic sector may create development-focused space policy to support and grow that sector, since it will quickly offset the expense of space capacity.²⁷ Put differently, the potential return on investment is greater for space technology that focuses on a sector that dominates an EMSA's economy, rather than for a smaller sector.

In summary, international relations, political priorities, bureaucratic institutions, and economic capacity can help explain why EMSAs may develop more security-focused or more development-focused space policies. Earlier studies tend to emphasize the international relations explanations, but more recent work has seen a more diverse set of perspectives. There is not yet a comprehensive study in the existing literature comparing the various theories to determine which is most important.

2. Understanding the African Context for Space Program Development

Regional dynamics in Africa suggest that their choices of space programs may deviate from other EMSAs. First, African countries are among the most aid dependent in the world. Aid dependency dampens Africa's global power and undermines their sovereignty in domestic affairs, impacting macroeconomic decisions and domestic

²⁴ Oyewole, "Space Research and Development in Africa," 202.

²⁵ Harding, *Space Policy in Developing Countries*, 29–30.

²⁶ Petroni and Bianchi, "New Patterns of Space Policy in the Post-Cold War World," 17.

²⁷ Petroni and Bianchi, 16.

governance structures in particular.²⁸ This aid dependency often “undermines the ability of Africans...to determine their own best economic and political policies.”²⁹ With a rapidly growing array of foreign players in African countries, however, African leaders have growing leverage in their international partnerships. Nonetheless, the robust presence of foreign donors and enduring post-colonial relationships may exert considerable influence on the way that African space programs emerge.

Africa also has a distinctive security landscape characterized by non-state internal or transnational threats rather than inter-state conflict or competition. Specifically, a Congressional Research Service report on Africa lists internal conflicts, Islamist extremism, maritime security, and a handful of institutional weaknesses as Africa’s primary security concerns.³⁰ Noticeably absent from this list are international conflicts or intra-African inter-state wars, though some have occurred. Instead, most African states behave in highly cooperative ways.³¹ Overall, the specific circumstances of Africa suggest some adaptations of the four theories outlined above to guide my research approach.

D. HYPOTHESES

I investigate four hypotheses to explain why EMSAs in Africa focus their space policies on security, development, or some mixture of the two. The four hypotheses draw on the explanations offered in the literature, adapted to the African EMSA context. Some explanations require reasonable extrapolation beyond the arguments of the original authors to understand how those factors might directly affect the choice of space program. The four

²⁸ William Brown, “Sovereignty Matters: Africa, Donors, and the Aid Relationship,” *African Affairs* 112, no. 447 (April 2013): 270–72, <https://doi.org/10.1093/afraf/adt001>.

²⁹ Dambisa Moyo, *Dead Aid: Why Aid Is Not Working and How There Is a Better Way for Africa* (New York: Farrar, Straus and Giroux, 2010), 67.

³⁰ Tomas F. Husted et al., *Sub-Saharan Africa: Key Issues and U.S. Engagement*, CRS Report No. R45428 (Washington, DC: Congressional Research Service, 2019), 6–8, <https://crsreports.congress.gov/product/pdf/R/R45428>.

³¹ Jeffrey Ira Herbst, *States and Power in Africa: Comparative Lessons in Authority and Control* (Princeton: Princeton University Press, 2000).

hypotheses include (1) foreign security and development partnerships, (2) domestic political prioritization, (3) bureaucratic institutions, and (4) economic capacity.

The first hypothesis focuses on foreign security and development partnerships, which relates to the international relations explanations. African EMSAs often depend on cooperation with international partners for access to space technology and funding. The convergence of space and aid dependency implies that African countries would develop whatever programs foreign partners are willing to sponsor. Harding's observation that space policy typically mirrors terrestrial policies also suggests that existing or previous partnerships in other policy spheres will guide space cooperation and program development.³² Evidence that past partnerships or alliances constrain the evolution of African space policy would support this hypothesis. When EMSAs in Africa collaborate with existing partners, their space programs' objectives should align with previous agreement priorities.

The second hypothesis, domestic political prioritization, adopts the logic of the political prioritization explanation from the literature review. This hypothesis predicts that space programs will reflect domestic political priorities. Furthermore, the design of programs will help politicians to achieve both their political and policy goals. These goals include political survival and the use of state resources, which could include space resources, as a neopatrimonial tool to preserve their power.³³ Consequently, politicians are more likely to prioritize a space program if it helps solve a primary domestic political concern or offers opportunities to distribute neopatrimonial benefits to political supporters. This hypothesis predicts that countries that politically prioritize their security concerns will lean towards a security-based space policy whereas those that prioritize development will adopt a development-focused policy, unless politicians favor a contradictory space program for its potential neopatrimonial benefits. Due to the non-state nature of most security threats in Africa, EMSAs that adopt security-focused space programs are more

³² Harding, *Space Policy in Developing Countries*, 25.

³³ Nicolas Van de Walle, *African Economies and the Politics of Permanent Crisis, 1979–1999* (New York: Cambridge University Press, 2001), 16–17.

likely to develop remote sensing satellites with military or dual-use applications, since ballistic missiles are generally reserved for interstate conflict.

Although the literature on bureaucratic institutions, the third hypothesis, focuses primarily on the success of space programs, it is not a far leap to understand how institutions might influence space program objectives. Since space programs require buy-in from bureaucrats, often with their own interests, it follows that bureaucratic actors can push the overarching space policy towards security or development. Although an EMSA might have security- or development-focused space policy priorities, policy makers ultimately rely on bureaucratic institutions to execute their vision. A powerful defense or economic bureaucracy may push space policy toward its preferred applications. In other words, the complex array of bureaucratic interests may allow individual organizations to asymmetrically influence the direction of an EMSA's space policy.

A fourth and final hypothesis, economic capacity, argues that EMSAs in Africa with low levels of economic capacity are more likely to favor development-oriented space policy. The foundational reasons for this hypothesis are three-fold. First, the cost and risks of space, along with the diverging technology requirements between satellite and launch programs, mean that EMSAs with weak economies are unlikely to pursue satellite and launch capabilities simultaneously. The larger expense of launch technology, itself often associated with ballistic missiles, makes development-oriented satellite technologies more practical for low economic capacity EMSAs in Africa. Finally, EMSAs that rely on one economic sector generally have low economic capacity due to the lack of diversification. They are likely to adopt space programs to improve their primary sector, which increases the probability of meaningful economic returns. Conversely, EMSAs with high economic capacity and more diverse economies are less economically constrained in their space policies, so they have more freedom to choose space policies with objectives that focus on security, development, or some combination of the two.

E. RESEARCH DESIGN

This thesis uses comparative case studies to examine why EMSAs in Africa favor security or development space policies. A comparative case study is best for answering this

question because case study methodology allows detailed examinations of many variables when the sample size is too small for statistically significant quantitative testing.³⁴ Additionally, case studies can find support for causal mechanisms when there is no obvious method to operationalize several variables.³⁵ Finally, comparing cases may reveal several independent variables as control variables across hypotheses, resulting in better conclusions.³⁶

1. Case Selection

This thesis examines space programs in South Africa and Nigeria. Historically, these two countries have been regional leaders, and they are likely to maintain their positions of relative power in Africa for some time.³⁷ They also lead the region in space programs, and control the vast majority of satellites from Africa.³⁸ Furthermore, South Africa's and Nigeria's roles as sub-regional powers may propel the development of other African EMSAs, since the most successful intra-African space cooperation occurs when sub-regional powers assume leadership roles, according to Froehlich and Siebrits.³⁹ South Africa's space program is particularly interesting because it permits comparisons between two distinct space programs over time. South Africa's space policy was security-focused during the Cold War, and, after a six-year gap in space activity, transitioned to a development-focused policy after apartheid.⁴⁰ As the leaders in space capacity in Africa

³⁴ Jason Seawright and John Gerring, "Case Selection Techniques in Case Study Research: A Menu of Qualitative and Quantitative Options," *Political Research Quarterly* 61, no. 2 (June 2008): 294, <https://doi.org/10.1177/1065912907313077>.

³⁵ David Collier, Henry E. Brady, and Jason Seawright, "Introduction to the Second Edition: A Sea Change in Political Methodology," in *Rethinking Social Inquiry: Diverse Tools, Shared Standards*, ed. Henry E. Brady and David Collier, 2nd ed. (Lanham, MD: Rowman & Littlefield Publishers, 2010), 5–6.

³⁶ Seawright and Gerring, "Case Selection Techniques in Case Study Research," 304.

³⁷ Jakkie Cilliers, Julia Schünemann, and Jonathan D. Moyer, *Power and Influence in Africa: Algeria, Egypt, Ethiopia, Nigeria and South Africa* (Pretoria, South Africa: Institute for Security Studies, 2015), 1–2, <https://issafrica.s3.amazonaws.com/site/uploads/AfricanFuturesNo14-V2.pdf>.

³⁸ Froehlich and Siebrits, *Space Supporting Africa*, 269–71.

³⁹ Froehlich and Siebrits, 145.

⁴⁰ Harding, *Space Policy in Developing Countries*, 141.

with the most developed space programs, South Africa and Nigeria are important cases to understand how space policies evolve in Africa.

2. Identifying the Security or Development Character of Space Programs

Whereas South Africa's space policy transitioned from security to development across two distinct programs, Nigeria's space program began with a general focus on development applications but has progressed to include security objectives in addition to the existing development applications. To further illustrate the nature of these space programs, I examine their stated policy goals, space institutions, and technology applications throughout their space history. A space agency's policy and strategy documents provide a general overview of an EMSA's stated policy goals, and thus offer a useful starting point for understanding the program's objectives.

Beyond stated policy objectives, elements of an African EMSA's space institutions help further identify their space policy's security or development focus. The location of the lead space institution within the broader government organization helps to determine whether the program is part of the government's development or security sectors. Similarly, the links between an African EMSA's space agency and international space institutions may emphasize a security or development focus. Finally, the funding sources for specific space programs and the team that executes the program's mission may reveal the program's position on the security-development spectrum.

Space technology is another expression of whether an EMSA has chosen a security or development space program. Differentiating between the technology applications helps to clarify space policy objectives by providing details on space policy execution. The next paragraphs explore development and security space technology, and describe the overlapping benefits for dual-use space programs.

Development-focused space programs provide a wide variety of socioeconomic benefits. Many EMSAs develop space capacity with aspirations of advancing human capital and creating an aerospace industry with diverse job opportunities.⁴¹ More relevant

⁴¹ Oyewole, "Space Research and Development in Africa," 197, 199.

than education and industry aspirations, African EMSAs harness space technology and infrastructure to influence other areas of development. For example, Earth observation (EO) satellites improve weather forecasts, monitor crops, identify potential resource deposits, and track human and animal populations.⁴² Communications satellites generate socioeconomic development by extending Internet access, which creates opportunities for “telecommunication, e-commerce, e-governance, teleeducation, and telemedicine” in previously difficult to reach locations.⁴³ Finally, some African EMSAs lease their satellites to capitalize on their space technology investments.⁴⁴ This list certainly does not include all development-focused space technology applications, but it illustrates how space technology helps fulfill development goals.

In a military capacity, remote sensing satellites support intelligence, surveillance, and reconnaissance; position, navigation, and timing (PNT) satellites guide precision weapons; communications satellites facilitate over-the-horizon communication with high data rates; and ballistic missiles directly employ space launch technology.⁴⁵ Once again, this list is not all-inclusive for military space applications, and is much less inclusive for non-defense security utility, but it provides a general overview. So far, the space technology examples separate security and development objectives, but EMSAs can create dual-use space programs to achieve both objectives.

In reality, many applications of space technology overlap between security and development. The expanding definition of security, beyond military capabilities and national defense, widens this overlap. Contemporary countries consider non-defense security policies for environmental, energy, economic, political, cultural, and health elements, among others.⁴⁶ The data from EO satellites that monitor weather, agriculture,

⁴² Oyewole, 187, 200.

⁴³ Oyewole, 198.

⁴⁴ Oyewole, 198.

⁴⁵ Oyewole, 187, 201.

⁴⁶ Anton Grizold, “The Concept of National Security in the Contemporary World,” *International Journal on World Peace* 11, no. 3 (September 1994): 40–41, 46.

populations, and resources can contribute to environmental, food, political, and energy security since EMSAs use this data to make national security decisions.⁴⁷ Similarly, the PNT satellites that guide advanced weapons can help a farmer implement precision agriculture to maximize coverage and crop yield.⁴⁸ In practice, many EMSAs deploy dual-use satellites for both security and developmental purposes, since the satellites can deliver data to multiple customers.⁴⁹ Launch programs are distinct as potential dual-use technology because the direct application of launch technology to offensive military capabilities makes it a likely candidate for security-focused space objectives.⁵⁰

3. Investigating the Hypotheses

To research the four hypotheses, this thesis uses a wide variety of sources including government documents, international agreements, economic data, and news media. Government documents such as policy papers, strategies, briefings, program justifications, and budget requests provide evidence for the domestic political priorities and bureaucratic institutions hypotheses by illuminating the government's internal motivations for developing a space program. International agreements like memorandums of understanding or institutional policy documents can explain the leading actor relationships and internal dynamics of partnerships, which helps test the partnerships hypothesis. For the economic capacity hypothesis, economic data can compare and categorize the capacity of African EMSAs. Finally, news sources reveal additional details which may supplement or support more official sources for all four hypotheses.

F. ROADMAP

This thesis continues with three remaining chapters. The next two chapters are case studies on the space programs of South Africa and Nigeria, respectively. Both chapters

⁴⁷ The following provides a few specific environmental security and disaster management examples for EO satellites: Oyewole, "Space Research and Development in Africa," 201.

⁴⁸ Oyewole, 187.

⁴⁹ Michael Sheehan, "Viewpoint: Space Security and Developing Nations," *Space Policy* 37, no. 1 (August 2016): 23, <https://doi.org/10.1016/j.spacepol.2016.10.005>.

⁵⁰ Harding, *Space Policy in Developing Countries*, 29–30.

begin with a brief historical analysis of the trajectory of each country's space program, highlighting stated policy goals, space institutions, and space technologies. South Africa had two distinct space programs: a Cold War-era program entirely focused on security during apartheid, and a contemporary development-focused program established by the post-apartheid government. Nigeria's space program, in contrast, shifted from an initial focus on development to subsequently include more security applications to address regional terrorism concerns. I then systematically investigate the relevance of all four hypotheses to understand how each factor has impacted the country's space policy decisions. Overall, the evidence strongly supports the political prioritization hypothesis in both case studies, with minimal support for the remaining three hypotheses. The information in the case studies set up the concluding chapter, which compares the case studies' findings, explores implications, recommends policy actions, and discusses future research areas.

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II. SOUTH AFRICA'S CONTEMPORARY SPACE PROGRAM

A. OVERVIEW

There have been two distinct space programs in South Africa's space history. South Africa's space activities transitioned from a security-focused space program that was active during apartheid to a contemporary program that focuses on socioeconomic development. This shift is surprising, since institutional inertia from South Africa's apartheid-era space program could have facilitated the rebirth of a security-focused space program. This chapter describes the shift from the apartheid-era space program to the contemporary program, and analyzes the factors that influenced South Africa's new development focus in its space activities.

South Africa's space history can be broken into three periods. First, from 1953 to 1993, South Africa had a military-led space program, which coincided with the apartheid system of governance. Second, when the apartheid government lost power in the early 1990s, the new South African government dismantled its military space program and transitioned to the contemporary space program, a process which lasted from 1993–2007. Finally, from 2008 on, South Africa has formalized its contemporary space program and developed new space technology to implement the country's space policies. The first part of the chapter describes how South Africa's space policies, institutions, and technology have shifted from a security-focus to developmental one.

After describing South Africa's space history, I analyze the four hypotheses laid out in Chapter I to understand what factors have driven this transition. I show that the shift to a development-focused space program is primarily a reflection of South Africa's domestic political priorities. Although it is possible that other factors such as bureaucratic institutions exerted marginal influence on the direction of South Africa's contemporary space policy, consistent alignment between South Africa's broader political goals and its space policies strongly supports the political priorities hypothesis.

B. UNDERSTANDING THE SECURITY-DEVELOPMENT TRAJECTORY OF SOUTH AFRICA'S SPACE HISTORY

From the 1950s to the early 1990s, an institutionalized system of racial segregation, known as apartheid, governed South Africans.⁵¹ Apartheid collapsed in the early 1990s under domestic and international pressure, and South Africa fully transitioned to a democracy in 1994.⁵² This political transformation also marked an important transition for South Africa's space program, as the post-apartheid government drastically changed the space program's goals, institutions, and technology. The late 2000s was another important period in South Africa's space history, as government officials formalized and began implementing the contemporary program's space policies. This section describes South Africa's space history, and shows how the space programs evolved through each transition point.

1. The Military Space Program: 1953-June 1993

South Africa's first space activities occurred in 1953, when a group of non-government enthusiasts established the South African Interplanetary Society.⁵³ This society, which formed the South African Rocket Research Group in 1959, began experimenting with rocketry, conducting over 600 engine tests and rocket launches by 1963, none of which officially crossed into space.⁵⁴ Additionally, in 1961, the South African government partnered with the United States to build a satellite tracking ground station near Johannesburg, which assisted several exploration missions run by the U.S. National Aeronautics and Space Administration (NASA) during the space race.⁵⁵

⁵¹ Nigel Worden, *The Making of Modern South Africa: Conquest, Apartheid, Democracy*, 5th ed. (Malden, MA: Wiley-Blackwell, 2012), 8.

⁵² Worden, 131.

⁵³ Keith Gottschalk, "South Africa's Space Program," *Astropolitics* 8, no. 1 (July 2010): 36, <https://doi.org/10.1080/14777622.2010.496528>.

⁵⁴ Harding, *Space Policy in Developing Countries*, 138.

⁵⁵ Harding, 138; and Martinez, "The Development and Initial Implementation of South Africa's National Space Policy," 31.

Government officials indefinitely banned all civilian rocket launches, including the South African Rocket Research Group's launches, in 1962, after which South Africa's military took control of the country's rocket program from 1963 until the early 1990s, including a variety of military missile programs.⁵⁶ The rocket program's space contribution included three sub-orbital test launches of the RSA-3, which was a South African rocket with Israeli origins that was theoretically capable of placing satellites into orbit.⁵⁷ Beginning in 1975, South Africa gained access to this orbital launch technology through a secret military partnership with Israel to share rocket and nuclear technology.⁵⁸ The RSA-3's sub-orbital test launches all occurred at the Overberg test range, which South Africa constructed throughout the 1980s to support orbital launch technology.⁵⁹ The orbital rocket program's underlying purpose was developing more powerful ballistic missiles to improve South Africa's nuclear deterrence.⁶⁰ In 1980, the government also began a project for a reconnaissance satellite that could spy on the Angolan military, but the satellite never launched.⁶¹

By the early 1990s, international tolerance for South Africa's military-led rocket program had ended. In 1991, the U.S. sanctioned arms trade with South Africa to pressure the South African government to conform with the Missile Technology Control Regime (MTCR), in response to the Israeli-South African rocketry partnership.⁶² The MTCR is an international regime devised to prevent "the spread of missiles and missile technology" in order to "limit the risks of proliferation of weapons of mass destruction by controlling

⁵⁶ Gottschalk, "South Africa's Space Program," 36–38.

⁵⁷ Gottschalk, 37.

⁵⁸ Harding, *Space Policy in Developing Countries*, 139.

⁵⁹ Harding, 139; and "History and Milestones," Denel Overberg Test Range, accessed October 8, 2020, <http://www.denelotr.co.za/about-us/history--milestones>.

⁶⁰ Harding, *Space Policy in Developing Countries*, 139–40; and Martinez, "The Development and Initial Implementation of South Africa's National Space Policy," 31.

⁶¹ Gottschalk, "South Africa's Space Program," 37–38.

⁶² Deborah A. Ozga, "A Chronology of the Missile Technology Control Regime," *The Nonproliferation Review* 1, no. 2 (March 1994): 80, <https://doi.org/10.1080/10736709408436541>.

transfers that could make a contribution to delivery systems for such weapons.”⁶³ In the following two years, the South African government repeatedly expressed interest in at least adhering to the MTCR.⁶⁴ Then, on June 30, 1993, the South Africa government ended its launch program, while suggesting that the U.S. should lift the 1991 sanctions in response.⁶⁵ South Africa’s decision to end its launch program also effectively ended the military-led space program.

Overall, the apartheid-era space program demonstrated a strong orientation towards security-focused objectives. Although there was no explicit space policy for the apartheid-era space program, its link with South Africa’s military suggests an institutional bias towards the security extreme of the security-development spectrum. More importantly, however, the space technology from the apartheid-era space program clearly indicates goals geared toward increasing military power and deterring Soviet expansion in the region.⁶⁶ For example, the South African military used the South African Rocket Research Group’s experiments to improve short-range missile technology. Additionally, government officials planned to launch a military reconnaissance satellite to spy on the military activities of South Africa’s adversaries. Most significantly, South Africa established a partnership with Israel to access orbital launch technology in an effort to advance South Africa’s ballistic missile capacity.

2. The Transition: July 1993–2007

Starting in July 1993, just as political leaders set an election date and evaluated a new constitution, the South African government began transitioning toward a new contemporary space program with vastly different objectives.⁶⁷ Just two days after ending the apartheid-era launch program, the South African government passed the Space Affairs

⁶³ Ozga, 66.

⁶⁴ Ozga, 80–81, 85, 87.

⁶⁵ Harding, *Space Policy in Developing Countries*, 140; and Ozga, “A Chronology of the Missile Technology Control Regime,” 88.

⁶⁶ Harding, *Space Policy in Developing Countries*, 139.

⁶⁷ Worden, *The Making of Modern South Africa*, 150–51.

Act of 1993, South Africa's first contemporary space legislation.⁶⁸ The Space Affairs Act of 1993 endorsed the Department of Trade and Industry (DTI) as the contemporary space program's lead institution by empowering the Minister of Trade and Industry (MTI) to define South African space policy, and mandating other government ministers to exercise their responsibilities in accordance with the MTI's space policy.⁶⁹ Also, the Space Affairs Act established a Council for Space Affairs to advise and regulate space activity in South Africa.⁷⁰ Finally, the Space Affairs Act also instructed the MTI to regulate and limit space technology that could support weapons of mass destruction, like ballistic missiles.⁷¹ The DTI's leading role in the contemporary space program demonstrates South Africa's focus on using space technology to advance socioeconomic development. If national security was the primary objective, it is more likely that the South African Parliament would have directed the Department of Defence, or another security-focused institution, to administer national space policy, similar to the military's control of South Africa's space program during apartheid.⁷² Instead, the DTI's broader focus on economic trade and growth created an institutional bias toward socioeconomic development, despite a broad policy vacuum.

For the next decade, as the post-apartheid South African government established new policies and laws based on the ideals of democratic governance, South Africa's space leaders primarily focused on ending the apartheid-era program. Martinez describes space activity in the 1990s as taking place "in an isolated, uncoordinated *ad hoc* fashion at the institutional level and in a policy vacuum at national level."⁷³ Government officials dismantled the infrastructure that supported South Africa's first space program, especially

⁶⁸ Republic of South Africa, "Space Affairs Act, 1993," *Government Gazette* 337, no. 14917 (July 1993): 1–24.

⁶⁹ Republic of South Africa, 4.

⁷⁰ Republic of South Africa, 4, 6.

⁷¹ Republic of South Africa, 4.

⁷² Gottschalk, "South Africa's Space Program," 36.

⁷³ Martinez, "The Development and Initial Implementation of South Africa's National Space Policy," 31.

launch capacity.⁷⁴ A notable exception was the Overberg test range, which the new space program inherited with the elements required for orbital launch intact.⁷⁵ Although the test range has only supported non-space systems testing since then, it remains capable of launching sun-synchronous and polar orbits up to low Earth orbit (LEO).⁷⁶ In 1995, during this near-complete breakaway from the security-focused launch program, South Africa officially joined the MTCR, which signaled the government's enduring assurance that South Africa would not resume its proliferation of missile technology.⁷⁷

The launch of South Africa's first satellite in 1999 indicated that the contemporary space program was advancing. *SunSat-I*, the first South African satellite in orbit, was an experimental satellite that launched on a Delta II rocket from Vandenberg Air Force Base, California, in 1999.⁷⁸ Postgraduate students at the University of Stellenbosch designed and constructed the majority of *SunSat-I*, including a variety of experiments and a high-resolution imager as the payload.⁷⁹ The high-resolution imager achieved a ground resolution of 15 meters, which was advanced for a microsatellite at the time.⁸⁰ Arguably, the high-resolution imager could have supported a security mission by capturing images of large objects like large ships, sizeable aircraft, or military bases, but the actual images transmitted to a ground station at the University of Stellenbosch, including images of mountains in South Africa and irrigation systems in the Middle East, make the security

⁷⁴ Harding, *Space Policy in Developing Countries*, 140.

⁷⁵ Froehlich and Siebrits, *Space Supporting Africa*, 247.

⁷⁶ "Space Initiatives," Denel Overberg Test Range, accessed July 16, 2020, <http://www.denelotr.co.za/products--services/space-initiatives>.

⁷⁷ Harding, *Space Policy in Developing Countries*, 140.

⁷⁸ "South African Satellites," South African National Space Agency, accessed July 9, 2020, http://atlas.sansa.org.za/atlas-sa_satellites.html.

⁷⁹ South African National Space Agency.

⁸⁰ "SunSat," Earth Online, accessed July 9, 2020, <https://earth.esa.int/web/eoportal/satellite-missions/s/sunsat>.

alternative unlikely.⁸¹ Additionally, the students allowed NASA officials to include an experiment onboard in exchange for NASA sponsoring the Delta II launch.⁸²

Starting in the early 2000s, government interest in the socioeconomic benefits of space activity became more apparent.⁸³ In 2003, the Department of Science and Technology (DST) and several space advocates, including Martinez, began to coordinate and unify the diverse interests in space activity across departments within South Africa's national government.⁸⁴ Then, in 2007, government officials passed the Astronomy Geographic Advantage Act of 2007.⁸⁵ This act allowed the Minister of Science and Technology (MST) to declare an area within South Africa as an astronomy advantage area, thereby subjecting that area to a collection of regulations designed to protect and preserve the natural conditions that benefit astronomy activities.⁸⁶ In other words, the Astronomy Geographic Advantage Act focused exclusively on protecting observatory science, which overwhelmingly benefits development objectives rather than security objectives.⁸⁷ The Astronomy Geographic Advantage Act was the final example of space activity in South Africa's transition toward its contemporary space program.

⁸¹ Earth Online; and Garth W. Milne et al., "SUNSAT - Launch and First Six Month's Orbital Performance," in *13th Annual AIAA/USU Conference on Small Satellites* (Logan, Utah: Utah State University, 1999), 14, <https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2115&context=smallsat>.

⁸² Earth Online, "SunSat."

⁸³ Martinez, "The Development and Initial Implementation of South Africa's National Space Policy," 31.

⁸⁴ Martinez, 32.

⁸⁵ Republic of South Africa, "Astronomy Geographic Advantage Act, 2007," *Government Gazette* 516, no. 31157 (June 2008): 1–56.

⁸⁶ Republic of South Africa, 12, 14.

⁸⁷ Observatory science primarily focuses on the birth, life, and death of solar systems and other galactic structures. The scientific knowledge gained from studying supernovae, planets, black holes, neutron stars, and nebulae creates little, if any, security benefits. Some may argue that observatory science provides a better understanding of nuclear fusion, which could be used to improve nuclear weapon technology, but that is a fairly weak argument, especially since most developing nations are unable to produce a fission nuclear bomb, which is less technically demanding than a fusion nuclear weapon. For a specific African example of the applications of observatory science, see Oyewole, "Space Research and Development in Africa," 199.

Although there was no explicit space policy during this period of transition, South Africa's space institutions and technology illustrate the contemporary space program's divergence from the military focus of the apartheid-era space program. The South African government placed its new space institutions under departments, like the DTI and DST, that already directed their efforts toward socioeconomic development. More importantly, the post-apartheid government actively dismantled the country's launch capacity, which was the cornerstone of the apartheid-era program.

3. Space for South Africa's Development: 2008-Present

The Space Affairs Act of 1993 had already established regulatory institutions, but the South African government lacked an institution responsible for implementing space policy and delivering space-related activities and products to the diverse array of government space customers. The South African National Space Agency Act of 2008 established the South African National Space Agency (SANSA) under the DST to accomplish these exact objectives and fill the institutional gap.⁸⁸ By placing SANSA under the DST, which uses science and technology to advance South Africa's socioeconomic development, the government officials continued the contemporary space program's institutional bias.⁸⁹ The South African National Space Agency Act listed five objectives of the new space agency that institutionalized South Africa's focus on peaceful space activities: to improve space industry, science, technology, human capital, and international cooperation.⁹⁰

Shortly after the establishment of SANSA, the National Space Policy, published in 2009, filled the policy vacuum. The DTI's National Space Policy explicitly states, "the guiding principle of the Policy is to support and promote relevant scientific research, capacity-building, innovation, and industrial development, with the aim of utilising space

⁸⁸ Republic of South Africa, "South African National Space Agency Act, 2008," *Government Gazette* 522, no. 31729 (December 2008): 4, 6.

⁸⁹ "Our Vision, Mission and Corporate Values," Department of Science and Technology, accessed October 8, 2020, <https://www.dst.gov.za/index.php/ourprogrammes>.

⁹⁰ Republic of South Africa, "South African National Space Agency Act, 2008," 4.

applications to contribute to economic growth, reduction of poverty, and the creation of knowledge.”⁹¹ Notably, the National Space Policy also repeatedly emphasizes the importance of improving space capacity for the explicit benefit of socioeconomic development. Space capacity, in this instance, refers to the human capital, material resources, and institutions required to produce space technology, which especially benefits science, technology, engineering, and mathematics (STEM) sectors. For example, the National Space Policy states that space capabilities are a “strong driving force for new technological developments, with many subsequent applications of benefit to the sustainable development of our economy, society and the environment.”⁹² The space capabilities to which this statement refers also include the associated human capital requirements.⁹³ Thus, South Africa’s space policy sees its space capacity as a way to advance the country’s broader socioeconomic interests, going as far as to call space capacity development “one of the cornerstones upon which the National Space Programme is built.”⁹⁴ In short, space capacity was seen as a path to broader economic diversification and growth beyond the space sector, especially in STEM-related fields.

Additionally, in 2009, a second South African satellite, *SumbandilaSat*, reached orbit, demonstrating capacity growth in technology and domestic industry. *SumbandilaSat*’s mission was technology demonstration, proving the satellite technology capacity of the University of Stellenbosch and a nascent university spin-off company called SunSpace.⁹⁵ This time, Russia launched South Africa’s satellite on a Soyuz-2 out of Kazakhstan in 2009.⁹⁶ *SumbandilaSat*’s primary payload was a multispectral imager (MSI)

⁹¹ Department of Trade and Industry, *South Africa’s National Space Policy* (Pretoria, South Africa: Department of Trade and Industry, 2009), 5, <https://www.sansa.org.za/wp-content/uploads/2018/05/South-Africas-National-Space-Policy.pdf>.

⁹² Department of Trade and Industry, 13.

⁹³ Department of Trade and Industry, 12–13.

⁹⁴ Department of Trade and Industry, 13.

⁹⁵ South African National Space Agency, “South African Satellites.”

⁹⁶ “SumbandilaSat,” Earth Online, accessed July 9, 2020, <https://directory.eoportal.org/web/eoportal/satellite-missions/s/sumbandilasat>.

with a 6.25m resolution.⁹⁷ The MSI's six spectral bands optimized images for agricultural and disaster management purposes.⁹⁸

Published in 2010, the DST's National Space Strategy continued formalizing the contemporary space program by supplementing South Africa's stated space objectives. The National Space Strategy guides SANSA by providing an implementation framework to fulfill the DTI's National Space Policy. The vision of the National Space Strategy states that South Africa should become a leader in "space science and technology to enhance economic growth and sustainable development and thus improve the quality of life for all."⁹⁹ The alignment of this vision statement with the National Space Policy's guiding principle is unsurprising, given that the National Space Strategy helps to implement the National Space Policy. In identifying areas for future advancement, the DST highlights three key benefits that it hopes the space program will deliver—(1) environmental resource management; (2) health, safety, and security; and (3) innovation and economic growth.¹⁰⁰ The second key benefit in the National Space Strategy—health, safety, and security—seems to favor security goals, but six of the seven sub-priorities under this category target forecasting disasters, mitigating risk, and monitoring legal compliance.¹⁰¹ Put simply, the benefits and sub-priorities that the National Space Strategy establishes strongly favor socioeconomic development.

Interestingly, South Africa used this period of space policy formalization to also influence space policy across the African continent. In 2010, the Fourth African Ministerial Conference on Science and Technology recommended creating a Space Working Group (SWG) to establish the African Space Policy for the African Union (AU).¹⁰² South Africa

⁹⁷ Earth Online.

⁹⁸ Earth Online.

⁹⁹ Department of Science and Technology, *South Africa's National Space Strategy* (Pretoria, South Africa: Department of Science and Technology, 2010), 10, <https://www.sansa.org.za/wp-content/uploads/2018/05/National-Space-Strategy.pdf>.

¹⁰⁰ Department of Science and Technology, 11.

¹⁰¹ Department of Science and Technology, 12–13.

¹⁰² Froehlich and Siebrits, *Space Supporting Africa*, 134.

was one of ten member states on the SWG, which consisted of states with “recognised expertise in space affairs, a national interest in shaping space policy, and in coordinating inputs from a variety of user sectors and [AU] policy organs.”¹⁰³ In short, the members of the SWG were the regional space leaders within Africa with directions to create the AU’s space policy. The SWG drafted the African Space Policy as a guide for an AU space program, which would use space technology to benefit the African continent.¹⁰⁴ The African Space Policy outlines just two goals; to serve the “social, economic, political and environmental needs of the continent,” and to create space regulations that ensure Africa is “a responsible and peaceful user of outer space.”¹⁰⁵

Throughout the 2010s, South Africa’s space institutions and stated objectives remained constant, and SANSA used this decade to advance South Africa’s space technology. In 2011, for example, South Africa firmly established itself as one of the global leaders in observatory science when the South African Large Telescope (SALT) began operations. SALT, which has contributed to 265 scientific papers since 2011, is one of the largest single optical telescopes in the world, and the largest telescope of this type in the southern hemisphere.¹⁰⁶ The SALT Foundation, which owns and operates the telescope, is a South African private company with international shareholders from the United States, South Africa, Poland, the United Kingdom, and India.¹⁰⁷ SALT’s three objectives are to “enable world-leading astrophysical research, pursue instrumentation development, and drive human capital development and science engagement.”¹⁰⁸ Notably, SALT’s instruments were the first to capture a star’s supernova, providing invaluable data to the

¹⁰³ Froehlich and Siebrits, 134–35.

¹⁰⁴ African Union, *African Space Policy: Towards Social, Political and Economic Integration* (Addis Ababa, Ethiopia: African Union, 2017), 3, https://au.int/sites/default/files/newsevents/workingdocuments/33178-wd-african_space_policy_-_st20444_e_original.pdf.

¹⁰⁵ African Union, 8.

¹⁰⁶ Board of the South African Large Telescope, *South African Large Telescope Annual Report 2019* (Cape Town, South Africa: Board of the South African Large Telescope, 2020), 8, 61, https://www.salt.ac.za/wp-content/uploads/sites/75/2020/03/SALT_Annual_Report_2019.pdf.

¹⁰⁷ Board of the South African Large Telescope, 8.

¹⁰⁸ Board of the South African Large Telescope, 9.

astrophysics community.¹⁰⁹ The unique capabilities of SALT make the telescope one of South Africa's flagship space programs.

For its third satellite, which launched in 2013, South Africa deliberately advanced its space capacity by venturing into the nanosatellite niche with a CubeSat called *ZACUBE-1*.¹¹⁰ Weighing in at just 1.2 kilograms, *ZACUBE-1* was another research satellite, which the Cape Peninsula University of Technology developed with the goal of improving South Africa's space engineering human capital.¹¹¹ Like *SumbandilaSat*, Russia launched *ZACUBE-1*, this time from a launch facility in Yasny on a Dnepr rocket in 2013.¹¹² The satellite's primary payload, a high-frequency beacon transmitter, has two purposes: to calibrate a radar array at SANSA's Antarctic research base and to study space weather by examining the Earth's ionosphere.¹¹³

In 2014, in what appears to be the only departure from the stated developmental goals of South African space policy, Russia launched South Africa's fourth satellite, a top-secret Department of Defence satellite called *Kondor-E*.¹¹⁴ South Africa's Department of Defence contracted a Russian company named NPO Mashinostroyeniya to build the

¹⁰⁹ Oyewole, "Space Research and Development in Africa," 199.

¹¹⁰ "ZACUBE-1 Launch Makes History," Cape Peninsula University of Technology, accessed July 9, 2020, <https://www.cput.ac.za/academic/faculties/engineering/zacube1>.

¹¹¹ "Science and Technology on South Africa's First Nano-Satellite, ZACUBE-1," South African Government, March 3, 2014, https://www.gov.za/south-africas-first-nano-satellite-zacube-1-tshepisosat-close-encounter-space-debris?gclid=Cj0KCQjwgJv4BRCrARIsAB17JI7CLUFWmLERUzMyglFhUfDxT70PohtPII5ugtLH9eG075ShCy8Te9waAIP2EALw_wcB.

¹¹² "ZACUBE-1," Earth Online, accessed July 9, 2020, <https://earth.esa.int/web/eoportal/satellite-missions/v-w-x-y-z/zacube-1>.

¹¹³ Earth Online; and Cape Peninsula University of Technology, "ZACUBE-1 Launch Makes History."

¹¹⁴ "Kondor-E," Gunter's Space Page, May 21, 2019, https://space.skyrocket.de/doc_sdat/kondor-e-1.htm.

military satellite in 2006.¹¹⁵ At the start of the *Kondor-E* contract, SANSA did not yet exist, and it is unclear if the Department of Defence included the DTI, DST, or Russian space agency in the contract process. The primary payload on *Kondor-E* is a synthetic aperture radar (SAR) capable of taking radar images with a ground resolution of 1–2 meters, despite cloud cover.¹¹⁶ *Kondor-E*'s SAR system is particularly useful for security missions, which require monitoring small objects, like ships or vehicles, on a frequent basis, regardless of the weather.¹¹⁷ Unfortunately, reliable information on *Kondor-E* is somewhat limited, especially considering allegations that South Africa's State Security Agency relied on a human intelligence source to discover details about the top-secret project, which suggests that the State Security Agency did not know about the South African satellite project beforehand.¹¹⁸ These collective reports about *Kondor-E* appear to contain at least some validity, however, based on a statement by the South African Secretary of Defence that mistakenly revealed the existence of a military satellite to the broader South African government.¹¹⁹

The fifth and sixth South African satellites, launched simultaneously in 2017, marked a return to the program's developmental orientation. The satellites were part of an international CubeSat constellation dedicated to scientific research called QB50, which the

¹¹⁵ "Top-Secret South African Satellite," MyBroadband, October 26, 2014, <https://mybroadband.co.za/news/security/112881-top-secret-south-african-satellite.html>; and Jan-Jan Joubert, "Scandal of R1.2 Billion Missing SA Satellite," *TimesLIVE*, January 19, 2014, <https://www.timeslive.co.za/news/south-africa/2014-01-19-scandal-of-r12-billion-missing-sa-satellite/>.

¹¹⁶ MyBroadband, "Top-Secret South African Satellite"; and Gunter's Space Page, "Kondor-E."

¹¹⁷ Many development-focused EO applications, like monitoring crops or deforestation, are typically not concerned with missing an imagery window due to cloud cover, since environmental changes generally occur over the course of months or years. In contrast, the movement of humans and vehicles can change quickly, and a SAR system's ability to reliably image a site makes SAR imagery uniquely suited for monitoring human-related movements. Additionally, SAR imagery is a common military reconnaissance tool. For details on *Kondor-E*'s SAR system in particular, see "Kondor-E," Earth Online, accessed September 3, 2020, <https://earth.esa.int/web/eoportal/satellite-missions/k/kondor-e>.

¹¹⁸ Will Jordan, "South Africa Spied on Russia for Satellite Project Details," *Al Jazeera*, February 25, 2015, <https://www.aljazeera.com/news/2015/02/south-africa-russia-joint-satellite-project-condor-spy-cables-guardian-150225154536792.html>.

¹¹⁹ MyBroadband, "Top-Secret South African Satellite."

European Union partially sponsored.¹²⁰ Both *ZA-AeroSat* and *nSight-1* launched onboard a United Launch Alliance Atlas-5 out of Florida in 2017, although the International Space Station deployed *ZA-AeroSat* a few days before *nSight-1*.¹²¹ The broad objectives of the QB50 constellation were enabling relatively cheap access to space by launching 50 university-developed CubeSats, and studying the lower thermosphere for an extended period of up to several months.¹²² Both satellites contained the same primary payload, an instrument called the Flux- Φ -Probe Experiment (FIPEX).¹²³ The FIPEX payload allowed the satellites to study the effects of atomic oxygen on spacecraft surfaces as the spacecraft entered thicker portions of Earth's atmosphere.¹²⁴ Whereas the University of Stellenbosch primarily developed *ZA-AeroSat*, a group of privately owned South African satellite companies called SCS Aerospace Group built *nSight-1*.¹²⁵

ZACUBE-2, South Africa's seventh satellite, is the most technologically advanced satellite in South Africa's constellation to date. Cape Peninsula University of Technology developed the satellite with SANSA sponsoring the mission.¹²⁶ Similar to many previous South African satellites, Russia launched *ZACUBE-2*, this time in 2018.¹²⁷ The satellite is a technology demonstrator for future CubeSats that will fly in a maritime domain

¹²⁰ "NSight-1," Earth Online, accessed July 14, 2020, <https://directory.eoportal.org/web/eoportal/satellite-missions/n/nsight-1>.

¹²¹ "ZA-AeroSat," Gunter's Space Page, June 25, 2018, https://space.skyrocket.de/doc_sdat/za-aerosat.htm; and Earth Online, "NSight-1."

¹²² Studying the lower thermosphere is development-focused because the data improves atmospheric models by gaining a better understanding of the interaction at the boundary between thicker sections of the atmosphere and the thermosphere. Ultimately, better atmospheric models improve predictions of atmospheric conditions for various environmental applications. "Mission Objectives," QB50, accessed July 14, 2020, <https://www.qb50.eu/index.php/project-description-obj.html>.

¹²³ "CubeSats Participating in the QB50 Project," QB50, August 22, 2017, <https://www.qb50.eu/index.php/community.html>.

¹²⁴ Earth Online, "NSight-1."

¹²⁵ Gunter's Space Page, "ZA-AeroSat"; and "NSight-1," SCS Space, accessed July 14, 2020, <http://scs-space.com/nsight-1/>.

¹²⁶ "ZACUBE-2," Earth Online, accessed July 9, 2020, <https://directory.eoportal.org/web/eoportal/satellite-missions/v-w-x-y-z/zacube-2>.

¹²⁷ Earth Online.

awareness constellation under the ocean economy sector of Operation Phakisa.¹²⁸ This sector of Operation Phakisa focuses on developing the economic potential of the ocean through six work streams, specifically active in South Africa's exclusive economic zone.¹²⁹ *ZACUBE-2* supports this ocean economic development by providing South Africa with independent automatic identification system (AIS) monitoring capabilities at a reduced cost and without third-party risk, when compared to commercial AIS systems.¹³⁰ *ZACUBE-2's* AIS capabilities may support a dual-use mission, since AIS facilitates collision avoidance, navigation, and vessel monitoring, but *ZACUBE-2's* relationship with the development-oriented Operation Phakisa indicates that maritime security is not the primary purpose of the satellite. Furthermore, the utility of AIS in maritime security is limited because ships participating in illegal activities can simply turn their AIS transmitter off. Of the six work streams, *ZACUBE-2's* AIS technology best assists the first, marine transport and manufacturing, and fourth, marine protection and governance, work streams by facilitating vessel tracking.¹³¹

South Africa's eighth and most recent satellite, *XinaBox ThinSat*, is the smallest satellite that students have developed in the country, and the program notably provided human capacity growth at the high-school level. Unlike the larger CubeSats from university students, South African high school students across 16 schools developed one *ThinSat* that launched as a part of a larger constellation to extreme LEO.¹³² The *ThinSats* launched onboard an Antares rocket out of Virginia in 2019.¹³³ For just a few days, the small *ThinSat*

¹²⁸ Hlengiwe Nhlathi, "ZACube-2 Leading South Africa's Fourth Industrial Revolution into Space," Department of Science and Technology, accessed July 14, 2020, <https://www.dst.gov.za/index.php/media-room/latest-news/2754-zacube-2-leading-south-africa-s-fourth-industrial-revolution-into-space>.

¹²⁹ "Operation Phakisa - Oceans Economy," Department of Environment, Forestry, and Fisheries, accessed July 14, 2020, <https://www.environment.gov.za/projectsprogrammes/operationphakisa/oceanseconomy>.

¹³⁰ Earth Online, "ZACUBE-2."

¹³¹ Department of Environment, Forestry, and Fisheries, "Operation Phakisa - Oceans Economy."

¹³² "ThinSAT Built by South African High School Students Successfully Launched," Space in Africa, April 17, 2019, <https://africanews.space/thinsat-built-by-south-african-students-successfully-launched/>.

¹³³ Bjarke Gotfredsen, "XChips from XinaBox Launched in Space," XinaBox, July 12, 2019, <https://xinabox.cc/blogs/in-the-news/xchips-from-xinabox-launched-in-space>.

constellation took basic measurements from a variety of sensors, which included an inertial measurement unit, temperature gauges, and infrared sensors.¹³⁴ Rather than contributing to a major scientific breakthrough, the short-lived South African *ThinSat* program was an effort to encourage space enthusiasm and human capital development at a young age.¹³⁵ Specifically, the goal of the *ThinSat* program was to inspire young students to eventually work in STEM careers by exposing the students to the space industry with high-tech projects like data analysis, sensor testing, and satellite hardware development.¹³⁶

Overall, the space policies, institutions, and technologies established in South Africa after 2007 solidified the focus of South Africa's contemporary space program. For the first time, South Africa had explicit national level space policies, which overwhelmingly demonstrated the contemporary space program's commitment to pursuing space activities for their potential development benefits. Furthermore, many of South Africa's space technology programs explicitly aimed to improve space capacity and human capital in STEM fields. The *Kondor-E* was the only space activity focused on security since South Africa's apartheid-era space program, and its scope was extremely minor in comparison to South Africa's broader space program.

4. Future Plans

SANSA's Strategic Plan for 2020–2025, which SANSA published in 2020 as a policy update, specifically addresses how the space agency intends to continue implementing the objectives set forth in the National Space Policy and National Space Strategy. Considering these stated policy goals, SANSA asserts that the fundamental purpose of a space program is to meet its government's highest priority, which in this case is socioeconomic development.¹³⁷ Similarly, both SANSA's vision statement and mission

¹³⁴ Gotfredsen; and Space in Africa, "ThinSAT Built by South African High School Students Successfully Launched."

¹³⁵ Space in Africa, "ThinSAT Built by South African High School Students Successfully Launched."

¹³⁶ Space in Africa.

¹³⁷ South African National Space Agency, *SANSA Strategic Plan 2020–2025* (Pretoria, South Africa: South African National Space Agency, 2020), 10, https://www.sansa.org.za/wp-content/uploads/2020/03/SANSA-Strategic-Plan-2020_2025.pdf.

statement in the plan address the advancement of human lives through space activities.¹³⁸ SANSa's strategic plan primarily examines future and aspirational space technologies to achieve South Africa's space policy objectives. Interestingly, the 2020–2025 SANSa Strategic Plan mentions evaluating the feasibility and potential benefits of domestic launch capabilities, which aligns with a 2010 speech by Naledi Pandor, then the MST, in which she briefly spoke about creating a 20-year plan to re-establish launch capabilities.¹³⁹ Nascent South African space launch ambitions do not inherently constitute a new security focus for the country's space policy, even though launch technology may appear to reactivate South Africa's first security-focused space program. SANSa could use launch technology solely to reduce its dependence on foreign countries for launching satellites with development missions. Nevertheless, launch technology provides an easy path to ballistic missile technology, and potentially represents a small deviation away from South Africa's broader focus on development objectives in its space policies.

Finally, The Square Kilometre Array (SKA) is another flagship space program in South Africa. The SKA, with support from 20 countries, aims to become the most advanced and largest radio telescope in the world, with construction beginning in 2021.¹⁴⁰ As one of two host countries for SKA, South Africa will build upon its precursor test facility called MeerKAT, creating an array of 200 satellite dishes across 150 kilometers.¹⁴¹ The array's primary objective is to answer some of the most challenging scientific questions of the

¹³⁸ South African National Space Agency, 14.

¹³⁹ South African National Space Agency, 51; and Department of Science and Technology, "Address by the Minister of Science and Technology Naledi Pandor MP, at the Launch of the South African National Space Agency and National Space Strategy, Midrand Conference Centre," South African Government, December 9, 2010, <https://www.gov.za/address-minister-science-and-technology-naledi-pandor-mp-launch-south-african-national-space-agency>.

¹⁴⁰ "The SKA Project," Square Kilometre Array, accessed July 16, 2020, <https://www.skatelescope.org/the-ska-project/>.

¹⁴¹ Square Kilometre Array.

modern era.¹⁴² These “science drivers” include discoveries in dark energy, gravity, magnetism, star formation, and interstellar life.¹⁴³

In summary, South Africa’s space history illustrates a clear shift from an entirely security-focused space program during apartheid to a contemporary space program that focuses almost exclusively on improving socioeconomic development. South Africa’s first space program primarily produced rocket technology for military use. As apartheid ended, South Africa’s space program entered a period of transition. This transition created a new contemporary space program, focused on socioeconomic development, that was divorced from the apartheid-era space program. After the DTI published the National Space Policy in 2009, SANSA spent over a decade implementing a space program to meet the development-focused objectives in the National Space Policy by supporting numerous satellites and astronomy programs. SANSA’s most recent strategic plan and the flagship SKA program reveal that the contemporary space program’s focus on socioeconomic development is likely to continue for at least the next five years.

C. EXAMINING THE HYPOTHESES

The remainder of this chapter turns to the question of why South Africa has shifted from a security-focused to a development-focused space program. The possible answers, outlined in the previous chapter, include foreign influence, political priorities, bureaucratic interests, and economic capacity. As the following analysis will show, all four hypotheses feasibly influence South Africa’s space policy, but only the political prioritization hypothesis has strong support.

1. Foreign Security and Development Partnerships

The primary question to answer for the first hypothesis is as follows: do foreign partnerships influence South Africa’s space policy? Influence, in this instance, refers to a foreign country’s capacity to direct South African space policy toward development or

¹⁴² Froehlich and Siebrits, *Space Supporting Africa*, 120–22.

¹⁴³ “SKA Science,” Square Kilometre Array, accessed July 16, 2020, <https://www.skatelescope.org/science/>.

security goals. This section seeks to answer the question of influence in two ways. First, and most importantly, I examine if foreign partners pushed South Africa's space program to have the central development-focus that is present today. Second, this hypothesis searches for instances of foreign influence that created the limited security objectives present in South Africa's space program. This second scenario looks for evidence that a foreign country successfully diverted South Africa's space program away from its stated development goals, to instead focus on the narrow security mission regarding *Kondor-E*. In general, a foreign country may be more likely to successfully influence South African space policy when South Africa is dependent on that foreign country for space technology or launch capacity. Thus, this hypothesis focuses on South Africa's international space partnerships. Furthermore, foreign influence can occur throughout South Africa's space history, but it is most likely to appear during the program's initial establishment since South Africa would be most dependent on foreign partners during this time.

Notably, the development of South Africa's first satellite, *SunSat-1*, and the 1996 agreement between South Africa and NASA, regarding the launch of *SunSat-1*, contradicts the foreign influence hypothesis.¹⁴⁴ In 1991, the University of Stellenbosch began formulating the engineering, science, and research objectives of *SunSat-1*, including the objective to produce imagery resolution better than 20 meters in a micro-satellite.¹⁴⁵ Sometime around 1994, *SunSat-1* lost its paid position on an Ariane Helios launch due to reduced funding, which resulted in a launch memorandum of understanding with NASA in 1996 for *SunSat-1*.¹⁴⁶ This timeline demonstrates that the University of Stellenbosch initiated *SunSat-1*'s development focus well before there was any potential for U.S. influence. Additionally, South Africa's initial willingness to pay for *SunSat-1*'s launch indicates limited opportunities for influence before the launch agreement. NASA's science instruments, integrated onto *SunSat-1* as a part of the launch agreement, simply added to the satellite's development mission. Most importantly, University of Stellenbosch graduate

¹⁴⁴ Milne et al., "SUNSAT - Launch and First Six Month's Orbital Performance," 4.

¹⁴⁵ Milne et al., 1–3.

¹⁴⁶ Milne et al., 3–4.

students developed the satellite's primary imager, electronic systems, and software almost entirely in-house, suggesting a high degree of agency in deciding *SunSat-1*'s development objectives since the satellite did not rely on technology transfer.¹⁴⁷

More significantly, *SunSat-1* demonstrates that government officials and the University of Stellenbosch maintained control over the satellite's development objectives, despite the various opportunities for U.S. influence. The first opportunity for influence emerged because the University of Stellenbosch developed *SunSat-1* when South Africa had only a handful of space institutions, established by the Space Affairs Act of 1993, that were operating without any explicit space policy guidance. Next, the United States was indisputably the most advanced space country in the world in the late 1990s, which contrasted against South Africa's nascent contemporary space program at the time. Finally, *SunSat-1* had to attach NASA's advanced global positioning system receiver and Meteoroid Impact Sensor, which would conduct science experiments, as a condition of the launch memorandum of understanding with NASA.¹⁴⁸ Thus, *SunSat-1* had strong potential for U.S. influence on South Africa's space program: dependency for access to space, limited institutional inertia, divergence in space capabilities, and a push for development-focused objectives due to NASA's scientific experiments. Regardless of these four factors indicating potential U.S. influence, the evidence clearly points to South African agency in deciding the trajectory of *SunSat-1*'s objectives.

The *SunSat-1* case is representative of most of South Africa's space programs where, despite reliance on foreign partnerships to access space, there is no evidence of foreign influence on the direction of the space program. By nature of being an EMSA without launch capabilities, South Africa depends on foreign countries for access to space. Unlike most EMSAs, however, South Africa has the capability to domestically produce most of its satellite technology, which allows it to pursue its own path with respect to satellite development. South Africa's space sector has proven its ability to produce

¹⁴⁷ Milne et al., 1–3.

¹⁴⁸ Earth Online, "SunSat."

satellites by domestically developing seven of the country's eight satellites.¹⁴⁹ The lone exception to these domestically-produced satellites is the *Kondor-E* military satellite, which I explore in detail later in this section. Domestic production indicates limited foreign involvement in South Africa's satellite technology, which means foreign countries or institutions assist South Africa's space technology rather than transfer technology to South Africa. In this sense, South Africa does not need to trade its agency in deciding the objectives of any particular space project for access to specific technology.

SANSA's expansive list of international space partners provides further indication that its space policy is not a product of foreign influence since having various partner options makes influence from any single partner less likely. Even from SANSA's first annual report in 2012, South Africa worked with 13 different foreign space agencies.¹⁵⁰ For comparison, the 2017–2018 annual report tallies 14 memorandums of understanding with overseas partners.¹⁵¹ The most recent SANSA annual report from 2019, shows that SANSA actively collaborated with 15 overseas partners during this time period.¹⁵² SANSA deliberately emphasizes the strategic importance of cultivating various international partnerships to create additional space opportunities and reduce dependency on any one country.¹⁵³ Maintaining several space partners, at differing stages of space capacity development, allows SANSA to examine multiple partnership options when considering how to complete a new space project. In effect, South Africa has an international marketplace to pitch each space project and its objectives. If one potential

¹⁴⁹ Samuel Oyewole, "The Quest for Space Capabilities and Military Security in Africa," *South African Journal of International Affairs* 27, no. 2 (June 2020): 156, <https://doi.org/10.1080/10220461.2020.1782258>.

¹⁵⁰ South African National Space Agency, *South African National Space Agency Annual Report 2011/2012* (Pretoria, South Africa: South African National Space Agency, 2012), 34, <https://www.sansa.org.za/wp-content/uploads/2018/05/SANSA-AR-2011-12.pdf>.

¹⁵¹ South African National Space Agency, *South African National Space Agency Annual Report 2017/2018* (Pretoria, South Africa: South African National Space Agency, 2018), 39, https://www.sansa.org.za/wp-content/uploads/2018/10/SANSA-Annual-Report-2017_18.pdf.

¹⁵² South African National Space Agency, *South African National Space Agency Annual Report 2018/2019* (Pretoria, South Africa: South African National Space Agency, 2019), 38, https://www.sansa.org.za/wp-content/uploads/2020/05/Annual-report-2018_19_.pdf.

¹⁵³ South African National Space Agency, 12–13.

partner tries to drastically deviate from SANSA's desired space objectives on a project, then SANSA could reasonably find a new international partner with a more complementary goal. Put simply, this competitive marketplace protects South Africa's space policy from any single country's strong influence.

In contrast, the acquisition of the *Kondor-E* satellite is one outlying example, in which Russian foreign influence is plausible. Unfortunately, the classified nature of *Kondor-E* makes definitive evidence of Russian influence almost impossible to find; however, there are some takeaways and inferences from the limited reporting. South African news reported that South Africa's Defence Intelligence paid the Russian company NPO Mashinostroyeniya 1.2 billion rand to build the satellite, which is one explanation for the rise in Defence Intelligence spending between 2007 and 2011.¹⁵⁴ Despite this high price, additional reporting suggested that South African Defence Intelligence would not control *Kondor-E*, nor be able to quickly or cheaply access its images, due to a "flaw" in the original contract, which caused government officials to temporarily suspend payments for *Kondor-E* in 2008.¹⁵⁵ In other words, *Kondor-E*'s original contract had South African Defence Intelligence paying for a satellite that they could not control, which would indicate that *Kondor-E* may have been a South African satellite only in name. *Kondor-E*'s high price and South Africa's debatable access to the satellite seem to indicate that Russia held at least some foreign influence over this particular aspect of South Africa's space program. Otherwise, without Russian influence, South Africa's space development objectives would offer little incentive for an expensive security satellite purchase that South Africa would not even control. It seems that Russian influence could possibly explain South Africa's *Kondor-E* contract, but there is no direct evidence to support this argument.

¹⁵⁴ For reference, in January 1993, 1 U.S. dollar converted to approximately 3.1 South African rand. The exchange rate from U.S. dollars to South African rand steadily increased until its peak in March 2020, at 1 U.S. dollar to about 18.5 South African rand. As of August 2020, the exchange rate is 1 U.S. dollar to about 16.3 South African rand. Joubert, "Scandal of R1.2 Billion Missing SA Satellite"; and "South African Rand 1992–2020," Trading Economics, accessed September 16, 2020, <https://tradingeconomics.com/south-africa/currency>.

¹⁵⁵ "Where Is South Africa's Secret Spy Satellite?," DefenceWeb, January 21, 2014, <https://www.defenceweb.co.za/sa-defence/sa-defence-sa-defence/where-is-south-africas-secret-spy-satellite/>.

The connection between the launch of *SumbandilaSat* and the *Kondor-E* contract provides an additional example of possible Russian influence. South Africa's space access dependency was most apparent with the Russian launch of South Africa's *SumbandilaSat*. According to the head of Russia's space agency, Roscosmos, Russia refused to launch *SumbandilaSat* in 2008, after the South African Department of Defence rejected a Russian satellite.¹⁵⁶ It seems that the head of Roscosmos, Perminov, was referring to the frozen *Kondor-E* contract, which the South African Department of Defence stopped making payments on due to concerns over Defence Intelligence's debatable control over the *Kondor-E*.¹⁵⁷ In this instance, Russia held *SumbandilaSat*'s launch hostage until South Africa resumed payments for the *Kondor-E* security satellite. South Africa presumably restarted payments, since Russia ultimately launched both *SumbandilaSat* and *Kondor-E*. It is not clear whether or not the launch of *SumbandilaSat* was always an explicit clause in the *Kondor-E* contract.¹⁵⁸ In either case, Russia temporarily prevented South Africa from realizing its development-focused space program, while also pushing a security-focused satellite contract. Russia's actions reveal that South Africa's foreign launch dependence makes its space program vulnerable to foreign influence, even if evidence to understand the extent of Russia's influence is inconclusive.

In summary, the foreign security and development partnerships hypothesis is unlikely to apply to the broader development-focused South African space program, but possibly explains the outlier, security-focused *Kondor-E* program. South Africa has demonstrated space technology capacity that is atypical for an EMSA, which helps protect the space program against foreign influence associated with technology transfer

¹⁵⁶ Keith Campbell, "SA 'Spy-Satellite' Programme Accidentally Exposed?," Engineering News, February 7, 2008, https://www.engineeringnews.co.za/article/sa-039spysatellite039-programme-accidentally-exposed-2008-02-07/rep_id:4136.

¹⁵⁷ Joubert, "Scandal of R1.2 Billion Missing SA Satellite"; and DefenceWeb, "Where Is South Africa's Secret Spy Satellite?"

¹⁵⁸ South Africa entered into a contract for *Kondor-E* on May 19th, 2006. The launch of *SumbandilaSat* was originally scheduled for December 5th, 2006, but the satellite did not launch until September 17th, 2009. This timeline makes it possible that the *SumbandilaSat* launch was a condition of the original *Kondor-E* contract, but there is no evidence to definitively prove or disprove this possibility. For details on the timeline, see Joubert, "Scandal of R1.2 Billion Missing SA Satellite"; and Earth Online, "SumbandilaSat."

agreements. Additionally, SANSA's numerous international partners give the space program alternatives if one partner tries to exert unwanted influence. Conversely, the *Kondor-E* case demonstrates that SANSA's reliance on international partners for space access leaves South Africa open to foreign influence. Still, there is no evidence to support the idea that foreign partnerships significantly impact the country's development-focused space policy.

2. Domestic Political Prioritization

South Africa's transition out of apartheid in the early 1990s changed the government's political priorities to focus more on socioeconomic development for citizens of all races, and likely contributed to the early development-focused decisions in South Africa's space policy. As the apartheid National Party government began to face civil resistance in the 1970s and 1980s, officials attempted to maintain political power and control over the population through military force.¹⁵⁹ President de Klerk began transitioning South Africa's political priorities from security-focused to development-focused when, in 1990, he removed the ban on the African National Congress (ANC), among other political parties, in an attempt to reduce domestic resistance, reverse South Africa's international isolation, and, consequently, improve South Africa's economic outlook.¹⁶⁰ It is unlikely that de Klerk envisioned the ANC as a legitimate political threat, but the ANC won the majority in the 1994 election by campaigning on socioeconomic development, especially for Black and mixed race populations that had been denied economic opportunities and political equality under apartheid.¹⁶¹ Once in power, the ANC enacted a series of policies—the Reconstruction and Development Programme in 1994; the Growth, Employment, and Redistribution Policy in 1997; the Employment Equity Act of 1998; and the Broad-Based Black Economic Empowerment Act of 2003—all aimed at

¹⁵⁹ Worden, *The Making of Modern South Africa*, 131.

¹⁶⁰ Worden, 147.

¹⁶¹ Worden, 148, 154.

reducing South Africa's pervasive socioeconomic inequality.¹⁶² Thus, South Africa's development-focused political environment throughout the 1990s and early 2000s fully aligned with the government's early space policy decisions, like the development-focused Space Affairs Act of 1993 and *SunSat-1* program. Unfortunately, racial segregation under apartheid created long-term socioeconomic challenges that the ANC policies failed to address, including "high levels of poverty, social inequality, and unemployment, as well as unequal access to education, municipal services, and other resources."¹⁶³

From 2008 to 2010, around the publishing of the National Space Policy and National Space Strategy, South Africa's government transitioned between presidential administrations, yet maintained continuity with respect to broadly favoring development objectives instead of security. In 2008, President Mbeki resigned the presidency after nine years because the ANC recalled him.¹⁶⁴ President Motlanthe served a short term after Mbeki, until 2009 when South Africa elected President Zuma, both of whom were also members of the ANC.¹⁶⁵ Despite the quick transitions that occurred in a three-year period, all three presidents promoted a vision centered on socioeconomic development. This development-focused vision aligned with the ANC's relentless efforts since the end of apartheid to overcome many development challenges associated with racial segregation.¹⁶⁶ All three presidents used similar language in their state of the nation addresses. President Mbeki primarily spoke about 24 "Apex Priorities" to improve South Africa's quality of life, particularly focusing on economic development, poverty reduction, and education.¹⁶⁷

¹⁶² Worden, 157–59.

¹⁶³ Nicolas Cook, *South Africa: Current Issues, Economy, and U.S. Relations*, CRS Report No. R45687 (Washington, DC: Congressional Research Service, 2019), 7, <https://crsreports.congress.gov/product/pdf/R/R45687>.

¹⁶⁴ "Historical and Political Context," The Presidency Republic of South Africa, accessed July 30, 2020, <http://www.thepresidency.gov.za/node/11>.

¹⁶⁵ The Presidency Republic of South Africa.

¹⁶⁶ Cook, *South Africa: Current Issues, Economy, and U.S. Relations*, 7.

¹⁶⁷ The Presidency Republic of South Africa, "State of the Nation Address of the President of South Africa, Thabo Mbeki: Joint Sitting of Parliament," South African Government, February 8, 2008, <https://www.gov.za/node/537711>.

Although President Motlanthe's speech primarily emphasized the strength of democratic institutions and the consequences of the global financial crisis of 2008, he also highlighted the importance of continued focus on development, specifically citing recommendations from South Africa's Growth and Development Summit.¹⁶⁸ Finally, President Zuma continued the development trend when he reaffirmed the government's commitment to five priorities, "education, health, rural development and land reform, creating decent work, and fighting crime."¹⁶⁹ These collective statements, across different administrations, demonstrated South Africa's persistent drive for socioeconomic development, a drive that followed the ANC's priorities. In the most crucial years for space policy, South Africa's presidents guided the government toward development goals.

Unsurprisingly, the national budgets from 2008 to 2010 also reflected South Africa's broad development objectives. Budget projections for the 2008 fiscal year assigned almost 80% of the total allocated expenditure to social and economic services, contrasting only 15% to protection services.¹⁷⁰ Similarly, the 2009 budget review placed two-thirds of allocated expenditures in the development-focused categories of housing and community amenities, economic affairs, education, and social protection, while the categories of defense, public order, and safety remained around 15%.¹⁷¹ Finally, the 2010 budget review's allocated expenditure percentages almost exactly matched the 2009 budget

¹⁶⁸ The Presidency Republic of South Africa, "State of the Nation Address of the President of South Africa, Kgalema Motlanthe, to the Joint Sitting of Parliament, Cape Town," South African Government, February 6, 2009, <https://www.gov.za/node/537724>.

¹⁶⁹ The Presidency Republic of South Africa, "State of the Nation Address by His Excellency JG Zuma, President of the Republic of South Africa," South African Government, February 11, 2010, <https://www.gov.za/node/537766>.

¹⁷⁰ National Treasury - Republic of South Africa, *Budget Review 2008* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2008), 108, <http://www.treasury.gov.za/documents/national%20budget/2008/review/Default.aspx>.

¹⁷¹ National Treasury - Republic of South Africa, *Budget Review 2009* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2009), 101, <http://www.treasury.gov.za/documents/national%20budget/2009/review/default.aspx>.

review, within one or two percentage points.¹⁷² Unfortunately, changes in the naming convention for functional categories between 2008 and 2009 make a direct comparison between budgets problematic.¹⁷³ Instead, the key takeaway from comparing multiple budgets is the continued dominance of development spending over security spending. South Africa also consistently spends significantly less on security, as a percentage of total government spending, than both the global average and the average within sub-Saharan Africa. For example, in 2008, the South African government spent about 4% of its total spending on its military, compared to about 6% in sub-Saharan Africa and 6.6% in the world.¹⁷⁴ The enduring trend of favoring development spending, and presidential speeches highlighting the importance of socioeconomic development, effectively demonstrate that South Africa politically prioritizes development objectives. Further, the evidence of space policy aligning with domestic political priorities throughout South Africa's post-apartheid era supports this hypothesis.

South Africa's most recent budget review continues with the development theme from the most critical years of establishing space policy. The 2020 budget review projects South African government expenditures from 2020 to 2023. Over two-thirds of the total allocated expenditures during this time period will go to socioeconomic development

¹⁷² National Treasury - Republic of South Africa, *Budget Review 2010* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2010), 118, <http://www.treasury.gov.za/documents/national%20budget/2010/review/Budget%20Review.pdf>.

¹⁷³ For example, the 2008 budget review lists a protection services expenditure function category that appears to split into two function categories in 2009: (1) defense and (2) public order and safety. Regardless of naming, these categories all fit into the security label for the purposes of this research. Similarly, social and economic services in the 2008 budget review, and the 2009 budget review's categories of housing and community amenities, economic affairs, education, and social protection all fall under the development label.

¹⁷⁴ "Military Expenditure (% of General Government Expenditure) - South Africa, Sub-Saharan Africa, World," The World Bank, accessed July 28, 2020, <https://data.worldbank.org/indicator/MS.MIL.XPND.ZS?locations=ZA-ZG-1W>.

programs, compared to just one-eighth spent on security.¹⁷⁵ Even in the supplemental budget that factors in the implications of COVID-19, development expenditures increased its share of total spending by 0.5%, while security lost 0.2%.¹⁷⁶ Clearly, the South African government plans to continue its preference of spending money on development issues instead of security challenges.

A second dimension of the political priorities hypothesis relates to the potential political benefits that leaders may obtain from space policy. Clientelism is a common characteristic in the politics of many African countries, including South Africa, thereby necessitating further examination in this hypothesis. The domestic political priorities hypothesis predicts that politicians may use space programs to advance private political goals, like raising political funds or rewarding supporters. For example, a politician employing the tools of patronage may grant a government contract to a particular domestic company if the contractor has offered political support in the past, or might do so in the future.

The *Kondor-E* satellite is the only South African space program with even indirect evidence of clientelism. South Africa's Department of Defence signed the *Kondor-E* contract during a period of defense contracting scandals involving President Mbeki and the ANC. For example, a 1999 arms deal erupted in scandal after allegations that Mbeki received bribes from the winning contractors, and that the ANC also received campaign

¹⁷⁵ Of the eight expenditure function categories – (1) learning and culture, (2) health, (3) social development, (4) community development, (5) economic development, (6) peace and security, (7) general public services, and (8) payments for financial assets – I count the first, third, fourth, and fifth categories under the label of socioeconomic development. For security, I only count the sixth function category. Regardless of which categories fit into the development label, the sum comparatively dwarfs spending on security, since each individual development category alone takes a larger share than the peace and security category. National Treasury - Republic of South Africa, *Budget Review 2020* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2020), 53, <http://www.treasury.gov.za/documents/national%20budget/2020/review/FullBR.pdf>.

¹⁷⁶ In fairness, development expenditures only outperformed security expenditures because of increased social development spending. Social development gained 2.6%, while learning and culture, community development, and economic development all lost 1.3%, 0.5%, and 0.3% respectively. If social development were not nested under the development label, then development expenditures would have lost more of the budget than security. National Treasury - Republic of South Africa, *Supplementary Budget Review 2020* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2020), 13, <http://www.treasury.gov.za/documents/national%20budget/2020S/review/FullSBR.pdf>.

funding from the deal.¹⁷⁷ Based on these previous defense contracting scandals, the *Kondor-E* contract may have provided personal bribes and political funding to Mbeki and the ANC, especially considering the satellite's top-secret classification. The bribes and funding would have helped the ANC, and President Mbeki, maintain political power, which may have incentivized the transaction. Additionally, the contract may have allowed President Mbeki to distribute state resources to loyal supporters. For example, the leaked top-secret document that Al Jazeera obtained specifically names former General Motau of the South African National Defence Force's (SANDF) Defence Intelligence as a key figure in the *Kondor-E* program.¹⁷⁸ The document also claims that Motau was working with a state-owned defense and security company named Denel for the satellite.¹⁷⁹ A top secret space contract worth approximately 1.2 billion rand would give Motau control of significant state resources with little accountability, thereby allowing him to funnel money into his personal accounts. Motau was serving as the Chief of Defence Intelligence for SANDF when he allegedly placed the order for *Kondor-E* in 2006.¹⁸⁰ Thus, it is feasible that Motau could have controlled this specific contract, allowing him to realize sizeable personal benefits from *Kondor-E*. Although there is no direct evidence supporting this argument, the indirect evidence certainly makes it possible. Conceivably, clientelism in defense contracting is key to understanding the limited security-focused objectives present in South Africa's space program.

Overall, South Africa's space policy has consistently aligned with the country's broader domestic political priorities, which lends strong support to this hypothesis. The

¹⁷⁷ Terry Crawford-Browne, "The Arms Deal Scandal," *Review of African Political Economy* 31, no. 100 (June 2004): 331–33; and "Mbeki Received Millions in German Defense Deal, Report Says," DW, March 8, 2008, <https://www.dw.com/en/mbeki-received-millions-in-german-defense-deal-report-says/a-3535872>.

¹⁷⁸ Jordan, "South Africa Spied on Russia for Satellite Project Details."

¹⁷⁹ Jordan; and "Company Profile," Denel SOC Ltd, accessed July 30, 2020, <http://www.denel.co.za/about-us/company-profile>.

¹⁸⁰ Ally Rakoma, "20 Years Celebration of Defence Intelligence in a Democracy," Department of Defence, accessed July 30, 2020, <http://www.dod.mil.za/news/2014/04/celebration.htm>; and Leon Engelbrecht, "'Mojo' Motau Appointed Armscor Chair," *DefenceWeb*, April 26, 2011, <https://www.defenceweb.co.za/governance/governance-governance/mojo-motau-appointed-armscor-chair/>.

space policy's alignment with the government's priorities is constant throughout the post-apartheid era, including in the critical stages of space policy and strategy institutionalization in the 1990s and 2000s. South Africa's space program is simply one component of the government's larger socioeconomic development machine, and may at times serve some clientelistic functions as well. Considering South Africa's general focus on socioeconomic development since the end of apartheid, the domestic political prioritization hypothesis has strong support.

3. Bureaucratic Institutions

Bureaucratic institutions are key to implementing any government policy, including space policy. Some institutions, however, can have a more powerful effect on policy than others. This hypothesis explores how South African institutions, and the relationships between institutions, affect space policy, especially considering the possible influence of bureaucratic institutions from South Africa's apartheid-era space program. Specifically, this section examines if bureaucratic interests pushed South Africa's space policy toward development in the transition period, when government officials established South Africa's contemporary space program.

The dismantling of South Africa's first space program in the early 1990s likely ended any bureaucratic inertia to continue with security-focused space policies in South Africa's contemporary space program. With the exception of select space infrastructure from the apartheid-era program, like the Overberg range, the contemporary space program was a fresh start from South Africa's first space program.¹⁸¹ The clean break between the two space programs likely neutralized the influence of bureaucratic institutions from the apartheid-era space program. This is especially probable, considering that launch programs—the primary focus of South Africa's first space program—have vastly different development requirements from satellite programs, which are the focus of South Africa's contemporary space program. Thus, it is unlikely that, in the early 1990s, bureaucratic inertia pushed the contemporary space program toward security objectives.

¹⁸¹ Harding, *Space Policy in Developing Countries*, 140.

SANDEF's early lack of interest in South Africa's contemporary space program almost certainly further removed bureaucratic pressure toward security objectives. Instead of dismantling South Africa's security forces in the early 1990s, like the space program, the transitioning government instituted a series of reforms. Leading up to the 1994 election, the South African government created the Joint Military Co-ordinating Committee, and directed the committee to establish the post-apartheid Department of Defence and SANDEF, while incorporating the interests of various security forces in South Africa, including the apartheid government's South African Defence Force and the ANC's military branch.¹⁸² The committee decided to merge South Africa's five existing constituent forces, several of which had previously clashed during apartheid, which created significant tension in SANDEF.¹⁸³ In short, when South Africa passed the Space Affairs Act of 1993, its security forces were focusing on internal tensions and reform. Thus, it is unlikely that there was any bureaucratic security interest in initially guiding South Africa's contemporary space policy. Even into the early 2000s, Martinez remarks that "the South African National Defence Force no longer had an active interest in developing independent space capabilities, so the policy area of outer space affairs was open for other actors to pursue."¹⁸⁴ SANDEF's disinterest almost certainly allowed the other bureaucratic actors that Martinez mentions to guide space policy towards development objectives in the 1990s and early 2000s; however, this initial absence of pressure towards security does not fully explain South Africa's near-complete focus on development objectives today.

After 2003, South Africa avoided the potential disproportionate influence of any one government department on space policy by creating an inter-department coordinating authority outside of any department's direct authority. Martinez argues that the DST, despite being a relatively minor department, lead South Africa's space dialogue starting in

¹⁸² Len le Roux, "The Post-Apartheid South African Military: Transforming with the Nation," in *Evolutions & Revolutions: A Contemporary History of Militaries in Southern Africa*, ed. Martin Revai Rupiya (Pretoria, South Africa: Institute for Security Studies, 2005), 240.

¹⁸³ le Roux, 253–54.

¹⁸⁴ Martinez, "The Development and Initial Implementation of South Africa's National Space Policy," 31–32.

2003.¹⁸⁵ It is worth noting that although the DTI ultimately finalized South Africa's space policy in 2009, under the authorities in the Space Affairs Act of 1993, Martinez credits the DST with nurturing the political motivation to formalize South Africa's space policy.¹⁸⁶ In this situation, the bureaucratic institutions hypothesis predicts that a more powerful institution might strongly influence South Africa's space policy to better meet its space requirements. Martinez acknowledges that several government departments had space requirements to satisfy, which the departments interpreted as competing mandates; however, South Africa prevented any one department from exercising asymmetric influence by creating a coordinating authority under the National Research Foundation, which already worked across departments as a coordinating agent, outside the control of any single department.¹⁸⁷ In this sense, no single department could commandeer the process of creating space policy, even though the DST was just a minor government department.

This coordinating authority likely had significant influence on the trajectory of South Africa's space policy. As a predecessor to SANSA, South Africa established the National Working Group on Space Science & Technology (NWGSST) in 2003 to fill this coordinating role.¹⁸⁸ Only four government departments originally established the NWGSST, but the working group eventually expanded to include input from all South African government departments with an interest in space technology.¹⁸⁹ Government officials created the NWGSST to align space policy with national priorities, "particularly with regard to issues of poverty reduction, disaster management, economic development,

¹⁸⁵ Martinez, 32.

¹⁸⁶ Martinez, 36.

¹⁸⁷ Martinez, 32.

¹⁸⁸ Gottschalk, "South Africa's Space Program," 41.

¹⁸⁹ Peter Martinez, "Space Science and Technology in South Africa: An Overview," *African Skies*, no. 12 (October 2008): 48.

technological empowerment, and improved quality of life.”¹⁹⁰ This statement reveals that the bureaucratic institutions hypothesis worked in combination with the domestic political priorities hypothesis in this circumstance. South Africa established the NWGSST to exert influence on space policy by guiding departmental discussions toward South Africa’s political priorities. Since the NWGSST was central to directing discussions on space applications between a wide range of government departments as the DTI formulated the National Space Policy, it is almost certain that the working group effectively influenced South Africa’s space policy to become what it is today.

In addition to the NWGSST, South Africa further removed the potential for bureaucratic influence from any single government department by separating user requirements from provider capabilities. While the NWGSST determined what space capacity South Africa could provide, government officials created a Government Lead Users’ Group (GLU) to determine what space applications government departments required.¹⁹¹ The GLU ultimately considered the requirements of 16 bureaucratic institutions, compiling a comprehensive list of necessary EO data.¹⁹² By separating conversations about user requirements from those of provider capabilities, South Africa ensured that a potential user of space technology could not dictate how South Africa’s space program would fulfill those requirements. In short, government institutions that benefited from space technology could not influence South Africa’s space policy, since the space policy itself clearly dictated how the necessary space capacity would be created.

Even the DTI and DST, as individual government departments, do not have complete authority over the direction of South Africa’s space program. Martinez reveals that South Africa deliberately integrated the inputs of all relevant government departments

¹⁹⁰ National Working Group on Space Science and Technology, *Space Science and Technology for Sustainable Development* (Pretoria, South Africa: Department of Trade and Industry, 2008), 10, <http://www.sacsa.gov.za/wp-content/uploads/2019/06/Space-Brocure-upgrade-2Sept08-p1-10.pdf>.

¹⁹¹ Martinez, “The Development and Initial Implementation of South Africa’s National Space Policy,” 33.

¹⁹² Martinez, 33.

when creating the National Space Policy in an approach called cooperative governance.¹⁹³ Cooperative governance includes separating space regulation, under the DTI, from space implementation with the DST, thereby preventing “a situation where a single agency of government is the rule-maker, referee and dominant player in space activities.”¹⁹⁴ Considering the deliberate and repeated decisions to divide the power of government institutions for dictating space policy, it appears that government officials in South Africa effectively mitigated the influence of individual government institutions during the formalization of space policy in the late 2000s, with the intentional exceptions of the NWGSST and GLU.

By the time the Department of Defence once again expressed interest in South Africa’s space program with the *Kondor-E* contract in 2006, there were already several checks on the Department of Defence’s ability to influence space policy. Furthermore, there is no evidence in Martinez’ article, which describes the evolution of space policy during this time frame, to suggest that the Department of Defence or SANDF, as institutions, attempted to exert influence on South Africa’s space policy in order to push the *Kondor-E* contract through.¹⁹⁵ This evidence suggests that the bureaucratic institutions hypothesis is not the best explanation for South Africa’s limited security space objectives.

In summary, there is only weak support for the bureaucratic institutions hypothesis in the case of South Africa. Initially, the dismantling of South Africa’s first space program, and the military’s disinterest in space activity likely removed bureaucratic pressure towards security-focused objectives. Development-oriented bureaucratic actors could then establish South Africa’s contemporary space program without any security bias, which partially supports this hypothesis, but does not fully explain the long-term focus of South Africa’s space program on development. Most importantly, during South Africa’s space policy formalization, in the late 2000s, government officials repeatedly created institutions to

¹⁹³ Martinez, 37.

¹⁹⁴ Martinez, 37.

¹⁹⁵ Martinez, “The Development and Initial Implementation of South Africa’s National Space Policy.”

restrict any single government department from taking control of South Africa's space policy, which strongly refutes this hypothesis.

4. Economic Capacity

The economic capacity hypothesis focuses on describing how a country's economy and space budget might affect the security-versus-development space policy decision. Specifically, this hypothesis predicts that low levels of economic capacity will force a country to pick between security- or development-focused space policies by limiting funding to pursue both. Furthermore, countries with low economic capacity may favor the development option because development-focused space programs can potentially create related economic benefits. To assess the strength of this hypothesis for explaining the trajectory of South Africa's space policy, this section searches for evidence in two scenarios. First, looking at South Africa's overall economy, this hypothesis seeks to determine how changes in economic capacity might affect South Africa's space budget. Second, to find support for the economic capacity hypothesis, the evidence must demonstrate that changes in South Africa's space budget influence decisions surrounding space policy objectives. In other words, has the amount of economic resources available for space activities impacted South Africa's space policy?

During the first few years of South Africa's contemporary space program in the early 1990s, it is possible that concerns over economic capacity partially contributed to the initial government decision to direct space policy towards development objectives. President de Klerk had initiated political reforms to revive South Africa's faltering economy, and the ANC's primary focus after the 1994 election was economic rebirth.¹⁹⁶ Put differently, government officials perceived South Africa's weak economic capacity as constraining, or even threatening. Economic statistics support the argument that South Africa's economic capacity was low during the late 1980s and early 1990s. In 1981, South Africa's gross domestic product (GDP) per capita peaked at \$6,895 before dropping 20%

¹⁹⁶ Worden, *The Making of Modern South Africa*, 147–48, 157.

to a relative minimum at \$5,517 in 1993.¹⁹⁷ Thus, South Africa was in a period of economic constraint when government officials passed the Space Affairs Act of 1993, which likely forced officials to pick between security and development objectives. It is not likely that government officials would spend scarce financial resources to rebuild the recently dismantled launch program. Consequently, South African space leaders in the early 1990s could reasonably spend money to develop a satellite-based space program with security or development objectives. South Africa's limited economic capacity at the time possibly incentivized the development choice, since development satellites possess the potential to return economic benefits. In this sense, South Africa's limited economic capacity possibly contributed to the purely development-focused trajectory that the Space Affairs Act initiated. This initial possible connection, however, does not fully explain South Africa's continued focus on development objectives.

Despite South Africa's many enduring socioeconomic challenges in the 21st century, the economy—with relatively high levels of diversity, industrialization, and income—is continually cited as one of the most-developed on the continent.¹⁹⁸ Put simply, South Africa has significant economic capacity, at least compared to other African countries. In this sense, South Africa is likely not as constrained in its space policy by economic capacity as other African countries, which allows South Africa more freedom to pick security, development, or some combination of space objectives. This level of capacity is partially the result of substantial growth since the end of apartheid in 1994; however, South Africa has also experienced three economic recessions during this period: the first from 2008 to 2009, the second in 2018, and the third starting in 2020.¹⁹⁹ Economic recessions place government spending in a spotlight,

¹⁹⁷ “GDP Per Capita (Constant 2010 US\$) - South Africa,” The World Bank, accessed September 11, 2020, <https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?locations=ZA>.

¹⁹⁸ Cook, *South Africa: Current Issues, Economy, and U.S. Relations*, 6–7, 17.

¹⁹⁹ I only examine the 2008 and 2018 recessions in this section since any economic influence on space policy requires more than a few months to materialize. The 2020 recession is simply too recent to properly evaluate its effects. “GDP Growth (Annual %) - South Africa,” The World Bank, accessed August 14, 2020, <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2019&locations=ZA&start=1994>; and “Economy Slips into Recession,” Department of Statistics South Africa, March 3, 2020, <http://www.statssa.gov.za/?p=13049>.

potentially focusing on space program spending, which is already contentious in Africa.²⁰⁰ Surprisingly, South Africa's space spending does not decrease during economic recessions, despite the potential for additional scrutiny.

Space funding data during the 2008 recession reveals that broader economic pressures likely did not influence space policy decisions during the contemporary space program's formative years. It is difficult to precisely determine South Africa's space budget during the 2008 recession because SANSA was not fully operational yet. Still, analyzing the DST's budget with respect to space activity gives some insight into how space funding reacted to economic constraints during this time. The DST's 2009 annual report reveals that space science funding actually increased from the 2007–2008 fiscal year to the 2008–2009 fiscal year by almost 18%, starting at 37.6 million rand and ending at 44.3 million rand.²⁰¹ Over the same timeframe, funding for the SKA almost tripled from 105.5 million rand to 289.8 million rand.²⁰² In the following fiscal year, which includes 2010, both space science and the SKA significantly increased funding again, to 62.2 million rand and 502.3 million rand respectively.²⁰³ The increase in space funding from 2008 to 2010 indicates that South Africa's space program did not experience budgetary pressure, despite the broader economic recession. Furthermore, none of the budget speeches between 2008 and 2010 highlight space spending, suggesting that space activity was not an economically contentious issue during the 2008 recession.²⁰⁴ Consequently,

²⁰⁰ Oyewole, "Space Research and Development in Africa," 195–96.

²⁰¹ Department of Science and Technology, *Annual Report 2008–2009* (Pretoria, South Africa: Department of Science and Technology, 2009), 127, <https://www.dst.gov.za/images/pdfs/DST%20Annual%20Report%200809.pdf>.

²⁰² Department of Science and Technology, 127.

²⁰³ Department of Science and Technology, *Annual Report 2009–2010* (Pretoria, South Africa: Department of Science and Technology, 2010), 89, <https://www.dst.gov.za/images/pdfs/DST%20Annual%20Report%20LR.pdf>.

²⁰⁴ Trevor A Manuel, *2008 Budget Speech* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2008), <http://www.treasury.gov.za/documents/national%20budget/2008/speech/speech.pdf>; Trevor A Manuel, *2009 Budget Speech* (Pretoria, South Africa: National Treasury - Republic of South Africa, 2009), <http://www.treasury.gov.za/documents/national%20budget/2009/speech/speech.pdf>; and Pravin Gordhan, *2010 Budget Speech* (Pretoria: National Treasury - Republic of South Africa, 2010), <http://www.treasury.gov.za/documents/national%20budget/2010/speech/speech2010.pdf>.

South Africa's recession probably did not constrain space policy decisions during this formative time around the 2008 recession, leaving both security-focused and development-focused objectives open as possibilities.

Circumstances in 2018 demonstrate once again, that South Africa's economic recessions do not automatically result in less space spending, which would potentially pressure space policy to choose between development or security objectives. Space spending during the 2018 recession is consolidated in SANSA's annual reports. In the 2016–2017 fiscal year, before the coming recession, SANSA received 125 million rand from the South African parliament in the form of grants.²⁰⁵ During the recession, in the 2017–2018 and 2018–2019 fiscal years, the amount that SANSA received from parliament increased to 131 million rand and 138 million rand respectively.²⁰⁶ These statistics indicate that South Africa's parliament did not decrease national space spending during the 2018 recession, despite broader economic pressure, which is a similar result to the 2008 recession. In this sense, the South African government did not allow decreasing economic capacity to influence SANSA's space activities. SANSA's revenue, however, consists of more than just parliamentary grants.

Even with SANSA's total revenue decreasing during the 2018 recession, SANSA's sizeable budget surpluses further suggest that the space agency did not experience financial pressure during this time. The space agency's revenue includes non-parliamentary grants in addition to parliamentary grants, which combine as non-exchange revenue, and contract revenue in exchange for services.²⁰⁷ Unlike SANSA's parliamentary revenue, the total revenue decreased between 2016 and 2019. In the 2016–2017 fiscal year SANSA's total

²⁰⁵ South African National Space Agency, *South African National Space Agency Annual Report 2016/2017* (Pretoria, South Africa: South African National Space Agency, 2017), 108, 121–22, <https://www.sansa.org.za/wp-content/uploads/2018/05/SANSA-AR-2016-17.pdf>.

²⁰⁶ South African National Space Agency, *South African National Space Agency Annual Report 2017/2018*, 112; and South African National Space Agency, *South African National Space Agency Annual Report 2018/2019*, 91.

²⁰⁷ South African National Space Agency, *South African National Space Agency Annual Report 2018/2019*, 91, 106.

revenue was 471 million rand.²⁰⁸ The total revenue declined to 433 million rand in 2017–2018, and again to 359 million rand in 2018–2019.²⁰⁹ Regardless, SANSA operated with a sizeable budget surplus of no less than 72 million rand throughout all three of these fiscal years, which, put simply, means that SANSA’s total governmental and non-governmental revenue exceeded the space agency’s expenditures.²¹⁰ The surplus, despite falling total revenue, suggests that SANSA did not broadly experience financial pressure during the 2018 recession, even as South Africa’s overall economic capacity collapsed. Despite the evidence from the past two recessions that economic capacity did not meaningfully pressure space spending, it is still important to determine if constrained space spending could influence space policy.

Funding constraints surrounding South Africa’s next satellite demonstrate the potential for economic capacity to stop the growth of new space projects, and potentially, direct future policy. SANSA’s 2018–2019 annual performance review provides some insight into how space policy reacts to financial constraints on space spending. Looking at SANSA’s 14 key performance indicators (KPI) the report notes that SANSA failed to achieve the objectives of two KPIs because of financial constraints.²¹¹ Specifically, both KPIs relate to the growth of South Africa’s space sector through the development of EOSat-1, for which SANSA did not receive funding.²¹² EOSat-1 is South Africa’s next EO satellite, with a primarily development-focused mission of monitoring agricultural

²⁰⁸ South African National Space Agency, *South African National Space Agency Annual Report 2016/2017*, 108.

²⁰⁹ South African National Space Agency, *South African National Space Agency Annual Report 2017/2018*, 112; and South African National Space Agency, *South African National Space Agency Annual Report 2018/2019*, 91.

²¹⁰ South African National Space Agency, *South African National Space Agency Annual Report 2016/2017*, 108; South African National Space Agency, *South African National Space Agency Annual Report 2017/2018*, 112; and South African National Space Agency, *South African National Space Agency Annual Report 2018/2019*, 92.

²¹¹ South African National Space Agency, *South African National Space Agency Annual Report 2018/2019*, 36.

²¹² South African National Space Agency, 36–37.

land, although EO technology could serve dual-use purposes.²¹³ This satellite will fulfill South Africa's role in the African Resource Management Satellite Constellation (ARMS-C), which is an intra-African satellite constellation that also focuses on development objectives like land use, resource management, and disaster monitoring.²¹⁴ In this situation, South Africa's economic capacity does not provide enough space funding to support space capacity growth. As such, financial constraints are preventing South Africa from meeting several development-focused objectives through the EOSat-1 project. While this single example does not determine if space budgetary constraints usually inhibit the advancement of development-focused projects, it does demonstrate that budgets can stop individual future projects. In South Africa's case, it appears that periods of reduced economic capacity can maintain existing space policies and projects, but can also prevent the growth of space capacity by halting future projects.

Overall, there is little, if any, support for the economic capacity hypothesis in South Africa. Limited economic capacity during the apartheid transition in the early 1990s may have contributed to the government's initial development-focused space policy decisions, but this hypothesis does not convincingly explain South Africa's long-term focus on development objectives. Multiple recent economic recessions emphasize that declining national economic capacity does not automatically correspond with a decrease in the overall space budget. Financial constraints, when they do occur in South Africa, may neglect space program growth, while maintaining existing space projects and policies. Thus, the analysis reveals that economic capacity constraints may only marginally affect space programs by pausing funding for specific programs. Still, it is inconclusive if the marginal influence of economic capacity could actually move the trajectory of South Africa's space policy.

²¹³ "The South African National Space Agency Has Developed a System to Monitor Crops," AUDA-NEPAD, May 12, 2017, <https://www.nepad.org/news/south-african-national-space-agency-has-developed-system-monitor-crops>.

²¹⁴ Froehlich and Siebrits, *Space Supporting Africa*, 110–11.

D. CONCLUSION

This chapter has shown how South Africa's space program, once heavily focused on military use, has, since the 1990s, become nearly entirely focused on development. With the exception of the *Kondor-E* satellite, South Africa's contemporary space program includes no tangible steps towards security-focused objectives. Of the four hypotheses that this chapter examines, the evidence strongly supports the political prioritization hypothesis as the best explanation for South Africa's space policy. The South African government has had a high degree of agency in deciding the trajectory of its space program. International, bureaucratic, or economic influences may contribute marginally to South Africa's development-focused space policy, but the final path seems to follow the country's political priorities. Table 1 summarizes the analysis of all four hypotheses.

Table 1. Summary of Hypotheses for South Africa's Space Program

Hypothesis	Level of Support	Key Findings
Foreign Partnerships	No Support	Domestic capacity and multiple partners prevent over reliance on any single partner
Political Prioritization	Strong	Space policy consistently aligned with ANC's political priorities
Bureaucratic Institutions	Weak	Officials established checks and balances against bureaucratic influence early
Economic Capacity	No Support	Declining economic capacity has not constrained space budgets

In the next chapter, I turn to the case of Nigeria's space program, which differs considerably from South Africa's in terms of its history, objectives, and technologies. Not only is Nigeria's space program newer, but it has evolved in the opposite way as South Africa's from a more development-focused to a more security-focused program. The differences between the space programs in South Africa and Nigeria make comparing both cases important, since the Nigerian case study can help assess the consistency of the results from the South African case.

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III. NIGERIA'S SPACE PROGRAM

A. OVERVIEW

Nigeria's space program is one of the oldest and most advanced on the continent. When the Nigerian government first established the space program in the 1990s, the program's objectives overwhelmingly focused on using space technology to advance Nigeria's socioeconomic development. Over a decade later, as the regional terrorist threat grew in the 2010s, Nigeria's space program began to incorporate security-focused objectives while preserving the program's development goals. As a result of this shift, Nigeria's space program is now dual-use, incorporating both security and development elements.

This chapter examines this shift in Nigeria's space program in two steps. First, I describe Nigeria's space history. Next, I analyze the four hypotheses—foreign partnerships, political prioritization, bureaucratic institutions, and economic capacity—to determine which factors best explain the trajectory of Nigeria's space history. The evaluated evidence reveals that Nigeria's political priorities primarily drove Nigeria's space policy decisions. There is either weak or no support in the existing evidence for the remaining hypotheses. Ultimately, the consistent alignment between Nigeria's general political priorities and the space program's objectives best explains why Nigeria's space decision makers pursued development first, and then a more balanced approach, to include security objectives.

B. UNDERSTANDING THE SECURITY-DEVELOPMENT TRAJECTORY OF NIGERIA'S SPACE HISTORY

Nigeria's space history can be broken down into two general periods. First, from the 1990s until 2010, Nigeria founded its space program and began to implement development-oriented policies. This foundational period aligned with Nigeria's transition from a military dictatorship to a civilian democracy in 1999, and the initial years of

Nigeria's Fourth Republic.²¹⁵ Then, from 2011 until the present day, the second period in Nigeria's space history, the space program gradually incorporated more security objectives to supplement the continued socioeconomic efforts. These security applications focused on combating the expanding regional terrorist threat posed by Boko Haram and the Islamic State's West Africa Province (ISWAP). This section describes Nigeria's space history, and explains how the space program shifted its position on the security-development spectrum.

1. Space for Nigeria's Development: 1995–2010

Although Nigeria's government first declared its desire to participate in space activities in 1976, there were no tangible steps towards establishing a space program until the 1990s.²¹⁶ Nigerian government officials approved the country's first space institution, the National Centre for Remote Sensing (NCRS), in 1988, but NCRS did not become operational until 1995.²¹⁷ NCRS's mission, once operational, was to use remote-sensing technology to monitor Nigeria's natural resources and environment.²¹⁸ In other words, the primary purpose of NCRS was to monitor resources that could contribute to Nigeria's economic growth and to reduce the socioeconomic impact of environmental crises. The NCRS's time in Nigeria's space spotlight, however, was short lived because the Nigerian government created its National Space Research and Development Agency (NASRDA) just four years later in 1999, and NCRS became one of NASRDA's research centers.²¹⁹

Nigeria's primary space institution, NASRDA, was established with a broader mission than NCRS. In 1999, a draft national space policy, formulated by the National Agency for Science and Engineering Infrastructure (NASENI) motivated Nigerian

²¹⁵ Toyin Falola and Matthew M. Heaton, *A History of Nigeria* (Cambridge, United Kingdom: Cambridge University Press, 2008), 235.

²¹⁶ Oluwaseun Tella, "Space as a Fulcrum of Nigeria's External Relations and Regional Hegemony," *Space Policy* 46 (November 2018): 47, <https://doi.org/10.1016/j.spacepol.2018.05.001>.

²¹⁷ Omotayo Oyewole, "The Nigerian Space Conundrum: On 20 Years of Space Exploration in Nigeria," *The Republic*, July 26, 2019, <https://republic.com.ng/june-july-2019/nigerian-space-conundrum/>.

²¹⁸ Oyewole.

²¹⁹ Oyewole.

government officials to create NASRDA.²²⁰ NASRDA fell under the Ministry of Science and Technology and was established with a “broad objective to pursue the development and application of space science and technology for the socio-economic benefits of the nation.”²²¹ Establishing NASRDA as an agency within the Ministry of Science and Technology, which broadly used science and technology to advance socioeconomic development, almost certainly started NASRDA with an institutional bias that was geared toward development.²²² Notably, NASRDA operated six research centers to accomplish its objectives. Table 2 names the six NASRDA centers and describes each center’s mandate.

Table 2. NASRDA’s Research Centers and Mandates²²³

Research Center	Mandate
Centre for Remote Sensing, Jos	Research, development, and operation of EO and remote sensing data and systems
Centre for Satellite Technology Development, Abuja	Manufacturing and development of satellites
Centre for Geodesy and Geodynamics, Toro	Analysis of remote sensing data to monitor seismic activity, land use, and natural resources
Centre for Space Transport and Propulsion, Epe	Building domestic space launch capacity
Centre for Basic Space Science and Astronomy, Nsukka	Studying the space environment and space phenomenon
Centre for Space Science Technology Education, Ile-Ife	Developing space-related human capital

²²⁰ Godstime Kadiri James, Joseph Akinyede, and Shaba Ahmad Halilu, “The Nigerian Space Program and Its Economic Development Model,” *New Space* 2, no. 1 (March 2014): 23, <https://doi.org/10.1089/space.2013.0041>.

²²¹ “About Us,” National Space Research and Development Agency, accessed October 1, 2020, <https://web.archive.org/web/20181112185052/http://nasrda.gov.ng:80/en/about-us/>.

²²² “Vision & Mission,” Ministry of Science and Technology, accessed October 16, 2020, <https://scienceandtech.gov.ng/vision-mission/>.

²²³ Adapted from James, Akinyede, and Halilu, “The Nigerian Space Program and Its Economic Development Model,” 24–25; and Lanre Adetoro and Olalekan Aro, “Nigeria Space Programs,” in *IFAC Workshop “Aerospace Guidance, Navigation and Flight Control Systems”* (Abuja, Nigeria: National Space Research and Development Agency, 2011), 2, <http://lib.physcon.ru/doc?id=4802ddefcb4d>.

In 2001, the Nigerian Federal Executive Council approved the National Space Policy, which remains the guiding strategy document for Nigeria's space program. Drafted by NASENI, the policy established the initial objectives of Nigeria's space program, which broadly stressed the importance of creating a space program for the purpose of socioeconomic development.²²⁴ For example, the National Space Policy stated, "Nigeria shall vigorously pursue the attainment of Space Capabilities as an essential tool for its socio-economic development and the enhancement of the quality of life of its people."²²⁵ Furthermore, seven of the space policy's eight applications for space technology included development goals like improving agriculture, discovering natural resources, mitigating disasters, and advancing education.²²⁶

Despite the larger focus on development, however, the National Space Policy also established explicit security objectives. For example, the eighth and final application for space capabilities in the National Space Policy was "National Defence and Security."²²⁷ In particular, the security objectives included providing reliable navigation information for military operations, improving intelligence collection, and enhancing command and control.²²⁸ Thus, Nigeria's earliest stated space objectives demonstrated a broad focus on development, while also recognizing the security-related benefits of a space program.

Nigeria's first satellite, *NigeriaSat-1*—launched in 2003 by a Russian Kosmos-3M rocket from Plesetsk, Russia—had the goal to reduce the socioeconomic impact of disasters.²²⁹ Surrey Satellite Technology Limited (SSTL), a British-based space company, built the \$13 million microsatellite and trained several Nigerian engineers throughout the

²²⁴ James, Akinyede, and Halilu, "The Nigerian Space Program and Its Economic Development Model," 23–24.

²²⁵ National Space Research and Development Agency, *National Space Policy* (Abuja, Nigeria: National Space Research and Development Agency, 2001), 2, <https://dawodu.com/space.pdf>.

²²⁶ National Space Research and Development Agency, 2.

²²⁷ National Space Research and Development Agency, 2.

²²⁸ National Space Research and Development Agency, 17–18.

²²⁹ "Kosmos-3M (11K65M)," Gunter's Space Page, accessed October 2, 2020, https://space.skyrocket.de/doc_lau_det/kosmos-3m.htm.

process.²³⁰ The primary payload on *NigeriaSat-1* was a MSI optimized for disaster monitoring.²³¹ With a 32-meter ground resolution, the imager could only reliably resolve large natural features like rivers, forests, and mountains. *NigeriaSat-1* was one of five satellites in the international Disaster Monitoring Constellation (DMC), which aimed to improve global disaster monitoring, and included the United Kingdom, China, Algeria, Nigeria, Turkey, Thailand, and Vietnam as participants.²³² Put simply, *NigeriaSat-1*'s primary objective was to reduce the negative consequences of disasters, like Hurricane Katrina, the 2004 Southern Asian Tsunami, and persistent Nigerian deforestation, by providing images of a disaster's impact.²³³

The Nigerian Federal Executive Council also approved a 25-year roadmap for Nigeria's space program in 2006, which serves as another example of Nigeria's initial orientation towards development-focused space objectives, albeit with some room for security-focused applications.²³⁴ This 25-year space roadmap included four primary goals: 1) training a Nigerian astronaut by 2015, 2) manufacturing a satellite in Nigeria by 2018, 3) domestically launching a Nigerian satellite by 2025, and 4) landing a Nigerian astronaut on the Moon by 2030.²³⁵ The first and fourth goals aimed to advance space exploration by training and flying a Nigerian astronaut. Chizea Francis, a NASRDA official, explains that space exploration in Nigeria was development-focused because human exploration missions help transform advanced space technology into terrestrial products that may

²³⁰ "NigeriaSat-1," UN-SPIDER Knowledge Portal, accessed October 2, 2020, <http://www.un-spider.org/node/9055>.

²³¹ "Instrument SLIM6," WMO OSCAR, accessed October 2, 2020, <https://www.wmo-sat.info/oscar/instruments/view/513>.

²³² UN-SPIDER Knowledge Portal, "NigeriaSat-1."

²³³ Ikpaye Ikpaye et al., "Quest of Nigeria into Space for Sustainable Development," in *SpaceOps 2016 Conference* (Reston, VA: American Institute of Aeronautics and Astronautics, 2016), 3–5, <https://doi.org/10.2514/6.2016-2345>.

²³⁴ Tella, "Space as a Fulcrum of Nigeria's External Relations and Regional Hegemony," 48.

²³⁵ Tella, 48; James, Akinyede, and Halilu, "The Nigerian Space Program and Its Economic Development Model," 25; and R.A. Boroffice, "The Nigerian Space Programme: An Update," *African Skies*, no. 12 (October 2008): 44.

benefit the national economy.²³⁶ The remaining two goals—manufacturing a satellite in Nigeria and domestically launching a Nigerian satellite—were neutral on the security-development spectrum without additional context. Building satellite manufacturing capacity could benefit security, development, or dual-use objectives, depending on the technologies employed on each Nigerian satellite. Similarly, domestic launch capabilities could support satellite launches, commercial companies, and military missile development simultaneously.

In 2007, a Chinese Long March—3B rocket launched Nigeria’s second satellite, *NigComSat-1*, from Xichang, China.²³⁷ *NigComSat-1* was a communications satellite and the first sub-Saharan African satellite to be placed into GEO.²³⁸ Nigerian government officials contracted the China Great Wall Industry Corporation (CGWIC) to develop and build *NigComSat-1*, which originally had a planned 15-year operational lifetime.²³⁹ The Nigerian Ministry of Communications established a government-owned company, Nigerian Communications Satellite Limited (NIGCOMSAT), to operate *NigComSat-1* and future government communications satellites for socioeconomic benefits.²⁴⁰ *NigComSat-1* had 28 transponders across four communication frequency bands, but a solar array malfunction caused the satellite to fail in 2008, at which point it was left in a graveyard

²³⁶ “‘Will Africa Ever Land on the Moon?’ - Leaders in the African Space Industry Express Opinions on Africa’s Capacity to Launch Lunar Missions,” Space in Africa, July 22, 2019, <https://africanews.space/will-africa-ever-land-on-the-moon-leaders-in-the-african-space-industry-express-opinions-on-africas-capacity-to-launch-lunar-missions/>.

²³⁷ “Our Fleet,” Nigeria Communications Satellite LTD, accessed October 6, 2020, <https://www.nigcomsat.gov.ng/fleet/nigcomsat>.

²³⁸ Kunle Adebajo, “NigComSat: Nigeria’s Satellite Company Still Not Profitable After 14 Years,” Space in Africa, March 23, 2020, <https://africanews.space/nigcomsat-nigerias-satellite-company-still-not-profitable-after-14-years/>.

²³⁹ “NigComSat-1 Program,” China Great Wall Industry Corporation, accessed October 6, 2020, <http://www.cgwic.com/in-orbitdelivery/communicationssatellite/program/nigcomsat-1.html>.

²⁴⁰ Adebajo, “NigComSat: Nigeria’s Satellite Company Still Not Profitable After 14 Years”; and “Home,” Nigeria Communications Satellite LTD, accessed October 6, 2020, <https://www.nigcomsat.gov.ng/>.

orbit.²⁴¹ *NigComSat-1*, like any communications satellite, had a vast array of potential applications, both for security- and development-focused purposes. Given *NigComSat-1*'s short operational lifespan, and the absence of evidence to determine how Nigeria used the satellite during operation, the location of *NigComSat-1* on the security-development spectrum is unclear, but likely dual-use.

Finally, NASRDA's governing legislation, the National Space Research and Development Act of 2010, provided opportunities for both security and development space objectives. This legislation listed 13 functions for Nigeria's space program, of which only one specifically aimed to advance Nigeria's socioeconomic development.²⁴² The remaining 12 functions ambiguously sought to build space capacity without specifying underlying objectives, which made the space program adaptable.²⁴³ The NASRDA Act did not radically depart from NASRDA's previous development-focused objectives, but rather, the legislation included flexibility for the pursuit of both security- and development-focused objectives later in Nigeria's space program evolution.

Initially, Nigeria's space program was clearly oriented towards the development side of the security-development spectrum. The National Space Policy, in particular, demonstrated a strong preference for space applications that would improve Nigeria's socioeconomic position. As Nigeria's space program approached the end of its first two decades, the program grew more mixed in its ambitions. Put simply, Nigeria's space program opened to permit both security- and development-focused goals. Still, explicit examples of security-focused objectives, institutions, and technology were outliers in Nigeria's space program through 2010.

²⁴¹ "NIGCOMSAT 1, 1R," Gunter's Space Page, July 21, 2019, https://space.skyrocket.de/doc_sdat/nigcomsat-1.htm.

²⁴² Federal Republic of Nigeria, "National Space Research and Development Agency Act, 2010," *Government Gazette* 97, no. 98 (August 2010): 1252–53.

²⁴³ Federal Republic of Nigeria, 1252–53.

2. A Growing Focus on Security: 2011-Present

The second period of Nigeria's space history began in 2011 with a series of satellite launches. During this second period, Nigeria sustained previous development-focused space applications. It also established projects and institutions with tangible security-related benefits, rather than simply acknowledging opportunities for security objectives, as in the first period. Nigeria's third and fourth satellites, *NigeriaSat-2* and *NigeriaSat-X*, both launched onboard the same Russian Dnepr rocket out of Yasny, Russia, in August, 2011.²⁴⁴ Government officials once again contracted SSTL to build the satellites in England, although the contract specified that Nigerian engineers would completely develop *NigeriaSat-X* with supervision and training from SSTL.²⁴⁵ *NigeriaSat-2*'s primary payload was a MSI with a ground resolution of 2.5 meters.²⁴⁶ Additionally, *NigeriaSat-2* had a second imager that was extremely similar to *NigeriaSat-1*'s MSI, with the same ground resolution of 32 meters.²⁴⁷ Likewise, the primary payload on *NigeriaSat-X* was an updated version of *NigeriaSat-1*'s imager that improved the ground resolution to 22 meters.²⁴⁸

NigeriaSat-2 and *NigeriaSat-X* accomplished five primary objectives. First, both satellites replaced the aging *NigeriaSat-1*, which ended operations in 2012, as participants in the DMC.²⁴⁹ Second, *NigeriaSat-2*'s imagery resolution met the 2.5-meter requirement to fulfill Nigeria's commitment to ARMS-C, which is an African EO data-sharing agreement designed to make information about land use, resource management, and

²⁴⁴ "Dnepr," Gunter's Space Page, September 20, 2018, https://space.skyrocket.de/doc_lau_det/dnepr-1.htm.

²⁴⁵ "NigeriaSat-2," Earth Online, accessed October 6, 2020, <https://directory.eoportal.org/web/eoportal/satellite-missions/n/nigeriasat-2>; and "NigeriaSat-X," Earth Online, accessed October 6, 2020, <https://earth.esa.int/web/eoportal/satellite-missions/n/nigeriasat-x>.

²⁴⁶ Earth Online, "NigeriaSat-2."

²⁴⁷ Earth Online.

²⁴⁸ Earth Online, "NigeriaSat-X."

²⁴⁹ Jacob Aron, "How Nigeria Has Been Using Its Satellites," *New Scientist*, August 9, 2013, <https://www.newscientist.com/article/dn24025-how-nigeria-has-been-using-its-satellites/>.

disaster monitoring broadly accessible to ARMS-C participants.²⁵⁰ Third, *NigeriaSat-X* provided an opportunity to develop Nigeria's space capacity and human capital by training Nigerian engineers on the entire satellite development process.²⁵¹ Fourth, imagery from both satellites contributed to the National Geospatial Data Infrastructure program in Nigeria, which is an effort to standardize and broaden access to geospatial data within Nigeria.²⁵² Fifth and finally, the 2.5-meter resolution of *NigeriaSat-2*'s imager, despite its primary purpose of supporting ARMS-C, also allowed security forces to track people and equipment.²⁵³ In fact, Oyewole states that *NigeriaSat-2* was "designed and managed for civil purposes but significantly employed for military purposes."²⁵⁴ For example, the Nigerian Air Force used imagery from *NigeriaSat-2* to analyze terrain in Niger at the site of a jet crash, presumably to aid a search and rescue mission.²⁵⁵ In this sense, *NigeriaSat-2* served a dual-use mission, while *NigeriaSat-X* was more focused on development.

Nigeria's fifth satellite, *NigComSat-1R*, launched just four months later in December, 2011, on a Chinese Long March 3B/E out of Xichang, China.²⁵⁶ *NigComSat-1R* was the replacement satellite for *NigComSat-1*, since the first communication satellite

²⁵⁰ Froehlich and Siebrits, *Space Supporting Africa*, 109–10.

²⁵¹ "NigeriaSat X," Gunter's Space Page, November 12, 2017, https://space.skyrocket.de/doc_sdat/nx.htm.

²⁵² Earth Online, "NigeriaSat-2"; and Olajide Kufoniyi and Ganiy Ishola Agbaje, "National Geospatial Data Infrastructure Development in Nigeria: The Journey so Far," in *FIG Working Week 2005 and GSDI-8: From Pharaohs to Geoinformatics* (Abuja, Nigeria: National Space Research and Development Agency, 2005), 5, https://www.fig.net/resources/proceedings/fig_proceedings/cairo/papers/ts_41/ts41_07_kufoniyi_agbaje.pdf.

²⁵³ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 153; and "Nigeria Launches Monitoring Satellites," DefenceWeb, August 19, 2011, <https://www.defencewebsite.co.za/joint/science-a-defence-technology/nigeria-launches-monitoring-satellites/>.

²⁵⁴ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 153.

²⁵⁵ Joseph Ibeh, "Nigerian Military Partners with NASRDA to Fight Boko Haram Insurgency," Space in Africa, April 27, 2019, <https://africanews.space/nigerian-military-partners-with-nasrda-for-state-defence/>.

²⁵⁶ Rui C. Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R," NASA Space Flight, December 19, 2011, <https://www.nasaspaceflight.com/2011/12/chinese-long-march-3be-launches-nigcomsat-1r/>.

failed in orbit in 2008.²⁵⁷ Considering that *NigComSat-1* failed well before its 15-year planned operational lifetime due to a solar panel malfunction, NIGCOMSAT and CGWIC agreed that *NigComSat-1*'s insurance policy would cover the development, launch, and orbital delivery costs for *NigComSat-1R* without additional funding from Nigeria.²⁵⁸ In replacing *NigComSat-1*, CGWIC developed *NigComSat-1R* to be virtually identical to *NigComSat-1*, with 28 transponders across four communication frequency bands, while including minor improvements to prevent a similar failure.²⁵⁹ The four frequency bands allowed for a range of dual-use applications, which included television, internet, tele-medicine, tele-education, security, and surveillance.²⁶⁰ Similar to *NigeriaSat-2*, however, Nigeria frequently uses *NigComSat-1R* for military purposes, according to Oyewole.²⁶¹

In 2013, Nigeria established the National Space Council to monitor NASRDA's implementation of space policy. The concept of a National Space Council existed as early as 2001, when the National Space Policy proposed creating a space council, with the Nigerian president as the chairman, for "the development of the nation's policy guidelines on space activities."²⁶² Then, in 2010, the NASRDA Act granted the National Space Council the power to control NASRDA's financial activity, approve NASRDA's partnerships, procure space-related technical support for NASRDA, and license all Nigerian space activity.²⁶³ With the legal and policy framework in place, President

²⁵⁷ Gunter's Space Page, "NIGCOMSAT 1, 1R."

²⁵⁸ Prince Osuagwu and Laide Akinboade, "Nigeria: With NigComSat-1R Launch, Country Returns to Space," *All Africa*, December 21, 2011, <https://allafrica.com/stories/201112210397.html>; and Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R."

²⁵⁹ Gunter's Space Page, "NIGCOMSAT 1, 1R"; and Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R."

²⁶⁰ Ikpaya et al., "Quest of Nigeria into Space for Sustainable Development," 9.

²⁶¹ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 153.

²⁶² National Space Research and Development Agency, *National Space Policy*, 5.

²⁶³ Federal Republic of Nigeria, "National Space Research and Development Agency Act, 2010," 1253–56.

Goodluck Jonathan formally established the National Space Council in 2013.²⁶⁴ The National Space Council's role and responsibilities, which consisted primarily of overseeing and facilitating NASRDA operations, indicated a focus on development-oriented space applications, since NASRDA's continued goal is to advance socioeconomic development.

Nigeria made its commitment to security objectives in its space program more explicit in 2014, when government officials established the Defence Space Administration (DSA), which is Nigeria's second space agency. Like the National Space Council, the National Space Policy had planned for a Defence Space Command under the Ministry of Defence in 2001, but government officials did not follow this guidance until the mid-2010s.²⁶⁵ In 2014, the Nigerian government finally established the DSA, and then, in 2016, government officials passed the DSA Act, which was the legislative backbone of the DSA.²⁶⁶ The DSA's mission was to "support the armed forces of Nigeria and other security agencies with relevant space products and solutions necessary for the conduct of operations in peace and wartime."²⁶⁷ Nigeria's space institutions and stated objectives had recognized the benefits of security-related space activities since 2001, but the DSA's establishment in 2014 demonstrates an explicit push toward security-focused objectives.

Additionally, in 2014, the Centre for Space Transport and Propulsion (CSTP) began to experiment with rocket technology—another move toward a more security-focused space program. In 2006, Nigeria's 25-year space roadmap had established the goal to domestically launch Nigerian satellites. CSTP expanded upon this objective by aiming to develop a launch program capable of putting satellites in both LEO and GEO orbits by

²⁶⁴ "Nigeria's National Space Council Inaugurated in Abuja," Panafrikan News Agency, June 11, 2013, https://www.panapress.com/Nigeria-s-National-Space-Council-a_873667-lang2-free_news.html.

²⁶⁵ National Space Research and Development Agency, *National Space Policy*, 3.

²⁶⁶ "History of DSA," Defence Space Administration, accessed October 2, 2020, https://dsa.mil.ng/page-history_of_dsa.

²⁶⁷ "Vision and Mission," Defence Space Administration, accessed October 2, 2020, https://dsa.mil.ng/page-vision_and_mission.

2030, along with sending probes to interplanetary space in the same timeframe.²⁶⁸ Since 2014, CSTP has conducted over 30 rocket tests, none of which have ascended beyond 10 kilometers.²⁶⁹ It is interesting that CSTP used solid rocket fuel (SRF) in its rocket tests because SRF is typically better suited to missile applications than orbital launch vehicles.²⁷⁰ In fact, since 2016, the Nigerian Air Force and DSA have developed guided missiles in a partnership with CSTP.²⁷¹ Perhaps this connection between military missiles and CSTP helps to explain the level of secrecy surrounding Nigeria's launch program.²⁷²

Finally, in 2017, the program saw to the launch of *NigeriaEduSat-1*, Nigeria's sixth and most recent satellite. This satellite, also known as *Bird-N*, launched on a Falcon 9 out of Florida in 2017.²⁷³ The Nigerian Federal University of Technology, Akure, working with Japan's Kyushu Institute of Technology, developed *NigeriaEduSat-1* as one of five

²⁶⁸ Joseph Ibeh, "Towards Africa's First Rocket Launch from Its Soil - NASRDA Centre for Space Transport & Propulsion Is Making Progress," Space in Africa, May 22, 2019, <https://africanews.space/towards-africas-first-rocket-launch-from-its-soil-nasrda-centre-for-space-transport-propulsion-is-making-progress/>.

²⁶⁹ Ibeh; and Joseph Ibeh, "Nigeria's CSTP Completes Three Successful Experimental Rocket Launches," Space in Africa, October 17, 2019, <https://africanews.space/nigerias-cstp-completes-three-successful-experimental-rocket-launches/>.

²⁷⁰ Orbital launch vehicles typically use liquid fuel because liquid fuel allows the engines to throttle and reignite, unlike SRF. Engine throttling allows a rocket to decrease thrust when it passes through its maximum dynamic pressure, which helps reduce stress on the rocket's structure and increases the probability that the rocket will make it to orbit intact. Engine reignition allows a rocket to take a more energy efficient trajectory into orbit. For example, a liquid-fueled engine can produce a trajectory out of Earth's atmosphere, cut thrust, coast for several minutes, and then reignite at apogee to circularize the orbit where it is most efficient. Conversely, SRF has one distinct advantage for missile applications. SRF stores well inside of rockets, which means that engineers can load SRF into a missile upon fabrication, instead of having to load liquid fuel before launch. In other words, SRF improves a missile's launch time, which increases adaptability for military applications. Nevertheless, SRF engines are significantly less complicated and cheaper than liquid-fueled engines, and could help explain why CSTP selected to test SRF. Ibeh, "Nigeria's CSTP Completes Three Successful Experimental Rocket Launches."

²⁷¹ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 162; and "Nigerian Defence Academy Partners Defence Space Agency in Defence Space Management," Defence Headquarters Nigeria, March 16, 2016, <https://defenceinfo.mil.ng/nigerian-defence-academy-partners-defence-space-agency-in-defence-space-management/>.

²⁷² Titilola Oludimu, "Why We Know Next to Nothing About Nigeria's Space Programme," Techpoint Africa, November 28, 2018, <https://techpoint.africa/2018/11/28/cstp-centre-epe/>.

²⁷³ "Bird B, BTN, G, J, JPN, LKA, M, MYS, N, NPL, PHL," Gunter's Space Page, June 20, 2020, https://space.skyrocket.de/doc_sdat/bird.htm.

CubeSats in an international constellation called Birds-1, which included satellites from Japan, Nigeria, Ghana, Bangladesh, and Mongolia.²⁷⁴ *NigeriaEduSat-1* served three primary purposes. First, and most importantly, this CubeSat aimed to build space capacity in Nigeria's university system in order to inspire STEM education and create related socioeconomic development benefits.²⁷⁵ Part of this first objective included uploading popular music to *NigeriaEduSat-1* and transmitting the songs to radio operators.²⁷⁶ *NigeriaEduSat-1*'s second objective was to take images of Nigeria with a 5 megapixel imager and a 0.3 megapixel imager onboard.²⁷⁷ Finally, *NigeriaEduSat-1* measured atmospheric density in LEO as its orbit decayed from an initial altitude of approximately 400 kilometers.²⁷⁸

Overall, since 2011, it is clear that Nigeria's space institutions and technology have increasingly supported explicit security objectives, even though there have not been any written policy updates. Specifically, the growing importance of security in Nigeria's space technology has taken two routes: dual-use satellite programs and military missile research. Nigeria's space program still includes development objectives, like STEM education in *NigeriaEduSat-1*, but the program now contains activities that advance both security and development objectives. Thus, over the last three decades, Nigeria's space program has shifted from a program that was primarily development-oriented, to one that incorporates both security and development institutions and technology in approximately equal measure.

²⁷⁴ Oluwaseun Akingboye, "FUTA Launches Satellite into U.S. Space," *The Guardian Nigeria*, June 2, 2017, <https://m.guardian.ng/technology/futa-launches-satellite-into-u-s-space/>; and Gunter's Space Page, "Bird B, BTN, G, J, JPN, LKA, M, MYS, N, NPL, PHL."

²⁷⁵ "FUTA Sets Nigerian Record, to Launch Nigeria's First Nanosatellite," *Space in Africa*, January 25, 2018, <https://africanews.space/futa-sets-nigerian-record-to-launch-nigerias-first-nanosatellite/>; and Akingboye, "FUTA Launches Satellite into U.S. Space."

²⁷⁶ Oluwaseun Akingboye, "Edusat-1 Satellite Goes into Orbit Today," *The Guardian Nigeria*, July 7, 2017, <https://t.guardian.ng/technology/edusat-1-satellite-goes-into-orbit-today/>.

²⁷⁷ For comparison, the iPhone 11 has two 12 megapixel cameras, which suggests that the two imagers on *NigeriaEduSat-1* could only resolve extremely large geographic features. Akingboye; and "iPhone 11 - Technical Specifications," Apple, accessed October 15, 2020, <https://www.apple.com/iphone-11/specs/>.

²⁷⁸ Akingboye, "Edusat-1 Satellite Goes into Orbit Today."

C. EXAMINING THE HYPOTHESES

The remainder of this chapter analyzes why the Nigerian government initially established a space program that was focused on development in the 1990s, before incorporating security objectives in the 2010s. Following the approach laid out in Chapter I and applied to South Africa in Chapter II, I explore four possible answers to this question: foreign influence, political priorities, bureaucratic interests, and economic capacity. The evidence in this section demonstrates that only political priorities have had a clear influence on the trajectory of Nigeria's space program.

1. Foreign Security and Development Partnerships

The foreign security and development partnerships hypothesis seeks to determine if foreign partnerships influenced the trajectory of Nigeria's space program from a development-focused space program initially to one that balanced between development and security after 2010. Specifically, if Nigeria relied on international space partners for either technology transfer or launch capacity there may have been opportunities for foreign influence. These opportunities would be especially strong in the foundational years of Nigeria's space program, when there was limited institutional inertia but a high degree of dependency on foreign space technology.

Early in Nigeria's space history, government officials repeatedly solicited foreign partners for help in developing the country's space program. Nigeria's military government, for example, expressed interest in receiving technical foreign assistance after establishing its first space institution, NCRS, in 1988.²⁷⁹ Later, in 2000, Nigeria's Vice President Abubakar publicly requested launch support and technical assistance from more advanced space countries, just one year after the Nigerian government established NASRDA, citing the Nigerian-United Kingdom partnership on *NigeriaSat-1* as a positive

²⁷⁹ "Nigeria to Build Remote-Sensing System Plant," *Xinhua General Overseas News*, September 19, 1988, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=73363845-5e37-43d4-840e-824335380cc8&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A3SJB-3M70-000W-B43C-00000-00&pdcontentcomponentid=8078&pdteaserkey=sr2&pditab=allpods&ecomp=cxz2k&earg=sr2&prid=0b86dd7d-0e76-4c5f-8fed-095775b7db40>.

collaboration.²⁸⁰ Furthermore, the Director of NASRDA, Professor Boroffice, told Russian representatives in 2001 that implementing the National Space Policy with a focus on socioeconomic development would require international support.²⁸¹ Thus, it is clear that domestic leaders were actively *requesting* foreign support in the initial years of Nigeria's space program. These requests demonstrate that Nigerian leaders first formulated national space objectives or institutions before soliciting foreign assistance to help realize their objectives, rather than foreign partners *pushing* specific objectives onto Nigeria's space program. It remains possible, however, that Nigerian leaders designed the space program with the requirement for foreign support in mind, favoring objectives that would attract international assistance.

For their part, international space partners answered Nigeria's requests by providing support in terms of both space access and technology development for every Nigerian space project to date. For satellite technology, Nigeria has relied on three foreign partners to varying extents to produce every Nigerian satellite and educate Nigerian engineers on satellite development. Specifically, SSTL helped to build *NigeriaSat-1*, *NigeriaSat-2*, and *NigeriaSat-X*; CGWIC developed *NigComSat-1* and *NigComSat-1R*; and Japan's Kyushu Institute of Technology helped manufacture *NigeriaEduSat-1*. Similarly, just three foreign partners have been responsible for launching all of Nigeria's satellites. Russia launched Nigeria's first three imagery satellites, *NigeriaSat-1*, *NigeriaSat-2*, and *NigeriaSat-X*; China placed both communications satellites, *NigComSat-1* and *NigComSat-1R*, into GEO; and SpaceX, a U.S. commercial launch

²⁸⁰ Osborne Adi Jr., "Nigeria: Atiku Wants Greater Co-Operation on Transfer of Expertise," *Africa News*, October 8, 2000, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=f600eee6-30e3-4b48-ab53-dbf49f44d8de&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A41CG-YT00-0040-T484-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr0&pdtab=allpods&ecomp=czx2k&earg=sr0&prid=e26326c5-a7e8-4c12-8a51-66ca6826ac2d>.

²⁸¹ "Nigeria: Why Nigeria Needs Space Technology, by Minister," *Africa News*, June 27, 2001, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=75c9d6a0-87a0-4cee-9a2d-5f641d47e395&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A43CC-C4J0-0040-T0YK-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr2&pdtab=allpods&ecomp=czx2k&earg=sr2&prid=0d355ee1-9859-4000-951c-f9380d8a2151>.

company, launched *NigeriaEduSat-1*. Foreign partners have even assisted Nigeria's domestic launch capacity building efforts, with ten Nigerian engineers receiving rocketry training at the Russian Center in Science of Rocketry, while another six Nigerians attended the University of Alabama to obtain degrees related to rocketry.²⁸² Put simply, foreign partners have been involved, at least in a technical sense, in every Nigerian space achievement since the space program started in the 1990s.

Notably, by the late 2000s, Nigeria's growing space capacity meant that it relied less on foreign partners. Nigerian engineers primarily constructed *NigeriaSat-X*, thereby demonstrating Nigeria's increasing space capacity in the late 2000s, although the Nigerian engineers still utilized support from SSTL facilities and engineers.²⁸³ Nigeria's reduced reliance on foreign technology transfer provided foreign partners with fewer opportunities to influence Nigeria's space program.

Despite extensive foreign involvement, evidence from the Nigerian-United Kingdom space partnership does not reveal support for this hypothesis. The United Kingdom has been one of Nigeria's strongest space partners, starting with *NigeriaSat-1* in 2003. Even in this inaugural satellite partnership, however, Nigerian government officials included a ground control station in the contract with SSTL, which allowed Nigeria to directly control the satellite in orbit and to participate in the DMC as an equal international partner with the other constellation member countries.²⁸⁴ Following the success of *NigeriaSat-1*, the British government tried to incentivize future Nigerian contracts with SSTL. Specifically, British government officials approved a grant to SSTL, worth about

²⁸² "Sixteen Nigerian Engineers to Undergo Space Rocket Training Abroad," *Xinhua General News Service*, November 15, 2008, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=18a15c57-b8ff-43b5-ae83-26a13e7f3377&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A4TXV-B7V0-TWMB-300R-00000-00&pdcontentcomponentid=8078&pdteaserkey=sr9&pditab=allpods&ecomp=czx2k&earg=sr9&prid=42dc56a7-58a6-4600-8432-104586795479>.

²⁸³ Earth Online, "NigeriaSat-X."

²⁸⁴ "Surrey's DMC Satellites Reach Targeted Orbit Station," *Space War*, March 31, 2004, https://www.spacewar.com/reports/Surreys_DMC_Satellites_Reach_Targeted_Orbit_Station.html; and "NASRDA Gets Satellite Image Processing Capability," *Geospatial World*, March 30, 2012, <https://www.geospatialworld.net/news/nasdra-gets-satellite-image-processing-capability/>.

\$6.8 million, to help Nigeria build *NigComSat-1* in 2003.²⁸⁵ In effect, the grant would have acted as a subsidy to the Nigerian space program, allowing SSTL to offer a lower price to build *NigComSat-1*. In 2005, however, NASRDA solicited bids for *NigComSat-1* from 21 international satellite manufacturers, and the United Kingdom did not win the contract.²⁸⁶ The grant was simply not successful in influencing NASRDA to select SSTL as its partner for communications satellites. Regardless of the *NigComSat-1* contract, NASRDA and SSTL once again partnered to develop *NigeriaSat-2* and *NigeriaSat-X*. Shortly before both satellites launched in 2011, NASRDA signed a memorandum of understanding with the British company DMC International Imaging Limited to market and sell images taken from the satellites.²⁸⁷ This agreement suggests that Nigeria fully controlled the operation of both satellites, as well as the international rights to the satellites' images. Moreover, Seidu Mohammed, the director of NASRDA, explicitly clarified in a 2013 interview that Nigeria's space program had not accepted any money from the United Kingdom, removing any doubts of British foreign influence in Nigeria's space program.²⁸⁸

The extent of China's influence on the trajectory of Nigeria's space policy is less clear. Starting in the early 2000s, China began to drastically expand its economic relations

²⁸⁵ "Nigeria: Britain Donates to Nigeria's Satellite Project," *All Africa*, October 25, 2003, <https://allafrica.com/stories/200310260043.html>; and "USD NGN Historical Data," Investing, accessed January 5, 2021, <https://www.investing.com/currencies/usd-ngn-historical-data>.

²⁸⁶ Margaret Egbula and Qi Zheng, "China and Nigeria: A Powerful South-South Alliance," *West African Challenges*, no. 5 (November 2011): 13.

²⁸⁷ "Nigeria: UK Firm to Market Nigeria's Satellite Worldwide," *Africa News*, February 14, 2011, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=ad62e88d-00bb-48b1-a7d5-de406a6b47c7&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A525Y-RMN1-JC86-C0VS-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr31&pditab=allpods&ecomp=czx2k&earg=sr31&prid=b5a042c7-0b62-434d-9855-b1dfa1750c5c>.

²⁸⁸ "Nigeria: 'The Country Will Have Astronauts by 2015,'" *Africa News*, August 19, 2013, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=6cc13e48-d746-48e9-920a-f6c7eaa427a2&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A5959-W851-DYR8-33K5-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr2&pditab=allpods&ecomp=czx2k&earg=sr2&prid=cbc4ee43-9f8c-4f14-8bdc-e3c47e883be8>.

with Nigeria.²⁸⁹ In the space sector specifically, China's growing involvement in Nigeria fostered an enduring partnership that centered on communications satellites. In 2005, China's Exim Bank supplied a \$200 million loan to Nigeria for the construction and launch of *NigComSat-1*, while the Nigerian government provided the remaining \$51 million.²⁹⁰ Simultaneously, NASRDA also awarded the *NigComSat-1* contract to CGWIC.²⁹¹ Just one year later, in 2006, China and Nigeria signed a strategic partnership agreement which highlighted the telecommunications sector as an area of interest for Chinese investment, among other sectors.²⁹² While the next hypothesis shows that space-based communications were an important part of a domestic political program to spur socioeconomic development, China's \$200 million loan and strategic partnership agreement suggest that Nigeria's space-based communications were also important to Chinese foreign policy in Nigeria. In fact, *NigComSat-1* was "an important milestone for China, the first time it had designed, built and launched a satellite for another country."²⁹³ Although Nigeria's broader economic agenda suggested a Nigerian interest in communications satellite technology irrespective of Chinese financing, it is possible that the Nigerian space program might have required China's sizeable loan to execute its communications objectives. In other words, Chinese financing may have allowed the Nigerian space program to pursue *NigComSat-1*, but it is unlikely that China provided the initial motivation for the satellite.

After *NigComSat-1* failed in orbit in 2008, China remained involved in the communications sector of Nigeria's space program. A technical error caused *NigComSat-1* to fail just one year into its 15-year expected lifespan, which undermined China's efforts to establish an international reputation of reliability in satellite manufacturing.²⁹⁴ It is thus

²⁸⁹ Egbula and Zheng, "China and Nigeria: A Powerful South-South Alliance," 4.

²⁹⁰ Egbula and Zheng, 13.

²⁹¹ Egbula and Zheng, 13.

²⁹² Egbula and Zheng, 4.

²⁹³ Egbula and Zheng, 13–14.

²⁹⁴ Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R."

unsurprising that CGWIC used an insurance policy to cover the costs of building and launching *NigComSat-1R*.²⁹⁵ From this perspective, it is apparent that China's involvement in *NigComSat-1R* was primarily focused on the international reputation of the Chinese aerospace industry. Still, Barbosa indicates that Nigeria's continued space partnership with China was not a foregone conclusion when he writes "China Aerospace Science and Technology Corporation...reached a decision to build and launch NIGCOMSAT-1R with no extra cost."²⁹⁶ It is possible that China offered insurance funding as an incentive for NASRDA to continue pursuing satellite communications with CGWIC, thereby allowing the Chinese aerospace industry to redeem itself.

Then, in 2018, Chinese investment allowed Nigeria to continue pursuing satellite communications. In 2017, Minister of Communications Shittu approached the Nigerian Senate with a request for two new communications satellites, citing the need for backup satellites to the aging *NigComSat-1R* in order to build confidence in the reliability of Nigeria's satellite communications.²⁹⁷ Shittu argued that a \$550 million loan would make both satellites affordable, but this high cost sparked a debate about the merits of purchasing redundant communications satellites during a recession.²⁹⁸ Once again, China's Exim Bank provided financing to make both satellites feasible for Nigeria, this time purchasing almost a 50% equity stake in NIGCOMSAT for the price of \$550 million in 2018.²⁹⁹ In this sense, Chinese investment made it *possible* for Nigeria's space program to continue advancing communications applications, since it seems unlikely that the Senate would have

²⁹⁵ Julie Michelle Klinger, "China, Africa, and the Rest: Recent Trends in Space Science, Technology, and Satellite Development" (working paper, China Africa Research Initiative, 2020), 13, <https://static1.squarespace.com/static/5652847de4b033f56d2bdc29/t/5ecdb4ab6dad0e25fa0feb06/1590539437793/WP+38+-+Klinger+-+China+Africa+Space+Satellites.pdf>; and Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R."

²⁹⁶ Barbosa, "Chinese Long March 3B/E Launches NigComSat-1R."

²⁹⁷ Prince Osuagwu et al., "Space Tech: Future of Nigeria's Economy?," *Vanguard News*, August 30, 2017, <https://www.vanguardngr.com/2017/08/space-tech-future-nigerias-economy/>.

²⁹⁸ Osuagwu et al.

²⁹⁹ Tyler Way, "Challenges and Opportunities of Nigeria's Space Program," *Aerospace Security*, June 24, 2020, <https://aerospace.csis.org/challenges-and-opportunities-of-nigerias-space-program/>; and "Nigeria Agrees \$550 Million Satellite Deal with China," *Reuters*, January 3, 2018, <https://www.reuters.com/article/us-nigeria-satellite-china-idUSKBN1ES1G0>.

approved another large satellite loan. Still, Shittu approached the Nigerian government with his proposal before initiating negotiations with China's Exim Bank, which suggests that Chinese influence did not provide the original motivation for the acquisition of two more communications satellites.³⁰⁰ Notably, China's equity stake in NIGCOMSAT will likely increase Chinese influence in Nigeria's space program as the deal progresses, since equity ownership transforms China's role from external partner and financier to active internal participant. In total, the extent of China's influence on Nigeria's space program is unclear. It is likely that Chinese financing has repeatedly allowed Nigeria's space program to both establish and develop its communications objectives. In this sense, China has probably shaped the trajectory of Nigeria's space program; however, the available evidence also suggests that Nigeria's domestic actors provided the impetus to strive for space-based communications in the first place. Put simply, China likely provided the financial engine that Nigeria needed to develop satellite communications.

Although British and Chinese involvement did not fundamentally drive Nigeria's space policy, Nigeria's relationship with the U.S. at least partially illustrates why Nigeria's space program shifted to include both security and development objectives in the 2010s. Throughout the 2010s a new security threat emerged in Nigeria and the surrounding region. Two Salafist terrorist groups, Boko Haram and ISWAP, quickly grew in 2009 and 2015 respectively.³⁰¹ Although these terrorist organizations were not the only security threats in Nigeria, they have captured international attention over the last decade, resulting in significant foreign security assistance to Nigeria's neighboring countries.³⁰² Consequently, there has been international pressure on Nigeria, and the surrounding countries to contain these two groups. During the rise in terrorist activity in Nigeria, concerns over human rights abuses in the Nigerian military impeded U.S. security

³⁰⁰ Osuagwu et al., "Space Tech: Future of Nigeria's Economy?"; and Oyewole, "The Nigerian Space Conundrum: On 20 Years of Space Exploration in Nigeria."

³⁰¹ Tomas F. Husted and Lauren Ploch Blanchard, *Nigeria: Current Issues and U.S. Policy*, CRS Report No. RL33964 (Washington, DC: Congressional Research Service, 2020), 5–6, <https://fas.org/sgp/crs/row/RL33964.pdf>.

³⁰² Husted and Blanchard, 6–7.

assistance to Nigeria, which remained extremely low in the early 2010s despite the U.S. focus on combatting terrorism in the region.³⁰³ After the Nigerian public elected President Buhari in 2015, however, the Buhari administration instituted a series of reforms to address human rights abuses in the military, reduce corruption, and improve Nigeria's counterinsurgency efforts.³⁰⁴

A rare act of U.S. security assistance to Nigeria prior to 2015 possibly motivated the Nigerian government to use space applications to assist counterinsurgency efforts. When the U.S. provided satellite imagery to the Nigerian government to help locate 200 kidnapped schoolgirls in May of 2014, several Nigerian space critics began to publicly question why Nigeria's space program could not have provided these images itself.³⁰⁵ Just five months later, the Nigerian government established DSA, which represented an explicit push for applying Nigeria's existing space technology towards security objectives.³⁰⁶ Considering that the National Space Policy had recommended creating a Defence Space Command since 2001, the embarrassment of needing foreign satellite imagery helps to explain DSA's timing. In the following years, Nigeria's space program played an important role in improving Nigeria's counterinsurgency efforts and professionalizing the military under Buhari's reforms. For example, the 2016 partnership between the Nigerian Air Force, DSA, and CSTP facilitated the development of guided bombs and missiles that the Nigerian military used to fight Boko Haram.³⁰⁷ Additionally, the Nigerian military relied on satellite communications as Boko Haram tried to destroy telecommunication

³⁰³ Husted and Blanchard, 18.

³⁰⁴ Husted and Blanchard, 4.

³⁰⁵ "ICT and Telecom: Insurgency Beclouds Nigeria's Space Technology," *Africa News*, May 14, 2014, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=6ff9ec30-2f30-4156-b31a-25abe7df7f16&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A5C6X-0G21-DYR8-314N-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr6&pditab=allpods&ecomp=czx2k&earg=sr6&prid=383d7e1f-214d-4895-a97d-f078cbe2f0d4>.

³⁰⁶ Defence Space Administration, "History of DSA."

³⁰⁷ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 162.

infrastructure around Lake Chad.³⁰⁸ Finally, NASRDA and NIGCOMSAT continually train Nigerian service members on the military applications of satellite technology to assist the fight against Boko Haram.³⁰⁹ Thus, it is possible that U.S. security assistance indirectly triggered a chain of security objectives in Nigeria's space program by creating domestic controversy.

Overall, there is only weak support for the foreign partnerships hypothesis in Nigeria. The Nigerian government explicitly requested foreign assistance in its space program's foundational years and every project has relied on both foreign technology transfer and launch capacity to varying extents, which indicates that there were ample opportunities for foreign influence. Despite these opportunities, however, evidence of foreign space partnerships reveals that foreign partners only weakly influenced the direction of the space program. Critically, Nigerian domestic space actors likely provided the initial motivation for cornerstone space policy decisions, even if foreign partners made achieving space objectives possible. Support for this hypothesis moves from "no support" to "weak" simply because it is possible, but not certain, that space security assistance from the U.S. indirectly spurred Nigerian politicians and bureaucrats to develop space institutions and technology that better supported domestic security objectives. Still, even if there was clear evidence to affirm the U.S. security assistance example, it would not explain Nigeria's push for development in the 1990s and 2000s, or the slow acceptance of potential security applications in the early 2010s.

2. Domestic Political Prioritization

The main prediction of the domestic political prioritization hypothesis is that Nigeria's broad domestic political priorities from the 1990s to the 2010s initially directed Nigeria's space program toward development, before shifting to include security-focused objectives in the 2010s. Analysis of this hypothesis is divided into two parts. First, this section explores Nigeria's recent political history to understand how well it aligned with

³⁰⁸ Oyewole, 162.

³⁰⁹ Ibeh, "Nigerian Military Partners with NASRDA to Fight Boko Haram Insurgency."

the space program's trajectory. Second, I examine evidence of corruption and clientelism in Nigeria's space program to determine if Nigerian politicians used the space program to advance private political goals.

From 1984 to 1999, Nigeria was ruled by three military regimes that attempted to reform, with limited success, a struggling Nigerian economy stressed by a global economic recession and widespread corruption.³¹⁰ Muhammadu Buhari, the first military leader in this period of Nigeria's history who held power from 1984 to 1985, tried to advance Nigeria's economy by instilling "discipline"—referring to reform efforts like the War Against Indiscipline that aimed to end corruption—in order to support continued economic austerity measures and attract foreign investment.³¹¹ General Ibrahim Babangida overthrew Buhari in 1985 after it became clear that Buhari's discipline reforms did not properly address Nigeria's structural economic challenges.³¹² In 1986, Babangida launched a structural adjustment program (SAP) in Nigeria, which rejected International Monetary Fund financial support, but still contained a series of economic reforms like budget restrictions, privatization, and trade liberalization.³¹³ Nigeria's SAP produced mixed economic results; debt rescheduling and agricultural production growth benefited Nigeria's economy, while inflation, unemployment, and declining real income all created economic hardship.³¹⁴ Babangida also tried to transition to a civilian democracy in response to civil societal pressure, but Babangida invalidated the 1993 election results, and Nigeria instead continued with military rule until 1999.³¹⁵ General Sani Abacha, Nigeria's third military leader after the failed democratic transition in 1993, focused generally on consolidating his personal power and reversing economic policies in an attempt to create

³¹⁰ Falola and Heaton, *A History of Nigeria*, 209.

³¹¹ Falola and Heaton, 212–14.

³¹² Falola and Heaton, 216; and Peter Lewis, *Growing Apart: Oil, Politics, and Economic Change in Indonesia and Nigeria* (Ann Arbor, MI: University of Michigan Press, 2007), 161–62.

³¹³ Lewis, *Growing Apart*, 162.

³¹⁴ Falola and Heaton, *A History of Nigeria*, 218–20; and Lewis, *Growing Apart*, 163–64.

³¹⁵ Falola and Heaton, *A History of Nigeria*, 209, 211, 227.

growth.³¹⁶ Specifically, Abacha undermined existing political institutions, imprisoned political opponents, and oscillated between removing and reinstituting many SAP reforms, which produced economic stagnation.³¹⁷

During this period of military rule, Nigeria's space activity was limited to establishing and implementing plans for NCRS in 1988 and 1995, respectively. Although limited, NCRS's mission—using remote sensing technology to assist the development and management of Nigeria's natural resources like oil—fully supported the economic focus of Nigeria's military leaders who were extremely reliant on revenue and personal rents derived from Nigeria's oil sector.³¹⁸ Furthermore, Babangida's second-in-command personally discussed Nigeria's development-focused space ambitions with the United Nations in 1987, just one year before the government approved NCRS, which indicates that the early space program's objectives were, at least to some extent, advanced from the highest levels of government.³¹⁹

A democratic election in 1999 made Olusegun Obasanjo, a former military head of state who transitioned to civilian politics, Nigeria's first president in the Fourth Republic.³²⁰ Like the military dictators before him, Obasanjo focused primarily on economic reform, but his programs were more successful in arresting Nigeria's economic freefall over the next eight years.³²¹ Specifically, Obasanjo's economic policies included

³¹⁶ Falola and Heaton, 230; and Lewis, *Growing Apart*, 175.

³¹⁷ Falola and Heaton, *A History of Nigeria*, 230; and Lewis, *Growing Apart*, 175–79.

³¹⁸ Oyewole, “The Nigerian Space Conundrum: On 20 Years of Space Exploration in Nigeria”; and Peter M. Lewis, “Nigeria's Petroleum Booms: A Changing Political Economy,” in *The Oxford Handbook of Nigerian Politics*, ed. Carl Levan and Patrick Ukata (Oxford, United Kingdom: Oxford University Press, 2018), 502–3, 510–12, <https://doi.org/10.1093/oxfordhb/9780198804307.013.32>.

³¹⁹ “UN Experts Meeting on Space Science and Technology Opens in Nigeria,” *Xinhua General Overseas News*, April 27, 1987, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=a1c7ad97-78a3-44f7-9388-ab1da0b24ce5&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A3SJB-2W50-000W-B094-00000-00&pdcontentcomponentid=8078&pdteaserkey=sr7&pditab=allpods&ecomp=czx2k&earg=sr7&prid=4f080f6b-31b5-4885-8a2c-0e143ab3f1cd>.

³²⁰ Falola and Heaton, *A History of Nigeria*, 209, 235.

³²¹ Falola and Heaton, 235–36, 242.

an anti-corruption campaign, debt restructuring, attracting foreign investments, and supporting Nigerian industry with an emphasis on telecommunications.³²² Given the previous 15 years of economic challenges, it is not surprising that Obasanjo's primary objective was improving socioeconomic development.

Obasanjo also focused on reducing the Nigerian military's political power and instituting military reforms geared toward reducing the risk of another coup. For example, Obasanjo "retired all military officer [s] that had held political appointments in the country between 1984 and 1999...[and] brought to trial some top military officers."³²³ Additionally, Nigeria's new democratic constitution, enacted in 1999, explicitly subjugated the military to the power of civilian political leaders.³²⁴ Finally, Obasanjo hired a U.S. contractor to guide Nigeria's military reforms, despite strong resistance from military leaders.³²⁵ Notably, Obasanjo's military reform efforts did not include prioritizing the Nigerian military's training or equipment, which continued to be outdated and poorly maintained.³²⁶ This evidence illustrates that Obasanjo's security priorities entirely focused on establishing civilian control over military forces, rather than appeasing possible military political opponents. Overall, the transition to democratic rule under Obasanjo broadly prioritized socioeconomic development, with significant efforts to reduce military power.

High-level politicians in the Obasanjo administration primarily pushed Nigeria's space program to adopt development-focused objectives through NASRDA, the National Space Policy, *NigeriaSat-1*, and *NigComSat-1*. For example, when Vice President Atiku Abubakar requested foreign support for NASRDA in 2000, he argued that developing

³²² Lewis, *Growing Apart*, 245; and Falola and Heaton, *A History of Nigeria*, 235–36, 242.

³²³ Osabiya Babatunde, "Democratization and the Military in Nigeria: A Case for an Enduring Civil-Military Relations in the Fourth Republic and Beyond," *Review of Public Administration and Management* 3, no. 1 (2015): 4, <https://doi.org/10.4172/2315-7844.1000155>.

³²⁴ Babatunde, 4.

³²⁵ Max Siollun, "Civil Military Affairs and Military Culture in Post-Transition Nigeria," in *The Oxford Handbook of Nigerian Politics*, ed. Carl Levan and Patrick Ukata (Oxford, United Kingdom: Oxford University Press, 2018), 274–75, <https://doi.org/10.1093/oxfordhb/9780198804307.013.13>.

³²⁶ Siollun, 275.

countries like Nigeria could not obtain sustainable development without access to space technology.³²⁷ Similarly, Obasanjo illuminated the National Space Policy by commenting that space technology would support his development objectives by helping to exploit Nigeria's natural resources and improve telecommunications infrastructure.³²⁸ *NigeriaSat-1*, whose launch Obasanjo personally observed, began to fulfill the objective of exploiting natural resources by using remote sensing to monitor agriculture, water, and oil pipelines.³²⁹ Furthermore, the director of NASRDA, Robert Boroffice, revealed in 2004 that Obasanjo instructed NASRDA to deliver a fully operational *NigComSat-1* to orbit by 2006 to support sustainable development with "a broad array of communication needs in the areas of telephony, broadcasting, broadband and Internet services."³³⁰ These comments provide clear evidence that Obasanjo and other high-level politicians were directly involved in guiding the space program to meet development goals between 1999 and 2007.

President Obasanjo picked Umaru Yar'Adua to succeed him as the leader of the People's Democratic Party, and, after winning the 2007 elections, Yar'Adua became the

³²⁷ Adi Jr., "Nigeria: Atiku Wants Greater Co-Operation on Transfer of Expertise."

³²⁸ "Nigerian President Clarifies Space Technology Policy," *Xinhua General News Service*, August 1, 2001, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=6dbeb69e-2b63-4f9a-89c6-d4d67de2e416&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A43MY-72N0-00RC-90XG-00000-00&pdcontentcomponentid=8078&pdteaserkey=sr11&pdtab=allpods&ecomp=czx2k&earg=sr11&prid=0e60eb47-17b2-4a86-a40c-1bb26e5fd79f>.

³²⁹ "Nigeria: Country's First Earth Satellite for Launch Sept 26," *Africa News*, September 16, 2003, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=fad53e68-7262-4e8a-8be0-02c1768e8708&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A49JH-S2X0-0040-T522-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr6&pdtab=allpods&ecomp=czx2k&earg=sr6&prid=3795699b-5f27-43a2-a2cc-6e9506afaf95>.

³³⁰ "Nigeria: Country to Launch NigeriaSat-2 in 2007," *Africa News*, September 10, 2004, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=c246556b-d8e0-4ede-ad80-1bef34244220&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A4D92-VHX0-0040-T1NG-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr17&pdtab=allpods&ecomp=czx2k&earg=sr17&prid=9d9fedcf-3fb8-41ec-b6ec-a804e4e75529>.

Fourth Republic's second president until his death in 2010.³³¹ Yar'Adua's poor health, in combination with internal competition for power in the People's Democratic Party, generally impeded his ability to effectively enact policies.³³² Upon winning the election in 2007, however, Yar'Adua described his administration's objectives in a seven-point agenda.³³³ Yar'Adua's agenda established seven goals—energy infrastructure, agricultural production, economic diversification, transportation infrastructure, property rights, Niger Delta security, and education—for his administration to focus on in order to advance Nigeria's socioeconomic development.³³⁴ In this sense, Yar'Adua broadly favored development objectives, while also recognizing the economic value of Nigerian security.

Given Yar'Adua's relatively short presidency, his administration's space accomplishments were limited primarily to applying *NigComSat-1* towards new political priorities in the seven-point agenda. *NigComSat-1* was particularly useful in supporting economic diversification until it failed in orbit in 2008. After the Obasanjo administration oversaw the launch of *NigComSat-1*, Yar'Adua received the satellite from China once CGWIC delivered it to GEO, commenting that “this [*NigComSat-1*] will in turn create a visible multiplier effect on other sectors of the economy.”³³⁵ Beyond the spillover effects that Yar'Adua highlighted, *NigComSat-1* itself created economic diversification by

³³¹ John Campbell, *Nigeria: Dancing on the Brink* (Lanham, MD: Rowman & Littlefield Publishers, 2013), 117.

³³² Adigun Agbaje, Adeolu Akande, and Jide Ojo, “The People's Democratic Party: From the 1999 Transition to the 2015 Turnover,” in *The Oxford Handbook of Nigerian Politics*, ed. Carl Levan and Patrick Ukata (Oxford, United Kingdom: Oxford University Press, 2018), 356–57, <https://doi.org/10.1093/oxfordhb/9780198804307.013.18>.

³³³ Leke Oke, C. O. Oluwasuji, and O. O. Simon-Oke, “Millennium Development Goals (MDGs) and the Yar'Adua's Seven Point Agenda in Nigeria: Prospects and Challenges,” *African Research Review* 5, no. 1 (March 2011): 59, <https://doi.org/10.4314/afrev.v5i1.64509>.

³³⁴ Oke, Oluwasuji, and Simon-Oke, 62–64.

³³⁵ “Nigeria: ‘We’re Ready to Be Big Player in ICT’ - Yar'Adua,” *Africa News*, July 7, 2007, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=788b64eb-ea93-464d-a95c-bbe11c64b15f&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A4P53-Y580-TX2J-N225-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr42&pdtab=allpods&comp=czx2k&earg=sr42&prid=13dd9e0b-0136-4fd6-8fc5-d18ea4500960>.

providing a new revenue stream for the federal government. Shortly after launching, *NigComSat-1* attracted a series of bandwidth leasing agreements from companies in the U.S., Europe, Nigeria, China, Kenya, Rwanda, and one deal worth \$250 million from a Middle East-based company.³³⁶ Thus, it is clear that Yar'Adua considered the communications satellite as vehicle for economic diversification under his seven-point agenda, and the space program executed on making Yar'Adua's development objective a reality.

Yar'Adua's vice president, Goodluck Jonathan, became president after Yar'Adua died in 2010, holding the presidency until 2015.³³⁷ Much like his predecessors, President Jonathan largely favored socioeconomic policies, but a growth in regional terrorist activity caused Jonathan to also begin focusing on Nigeria's security challenges. The Transformation Agenda became Nigeria's cornerstone socioeconomic policy during the Jonathan presidency, aspiring to place Nigeria in the top 20 global economies by 2020 through an anti-corruption campaign, job creation, and diversified economic growth.³³⁸ In addition to the Transformation Agenda, however, Jonathan had to address the security challenges posed by Boko Haram, which had been expanding in northeast Nigeria since 2009.³³⁹ During his presidency, Jonathan took a series of initial, and largely unsuccessful steps to contain Boko Haram's expansion, which included granting Nigeria's military and State Security Service emergency powers, increasing security presence in northern Nigeria, improving security infrastructure, and advancing security-focused human capital.³⁴⁰

³³⁶ "Eutelsat, Globacom, Others Subscribe to NigComSat-1," *Balancing Act*, June 1, 2007, https://www.balancingact-africa.com/news/broadcast_en/10866/eutelsat-globacom-others-subscribe-to-nigcomsat-1; and As Wakama, "Nigeria to Launch Two New Space Satellites in Three Years," *IT News Africa*, May 12, 2007, <https://www.itnewsafrika.com/2007/05/nigeria-to-launch-two-new-space-satellites-in-three-years/>.

³³⁷ Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 2–4.

³³⁸ John Emmanuel Gyong, "A Social Analysis of the Transformation Agenda of President Goodluck Ebele Jonathan," *European Scientific Journal* 8, no. 16 (July 2012): 97–100, <https://doi.org/10.19044/esj.2012.v8n16p%25p>.

³³⁹ Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 5–6.

³⁴⁰ Campbell, *Nigeria: Dancing on the Brink*, 141; and Goodluck Ebele Jonathan, *2012 Budget Speech* (Abuja, Nigeria: Federal Government of Nigeria, 2011), 18, <https://www.budgetoffice.gov.ng/index.php/2012-budget?task=document.viewdoc&id=510>.

Aligning with his broader political objectives, Jonathan used *NigeriaSat-2*, *NigeriaSat-X*, *NigComSat-1R*, and the National Space Council to support his Transformation Agenda and national security efforts. When Russia launched *NigeriaSat-2* and *NigeriaSat-X* in 2011, Jonathan publicly offered congratulations to NASRDA and stated that “we will continue to emphasize investment in science and technology as a tool to drive the transformation agenda of this Administration.”³⁴¹ Just a few months later, *NigComSat-1R*’s launch prompted Jonathan to remark that the satellite would contribute to a range of applications to support the Transformation Agenda, like economic diversification and job creation, while also benefiting national security.³⁴² In fact, Jonathan was so invested in using space technology to advance his policies that he directed all government institutions to begin utilizing *NigComSat-1R* for communication.³⁴³ Finally, when Jonathan established the National Space Council in 2013, with himself as the chair, he explained that “given the critical place of space technology in national security, communication, industrialisation and sustained socio-economic development, the need to properly structure and drive the national space programme could not be over-emphasised.”³⁴⁴ In other words, the space program was a critical component of Jonathan’s broader political priorities.

Muhammadu Buhari, who served as the country’s military dictator from 1984 to 1985, won the 2015 presidential election by exploiting Jonathan’s failure to contain Boko

³⁴¹ “Nigeria: Remarks by President Jonathan on the Launching of NigeriaSat-2 and NigeriaSat-X,” *Africa News*, November 18, 2011, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=4ced7ef6-0a6a-46c0-9464-6350d06c4750&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A548V-P0F1-DYR8-3356-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr6&pdtab=allpods&ecomp=czx2k&earg=sr6&prid=ebe3ea18-5d84-4de5-ac46-d70719d73b27>.

³⁴² Osuagwu and Akinboade, “Nigeria: With NigComSat-1R Launch, Country Returns to Space.”

³⁴³ Laide Akinboade, “Jonathan Orders MDAs to Connect to NigComSat-1R,” *Vanguard News*, March 19, 2012, <https://www.vanguardngr.com/2012/03/jonathan-orders-mdas-to-connect-to-nigcomsat-1r/>.

³⁴⁴ “FG to Use Space Technology to Enhance National Development - Jonathan,” *Vanguard News*, June 12, 2013, <https://www.vanguardngr.com/2013/06/fg-to-use-space-technology-to-enhance-national-development-jonathan/>.

Haram's expansion in 2014 and promising to end corruption.³⁴⁵ As such, it is no surprise that the Buhari administration has increasingly prioritized Nigeria's security since 2015, committing additional resources toward counterterrorism operations against Boko Haram and assisting regional counterterrorism operations.³⁴⁶ More specifically, Buhari moved the military's headquarters closer to Boko Haram's operations in northern Nigeria and replaced the highest-ranking leaders in Nigeria's military and intelligence forces.³⁴⁷ Furthermore, much like his economic policies as a military head of state in the 1980s, it is clear that Buhari viewed corruption as Nigeria's primary economic challenge.³⁴⁸ To address this obstacle, Buhari focused on generating corruption convictions through the Economic and Financial Crimes Commission (EFCC) and recovering state resources that were stolen through corruption.³⁴⁹ In fact, between 2015 and 2018, the EFCC recovered \$1.4 billion and doubled "the rate of convictions secured by the EFCC under Jonathan."³⁵⁰ Overall, Buhari executed a significant shift to a security focus in 2015, while still enacting policies designed to address socioeconomic development obstacles.

Buhari primarily used Nigeria's space technology to help address national security challenges. For example, Buhari's efforts to professionalize the military have directly motivated funding for DSA since 2015.³⁵¹ More specifically, Buhari's administration used

³⁴⁵ Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 4.

³⁴⁶ Husted and Blanchard, 4.

³⁴⁷ Muhammadu Buhari, "Nigeria Committed to Good Governance and Fighting Terror," *Washington Post*, July 20, 2015, https://www.washingtonpost.com/opinions/nigeria-committed-to-good-governance-and-fighting-terror/2015/07/20/8c1acd00-2e21-11e5-8353-1215475949f4_story.html.

³⁴⁸ Adam Nossiter, "Nigerian President-Elect Muhammadu Buhari Sets Out His Agenda," *The New York Times*, April 1, 2015, <https://www.nytimes.com/2015/04/02/world/africa/nigerian-president-elect-muhammadu-buhari-sets-out-his-agenda.html>.

³⁴⁹ Charles E. Ekpo, Jide Chime, and Frank N. Enor, "The Irony of Nigeria's Fight Against Corruption: An Appraisal of President Muhammadu Buhari's First Eight Months in Office," *International Journal of History and Philosophical Research* 4, no. 1 (March 2016): 68.

³⁵⁰ John Campbell, "Nigeria Sees More High Level Corruption Convictions Under Buhari," Council on Foreign Relations, May 31, 2018, <https://www.cfr.org/blog/nigeria-sees-more-high-level-corruption-convictions-under-buhari>.

³⁵¹ Mohammad Abdulkadri, "Buhari Funds Defence Space Administration- Magashi," *PR Nigeria*, June 19, 2020, <https://prnigeria.com/2020/06/19/buhari-defence-space/>.

satellite imagery to monitor adversary forces throughout the country and began testing rockets for defense applications.³⁵² Finally, the chairman of the House Committee on Defence, Jimi Benson, illuminated the political importance of space technologies with security applications when he commented that the DSA's efforts helped to improve the military's effectiveness.³⁵³

The second aspect of this hypothesis is the use of state resources to accomplish private political goals. In Nigeria, this usually takes the form of clientelism or corruption, both of which are ubiquitous in Nigeria's institutions. For example, Transparency International, in its corruption perceptions index, ranked Nigeria 98th out of 99 countries—meaning Nigeria was the second most corrupt country—when Obasanjo became president in 1999, 147th of 180 when Yar'Adua took office in 2007, 143rd of 178 when Jonathan replaced Yar'Adua in 2010, and 136th of 198 when Buhari won the 2015 election.³⁵⁴ Although Nigeria's relative position on the index has slowly improved over two decades, Nigeria is continuously one of the most corrupt countries in the world. More importantly, Nigeria's corruption has persisted despite multiple anti-corruption campaigns and programs since 1975.³⁵⁵ In fact, every civilian president since 1999, with the exception of

³⁵² Levinus Nwabughio, "Buhari's Milestones in One Year - Presidency," *Vanguard News*, May 28, 2016, <https://www.vanguardngr.com/2016/05/buharis-milestones-in-one-year-presidency/>; and "Nigerian Army Exploring Use of Space Technology for Surveillance," *BBC Monitoring Africa*, February 9, 2017, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crid=bc8e061c-77ff-4be7-b50c-86be22f0bd2d&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A5MV4-3G01-JC8S-C0PV-00000-00&pdcontentcomponentid=10962&pdteaserkey=sr12&pditab=allpods&ecom=cx2k&earg=sr12&prid=fce477e7-b15e-4312-b650-62733fb8cccf>.

³⁵³ "Air Strikes Kill 30 Insurgents as NAF Launches Operation Rattle Snake in North-East," *This Day*, December 12, 2019, <https://www.thisdaylive.com/index.php/2019/12/12/air-strikes-kill-30-insurgents-as-naf-launches-operation-rattle-snake-in-north-east/>.

³⁵⁴ "Corruption Perceptions Index: 1999," Transparency International, accessed October 23, 2020, <https://www.transparency.org/en/cpi/1999>; "Corruption Perceptions Index: 2007," Transparency International, accessed October 23, 2020, <https://www.transparency.org/en/cpi/2007>; "Corruption Perceptions Index: 2010," Transparency International, accessed October 23, 2020, <https://www.transparency.org/en/cpi/2010>; and "Corruption Perceptions Index: 2015," Transparency International, accessed October 23, 2020, <https://www.transparency.org/en/cpi/2015/results>.

³⁵⁵ God'stime Osariyekemwen Igiebor, "Political Corruption in Nigeria: Implications for Economic Development in the Fourth Republic," *Journal of Developing Societies* 35, no. 4 (December 2019): 501–3, <https://doi.org/10.1177/0169796X19890745>.

Yar'Adua, has been accused of corruption despite implementing anti-corruption policies.³⁵⁶

It is possible that Nigeria's rampant political corruption and clientelism have spread to the space program. A review of NIGCOMSAT's financial records yielded several anomalies, which brought NIGCOMSAT's practices into question.³⁵⁷ The Nigerian government recently announced an investigation into NIGCOMSAT's activities since its inception in 2006 because of concerns over "alleged sleaze, misappropriation and non-profitability."³⁵⁸ In regards to corruption, the audit will investigate allegations of bribery and contract scams worth 8 billion naira.³⁵⁹ Beyond these allegations, however, direct evidence of corruption in Nigeria's space program does not presently exist. Notably, some of Nigeria's space institutions, like the National Space Council, implement anti-corruption policies that stop officials convicted of corruption from holding office; however, corruption convictions are historically uncommon, especially prior to the Buhari administration.³⁶⁰ It is likely that many corrupt officials do not face legal consequences for their corrupt practices. Thus, these anti-corruption policies are likely somewhat ineffective at preventing corruption in Nigeria's space program. While these examples provide some signs of potential corruption, there is not enough evidence to determine how extensively Nigeria's broad political corruption has infiltrated the space program. More importantly, the lack of evidence prevents an effective analysis of corruption's influence on the space program's security-development decisions.

³⁵⁶ Paul D. Ocheje, "Norms, Law and Social Change: Nigeria's Anti-Corruption Struggle, 1999–2017," *Crime, Law and Social Change* 70, no. 3 (October 2018): 366–68, <https://doi.org/10.1007/s10611-017-9736-9>; and Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 4.

³⁵⁷ "Reps Uncover Loopholes in NIGCOMSAT Accounts, Say Management Incompetent," Punch, February 18, 2020, <https://punchng.com/reps-uncover-loopholes-in-nigcomsat-accounts-say-management-incompetent/>.

³⁵⁸ "Nigeria Reps to Carry Out Forensic Audit on Nigcomsat," Space in Africa, June 3, 2020, <https://africanews.space/nigerian-reps-order-forensic-audit-on-nigcomsat/>.

³⁵⁹ In June, 2020, when the article was published, 8 billion naira was worth about \$22 million; however, it is unclear exactly when the alleged corruption occurred. Space in Africa; and Investing, "USD NGN Historical Data."

³⁶⁰ Federal Republic of Nigeria, "National Space Research and Development Agency Act, 2010," 1252; and Way, "Challenges and Opportunities of Nigeria's Space Program."

In summary, evidence of Nigeria's domestic political priorities strongly supports this hypothesis. The objectives, institutions, and technology of Nigeria's space program have consistently supported the government's broader domestic priorities. Since 1984, Nigeria's military regimes and democratic administrations have all focused primarily on economic reform and socioeconomic development, until the rise and expansion of Boko Haram after Yar'Adua's presidency. Increasing terrorist activity forced the government to include security objectives alongside development priorities in the 2010s. Nigeria's space history reveals that the space program's priorities almost perfectly matched this timeline. Furthermore, it is clear that political corruption and clientelism are common in Nigeria's government, and have possibly spread to the space program, but the extent and effects of this influence on the space program are less apparent. Regardless, the domestic political priorities hypothesis finds strong support in aggregate.

3. Bureaucratic Institutions

The central concept of this hypothesis is as follows: some domestic bureaucratic institutions are more powerful than others, and, in the process of implementing government policy, powerful institutions can guide the objectives of policies or programs to match institutional interests. Specifically, this section considers bureaucratic power and influence during the space program's formative and security transition years in the late 1990s and early 2010s, respectively. During these two periods, the space program's internal institutional inertia either did not exist, or was previously directed almost exclusively towards development objectives, suggesting that factors external to the space bureaucracy altered the security-development course.

Given the institutional-level dynamics that still strongly favored Nigeria's military during the period of democratic transition, this hypothesis predicts that the nascent space program would emerge with a security bias. Yet, in 1999, government officials established NASRDA with a near-complete focus on socioeconomic development. This inconsistency, however, may be at least partially explained by evidence of bureaucratic influence both during and after Nigeria's military regimes. Dible, for example, uses interviews with Nigerian officials to determine that the military's colonial legacy of inefficiency allowed a

powerful, yet corrupt Nigerian bureaucracy to shape policy even at the height of military political power in the 1990s.³⁶¹ Similarly, Omotoso illustrates how bureaucratic institutions have continued to mold policies by delaying implementation of a policy or issuing government circulars to directly change a policy.³⁶² Omotoso also shows that bureaucratic and personal interests have caused bureaucratic institutions to compete against one another for resources and influence.³⁶³ Thus, throughout Nigeria's space history, bureaucratic institutions have exerted a powerful influence over Nigeria's policy process in general. For this hypothesis to be supported, however, general bureaucratic interest and influence in public policy must also extend to the space sector more specifically.

Despite the strength of bureaucratic power in Nigeria's general policy process, several space milestones reveal that bureaucratic institutions typically implement existing space policy, rather than driving the policy-level trajectory of the space program. In 2001, the director of NASRDA, Robert Boroffice, disclosed that the Nigerian space program planned to closely implement the space policy guidelines that the Federal Executive Council—a political institution chaired by the Nigerian president—established through the National Space Policy.³⁶⁴ In implementing the political vision captured by the National Space Policy, bureaucrats occasionally suggested additional uses for specific space technology, but these expanded applications received political approval and continued

³⁶¹ Robert Aziakpono Dibie, "The Military-Bureaucracy Relationship in Nigeria: A Study of Public Policy Making and Implementation" (PhD diss., Western Michigan University, 1997), 258–59, <https://scholarworks.wmich.edu/cgi/viewcontent.cgi?article=2644&context=dissertations>.

³⁶² Femi Omotoso, "Bureaucratic Politics and the Policy Process in Nigeria," in *Public Policy and Development in Developing Nations: Selected Cases*, ed. Ola Abegunde (Bloomington, Indiana: Xlibris, 2015), 86–87, https://www.researchgate.net/profile/Jonathan_Maseng/publication/327700558_The_Complexities_of_Political_Participation_in_South_African_Public_Policy/links/5e39748792851c7f7f1b4978/The-Complexities-of-Political-Participation-in-South-African-Public-Policy.pdf#page=93.

³⁶³ Omotoso, 87–88.

³⁶⁴ "Nigeria: Tapping Space Technology for National Development," *Africa News*, September 14, 2001, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=8a6d2a17-18d2-421a-8b54-53169c05e40f&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A440B-9FN0-0040-T49B-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr2&pdtab=allpods&ecomp=cxz2k&earg=sr2&prid=ed8050f0-8fd9-43fb-94be-05a6815cbe35>.

supporting broader political priorities. After the launch of *NigComSat-1* in 2007, for example, Boroffice approached President Obasanjo for approval to pursue additional communications licenses through the Nigerian Communication Commission to fully exploit the satellite's capabilities.³⁶⁵ Similarly, after the launch of *NigeriaSat-2* and *NigeriaSat-X* in 2011, the director of NASRDA, Seidu Mohammed, offered detailed examples of how these two imagery satellites would help to meet the development goals under Jonathan's Transformation Agenda by 2020.³⁶⁶ Finally, both the director of NIGCOMSAT, Ahmed-Rufai, and Minister of Communications Omobola Johnson described a range of technology applications for *NigComSat-1R* that would directly support the Transformation Agenda after the satellite launched in 2011.³⁶⁷ These examples demonstrate that space bureaucrats publicly acknowledged the space program's politically-driven objectives, implemented technology applications that supported political agendas, and requested political approval to pursue additional functions. In other words, space bureaucrats generally stayed within the bounds of policy direction handed down by politicians.

Even in the following example, where it appears that NIGCOMSAT attempted to exert bureaucratic control of the communications component of the space program, the evidence demonstrates that politicians remained in control. In 2010, the Committee on Science and Technology in the Nigerian House of Representatives took notice of an

³⁶⁵ "Nigeria: NigComSat-1 Pushes Controversial Bid for Unified Access Licence," *Africa News*, June 11, 2007, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=c53b0d6a-354e-43d2-ab28-9a3433418e78&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A4NY5-M8R0-TX2J-N1SH-00000-00&pdcontentcomponentid=8320&pdteaserkey=sr0&pditab=allpods&ecomp=czx2k&earg=sr0&prid=d3b8c748-6193-4500-919a-cc93dc2ee78c>.

³⁶⁶ "Nigeria Launches Two Satellites from Russian Service Provider," *BBC Monitoring Africa*, August 17, 2011, <https://advance-lexis-com.libproxy.nps.edu/document/?pdmfid=1516831&crd=b53a9bcd-be1d-4a48-aa47-bddc7ca0af8b&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A53K0-GX31-DYRV-32KR-00000-00&pdcontentcomponentid=10962&pdteaserkey=sr29&pditab=allpods&ecomp=czx2k&earg=sr29&prid=9d9fd3ac-0655-4509-9445-8df519e213fe>.

³⁶⁷ Osuagwu and Akinboade, "Nigeria: With NigComSat-1R Launch, Country Returns to Space."

ongoing dispute between NIGCOMSAT and NASRDA, in which NIGCOMSAT argued that it was institutionally independent from NASRDA, rather than its subsidiary.³⁶⁸ The fighting peaked in 2011, when NIGCOMSAT stopped NASRDA engineers from accessing the command ground station for *NigComSat-1R* by erecting a physical barrier, even though NASRDA was supposed to take control of the satellite.³⁶⁹ By 2012, the Nigerian government moved responsibility for NIGCOMSAT from the Ministry of Science and Technology to the Ministry of Communications.³⁷⁰ The federal government's decision to transfer NIGCOMSAT to the Ministry of Communications in response to bureaucratic jockeying illustrated political control over the space program.

Once the Ministry of Communications became responsible for NIGCOMSAT, however, there were additional attempts to use bureaucratic interest to influence Nigeria's space program. In 2017, the Nigerian Senate rejected the Minister of Communications' demands for additional communications satellites, questioning if satellite acquisition was the best use of scarce government revenue to support socioeconomic development.³⁷¹ The Senate's concerns centered on budgetary constraints after a recession, considering that the satellites would require a \$550 million loan from China's Exim Bank.³⁷² Then, in 2018, the Minister of Communications, Alhaji Adebayo Shittu, sold almost half of NIGCOMSAT's equity, worth approximately \$550 million, to Chinese investors to purchase the two additional communications satellites.³⁷³ Although this action seemingly suggested that bureaucratic interest was able to overpower the Senate's concerns, Shittu actually addressed the financial concerns by renegotiating the satellites' contract so the

³⁶⁸ Onwuka Nzeshi, "Nigeria: House Wades into Nasdra, NIGCOMSAT Tussle," *All Africa*, July 8, 2010, <https://allafrica.com/stories/201007080678.html>.

³⁶⁹ Emma Uja, "Nigeria's Space Programme in Jeopardy," *All Africa*, November 10, 2012, sec. News, <https://allafrica.com/stories/201211100426.html>.

³⁷⁰ Uja.

³⁷¹ Oyewole, "The Nigerian Space Conundrum: On 20 Years of Space Exploration in Nigeria"; and Osuagwu et al., "Space Tech: Future of Nigeria's Economy?"

³⁷² Osuagwu et al., "Space Tech: Future of Nigeria's Economy?"

³⁷³ Way, "Challenges and Opportunities of Nigeria's Space Program"; and Oyewole, "The Nigerian Space Conundrum: On 20 Years of Space Exploration in Nigeria."

Nigerian government would not need to provide any funding, and Shittu received Buhari's approval before finalizing the contract.³⁷⁴ Shittu, a career politician himself, was driving the Ministry of Communications' bureaucratic interests, and he needed to ameliorate political concerns at multiple levels across the federal government before proceeding with the deal. Put simply, political priorities once again constrained bureaucratic interests.

In total, the existing evidence offers only weak support for the bureaucratic institutions hypothesis. Broadly, Nigeria's bureaucratic institutions have historically been influential in guiding policy. Furthermore, there has been extensive bureaucratic interest in the space program since at least the 2000s. Despite this interest, however, multiple examples reveal that the bureaucracy generally follows the space policy set by politicians. In this sense, bureaucratic institutions have the power to implement existing space policy in Nigeria, and even expand upon existing space technology applications, which offers limited support to this hypothesis. Regardless, there is no evidence that bureaucratic institutions have guided space policy away from political priorities or been the underlying force behind the political priorities that steer space policy.

4. Economic Capacity

The economic capacity hypothesis predicts that low levels of economic capacity will (1) force a government to reduce space program funding; (2) consequently pressure officials to pick either a security- or development-focused space program, since available resources prevent the simultaneous pursuit of both options; and (3) provide incentives for a development-focused space program that could boost the country's overall economic capacity, thereby relieving economic pressure. This section first investigates how reduced economic capacity impacts Nigeria's space program funding. Then, I examine how funding constraints have affected Nigeria's space program, looking for evidence that reduced funding repeatedly helps explain the space program's trajectory.

³⁷⁴ Reuters, "Nigeria Agrees \$550 Million Satellite Deal with China"; and Gbenga Bada, "Shittu Briefs President on \$550m New Satellites from China," *Pulse Nigeria*, January 3, 2018, <https://www.pulse.ng/news/local/buhari-shittu-briefs-president-on-dollar550m-new-satellites-from-china/0vfzqpx>.

Nigeria's economy became the largest in Africa when, in 2012, Nigeria's GDP surpassed South Africa's after multiple years of economic competition between the two countries.³⁷⁵ As a single indicator, Nigeria's GDP suggests a relatively high level of economic capacity, but the government's dependence on oil diminishes its ability to capitalize on the expanding size of Nigeria's economy. Specifically, oil accounts for approximately half of Nigeria's government revenue, and decades of dependence on oil revenue have facilitated an extremely weak non-oil tax revenue base.³⁷⁶ Oil dependence effectively reduces Nigeria's domestic economic capacity, because oil exports are largely dependent on global prices and demand. Thus, Nigeria's capacity to employ its large economy towards a government objective, like the space program, is directly related to the price of oil unless foreign loans are available for specific government projects. Endemic corruption further undermines Nigeria's economic capacity, as already limited state resources are siphoned into personal accounts.³⁷⁷ As such, Nigeria's economic capacity is far lower than its GDP would suggest.

From 1999 to 2015, Nigeria's economy exhibited strong growth, but still faced several important constraints. Specifically, Nigeria's GDP increased by 2.1% per year on average from 1995 to 1999, over 6% per year on average from 2000 to 2014, and 2.6% in 2015.³⁷⁸ Regardless of the strong growth from 1999 to 2015, however, inflation was persistently high—above average GDP growth for the same period—while the unemployment rate grew “at a compound annual average of 4.8 percent” from 2000 to

³⁷⁵ “GDP (Current US\$) - Sub-Saharan Africa, Nigeria, South Africa,” The World Bank, accessed November 3, 2020, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ZG-NG-ZA&most_recent_value_desc=true.

³⁷⁶ Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 12.

³⁷⁷ Husted and Blanchard, 12.

³⁷⁸ Olu Ajakaiye et al., “Nigeria: The Relationship Between Growth and Employment,” in *Africa's Lions: Growth Traps and Opportunities for Six Leading African Economies*, ed. Haroon Borat and Finn Tarp (Washington, D.C.: Brookings Institution Press, 2016), 185, <https://muse-jhu-edu.libproxy.nps.edu/chapter/1883660/pdf>; and “GDP Growth (Annual %) - Nigeria,” The World Bank, accessed January 7, 2021, <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=NG>.

2014.³⁷⁹ Put simply, more Nigerians struggled to find work and the naira lost substantial value, despite an expanding economy. Of critical significance to this hypothesis, Nigeria's government expenditures also suffered during this period. In 1999, total government expenditures peaked at almost 18% of GDP before dropping precipitously to just 6.8% in 2006, at which point expenditures briefly increased to 8.3% by 2008, before beginning a steady decline to 5.3% in 2015.³⁸⁰ Although Nigeria did not technically encounter a recession between 1999 and 2015, these indicators demonstrate that Nigeria's economic expansion did not necessarily translate into improved living conditions or, more importantly for this hypothesis, increased government funding for national objectives in relative terms.

Considering the increasingly negative impacts of Nigeria's financial challenges from 1999 to 2015, this hypothesis predicts that the Nigerian space program would become progressively more constrained by growing competition for falling government funding. Put differently, the Nigerian government could have established a dual-use space program while government funding was relatively high in 1999, but the space program would begin to specialize in *either* security or, more likely, development objectives towards the end of this period. Additionally, we would expect to see Nigeria's space program contract in size due to decreased funding, if there were strong support for the economic capacity hypothesis.

Nigeria's space history, however, reveals a story that contrasts with these predictions. Although Nigeria established NASRDA in 1999, the government did not provide funding to NASRDA for two years—the Nigerian government allocated \$93 million to NASRDA in 2001.³⁸¹ By 2001, government expenditure had already dropped from 18% to 12.5% of GDP, and the investment in NASRDA represented over 1% of total

³⁷⁹ "Inflation, GDP Deflator (Annual %) - Nigeria," The World Bank, accessed November 4, 2020, <https://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG?locations=NG&view=chart>; and Ajakaiye et al., "Nigeria: The Relationship Between Growth and Employment," 192.

³⁸⁰ "2019 Statistical Bulletin: Public Finance Statistics," Central Bank of Nigeria, June 29, 2020, <https://www.cbn.gov.ng/documents/statbulletin.asp>.

³⁸¹ Oyewole, "Space Research and Development in Africa," 193–94.

expenditure for the year.³⁸² In other words, the Nigerian government made an extremely significant investment in their space program despite a recent contraction in relative government spending. The subsequent investments in satellites demonstrated a commitment to *expand* the space program, even though relative government spending steadily decreased between 1999 and 2015. Nigeria spent \$13 million on *NigeriaSat-1* in 2003, \$300 million—only \$51 million was required up front—on *NigComSat-1* in 2007, and \$112 million combined on *NigeriaSat-2* and *NigeriaSat-X* in 2011.³⁸³ More important than the expanding size of Nigeria’s space program, however, is that the space program shifted from mostly development-focused objectives throughout the 2000s to include explicit security-focused objectives in the 2010s. Instead of specializing in either security or development, Nigeria’s space program expanded in both size and scope during this period of economic challenges, which directly contradicts this hypothesis.

Nigeria’s economic challenges only worsened after 2015. In 2016, Nigeria’s economy contracted for the first time in 25 years, which created the Fourth Republic’s first defined recession.³⁸⁴ As expected, the precipitous decline in oil prices at least partially caused Nigeria’s 2016 economic crisis, and also reduced total government *revenues* by 33% from their 2014 peak.³⁸⁵ Fortunately, the 2016 recession was short, ending in 2017, as Nigeria’s economy recovered alongside oil prices.³⁸⁶ The 2016 economic recession reduced the government’s overall economic capacity, which, this hypothesis predicts,

³⁸² Central Bank of Nigeria, “2019 Statistical Bulletin: Public Finance Statistics”; and Investing, “USD NGN Historical Data.”

³⁸³ Oyewole, “Space Research and Development in Africa,” 194.

³⁸⁴ “The World Bank in Nigeria - Overview,” The World Bank, October 13, 2019, <https://www.worldbank.org/en/country/nigeria/overview>.

³⁸⁵ Iwedi Marshal and Solomon Igbaniibo Dumini, “Nigeria Economy and the Politics of Recession: A Critique,” *Journal of Advances in Economics and Finance* 2, no. 4 (November 2017): 259, <https://doi.org/10.22606/jaef.2017.24006>; “The World Factbook - Nigeria,” Central Intelligence Agency, October 27, 2020, <https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html>; and “Details of Public Revenues - Nigeria,” Organization for Economic Cooperation and Development, accessed November 3, 2020, <https://stats.oecd.org/Index.aspx?DataSetCode=REVNGA>.

³⁸⁶ Central Intelligence Agency, “The World Factbook - Nigeria”; and Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 12.

indicates that Nigeria's space funding should have similarly declined during the same period.

Despite the predictions of this hypothesis, Nigeria's space program funding significantly increased during the 2016 economic recession. In 2015, one year before Nigeria's economic recession, the Nigerian government allocated over 9 billion naira to the space program, with 2.75 billion naira to NIGCOMSAT under the Ministry of Communications and 6.27 billion naira to NASRDA and its associated research centers under the Ministry of Science and Technology.³⁸⁷ Then, during the 2016 recession, the Nigerian government increased total funding to the space program by 47% with 3.45 billion naira to NIGCOMSAT, 7.88 billion naira to NASRDA and its research centers, and 1.96 billion naira to the nascent DSA under the Ministry of Defence, for a total of almost 13.3 billion naira to the entire space program.³⁸⁸ As the recession ended in 2017, the space program's funding once again increased by over 25% to a total of almost 16.7 billion naira, with 3.91 billion naira to NIGCOMSAT, 10.81 billion naira to NASRDA and its research

³⁸⁷ For reference the U.S. dollar to Nigerian naira exchange rate was about \$1 to 199 naira at the end of 2015, and \$1 to 360 naira at the end of 2017. Federal Government of Nigeria, *Federal Ministry of Communication Technology 2015 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2015), 256, <https://www.budgetoffice.gov.ng/index.php/2015-budget?task=document.viewdoc&id=65>; Federal Government of Nigeria, *Federal Ministry of Science and Technology 2015 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2015), 433–34, <https://www.budgetoffice.gov.ng/index.php/2015-budget?task=document.viewdoc&id=79>; and “USD to NGN Currency Chart,” XE, accessed November 4, 2020, <https://www.xe.com/currencycharts/?from=USD&to=NGN&view=10Y>.

³⁸⁸ Federal Government of Nigeria, *Federal Ministry of Communication Technology 2016 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2016), 1, <https://www.budgetoffice.gov.ng/index.php/2016-budget?task=document.viewdoc&id=17>; Federal Government of Nigeria, *Federal Ministry of Science and Technology 2016 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2016), 466–68, <https://www.budgetoffice.gov.ng/index.php/2016-budget?task=document.viewdoc&id=41>; and Federal Government of Nigeria, *Federal Ministry of Defence 2016 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2016), 1, <https://www.budgetoffice.gov.ng/index.php/2016-budget?task=document.viewdoc&id=31>.

centers, and 1.96 billion naira to DSA.³⁸⁹ These increases in space funding considerably outpaced inflation in Nigeria—9.5% in 2016 and 11.1% in 2017—which means that Nigeria’s space funding experienced a *real* increase during the 2016 recession.³⁹⁰ Thus, it is clear that Nigeria’s space funding growth during the Fourth Republic’s only defined recession undermines the first prediction of the economic capacity hypothesis.

In addition to the increase in total space funding during a period of reduced economic capacity, the Nigerian government also chose to diversify the space program’s objectives at the same time. The government’s decision to establish DSA in 2014 was the most explicit indication of the space program’s shift to security in the 2010s, ultimately leading to a position near the middle of the security-development spectrum. Notable to this hypothesis, however, DSA did not actually receive funding until 2016, despite its formation two years earlier.³⁹¹ Contrary to the prediction that reduced economic capacity would force government officials to pick between security or development, this timeline illustrates that Nigeria’s space program expanded, as measured by funding, to include both security and development objectives during the 2016 economic recession. As such, the DSA’s funding timeline effectively refutes the second aspect of this hypothesis.

The third prediction of this hypothesis asserts that lower economic capacity incentivizes development objectives because development-oriented programs may create economic benefits. Put differently, economic constraints should negatively impact

³⁸⁹ Federal Government of Nigeria, *Federal Ministry of Communication Technology 2017 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2017), 1, <https://www.budgetoffice.gov.ng/index.php/2017-approved-budget?task=document.viewdoc&id=643>; Federal Government of Nigeria, *Federal Ministry of Science and Technology 2017 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2017), 11–14, 89–96, 134–36, <https://www.budgetoffice.gov.ng/index.php/2017-approved-budget?task=document.viewdoc&id=634>; and Federal Government of Nigeria, *Federal Ministry of Defence 2017 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2017), 25–27, <https://www.budgetoffice.gov.ng/index.php/2017-approved-budget?task=document.viewdoc&id=619>.

³⁹⁰ The World Bank, “Inflation, GDP Deflator (Annual %) - Nigeria.”

³⁹¹ Federal Government of Nigeria, *Federal Ministry of Defence 2014 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2014), 1, <https://www.budgetoffice.gov.ng/index.php/2014-budget?task=document.viewdoc&id=128>; Federal Government of Nigeria, *Federal Ministry of Defence 2015 Budget* (Abuja, Nigeria: Federal Government of Nigeria, 2015), 21, <https://www.budgetoffice.gov.ng/index.php/2015-budget?task=document.viewdoc&id=66>; and Federal Government of Nigeria, *Federal Ministry of Defence 2016 Budget*, 1.

security-focused space program funding more than funding that supports development objectives. Even with increasing total space program funding from 2015 to 2017, many space program actors and scholars repeatedly cite funding as a restraining force on the space program's goals. In fact, in 2017, NASRDA had an extremely low level of funding when compared to more advanced and near-peer international space agencies.³⁹² Tella, for example, cites Nigeria's recession as an obstacle to Nigeria's 25-year space roadmap.³⁹³ Similarly, Okon explains that funding challenges inhibit domestic satellite manufacturing capacity and communications satellite procurement.³⁹⁴ Finally, an engineer at CSTP stated that Nigeria's launch program has progressed slowly because the Nigerian government did not provide enough funding due to a lack of launch technology prioritization.³⁹⁵

These accounts illustrate the *perception* that funding constraints affected all aspects of Nigeria's space program during the 2016 recession, including both development-focused activities like space exploration and security-focused launch capacity. There is only limited evidence that suggests that government officials marginally favored funding for development objectives during this time. Namely, allocated funding to DSA remained constant from 2016 to 2017, while overall funding for the space program increased by over 25% during the same period. Considering that the Nigerian government established DSA in 2016, however, this minimal evidence is insufficient to support the third prediction of the economic capacity hypothesis.

Overall, the existing evidence powerfully contradicts this final hypothesis. Between 1999 and 2015 an expanding economy could not prevent the relative decline of Nigeria's government spending. Despite this decline, Nigeria's space program expanded both in the

³⁹² Onuh Spencer et al., "Building the Appropriate Capacity for Enabling Space Programs in Africa: The Nigerian Experience," *International Journal of Sustainable Development Research* 5, no. 1 (March 2019): 21, <https://doi.org/10.11648/j.ijbmf.20190501.13>.

³⁹³ Tella, "Space as a Fulcrum of Nigeria's External Relations and Regional Hegemony," 51.

³⁹⁴ Emmanuel O. Okon, "Africa's Space Technology Investment and Socio-Economic Returns: The Case of Nigeria," *International Journal of Business and Management Future* 2, no. 1 (January 2018): 9–10, <https://doi.org/10.46281/ijbmf.v2i1.114>.

³⁹⁵ Oludimu, "Why We Know Next to Nothing About Nigeria's Space Programme."

number of satellites and scope of policy objectives. More significantly, total space funding increased during Nigeria's only defined economic recession in its space history. Space funding also expanded in scope in 2016, growing to support both security and development objectives. Despite the real growth in space funding's size and scope during the 2016 recession, a common perception existed that inadequate funding limited both development and security space objectives. Still, it is not clear if the perceived funding constraints were stronger for either security- or development-oriented projects. Considering these conclusions, there is no support for the economic capacity hypothesis.

D. CONCLUSION

This chapter has demonstrated how Nigeria's space program initially focused almost entirely on socioeconomic development in the 1990s but later shifted to include security objectives in the 2010s, which positions the current Nigerian space program in the middle of the security-development spectrum. Based on the analysis of all four hypotheses, it is apparent that Nigeria's space trajectory has primarily been a consequence of the government's political prioritization. While it is still possible that international, bureaucratic, or economic factors marginally influence Nigeria's space program, the existing evidence offers either weak or no support for these other hypotheses. Table 3 summarizes the level of support and key findings for each hypothesis.

Table 3. Summary of Hypotheses for Nigeria's Space Program

Hypothesis	Level of Support	Key Findings
Foreign Partnerships	Weak	Many opportunities for foreign influence, but little impact on space program's path
Political Prioritization	Strong	Space program's objectives repeatedly support Nigeria's political priorities
Bureaucratic Institutions	Weak	Bureaucratic interest in space was present, but not the primary driver of space policy
Economic Capacity	No Support	Space funding grew in size and scope during the 2016 recession

The next chapter concludes this research by comparing the South African and Nigerian case studies and summarizing the combined findings. Additionally, I examine the implications of the key findings, specifically discussing the broader significance of this research and making policy recommendations. Finally, the next chapter suggests areas for future research in order to advance our understanding of the decisions that EMSAs in sub-Saharan Africa make.

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IV. KEY FINDINGS AND IMPLICATIONS

This concluding chapter analyzes the combined case study findings, explains how the findings have advanced the understanding of African space programs, discusses what the results indicate for the future of African space ambitions, offers three policy recommendations, and highlights areas for future research. Crucially, I note that the combination of Africa’s expanding space capabilities and the political importance of space programs in Africa provide a pivotal opportunity for the U.S. to improve strategically important geopolitical relationships on the continent. As the world’s most advanced space faring country, the U.S. could use space cooperation with African countries to uniquely counter Chinese and Russian efforts to increase geopolitical influence in Africa.

A. COMPARATIVE DISCUSSION OF KEY FINDINGS

This research sought to discover why EMSAs in sub-Saharan Africa establish space programs with objectives that focus on national security, socioeconomic development, or some mixture of the two. Despite many differences in South Africa’s and Nigeria’s space programs, the results in the two cases are remarkably similar. Of the four hypotheses—foreign partnerships, political prioritization, bureaucratic institutions, and economic capacity—only the political prioritization hypothesis has strong support in both cases. Conversely, the remaining three hypotheses have either weak or no support. Table 4 summarizes the combined findings. This section compares the results of both case studies for each hypothesis individually.

Table 4. Strength of Hypotheses in South Africa and Nigeria

Hypothesis	Level of Support: South Africa	Level of Support: Nigeria
Foreign Partnerships	No Support	Weak
Political Prioritization	Strong	Strong
Bureaucratic Institutions	Weak	Weak
Economic Capacity	No Support	No Support

The first hypothesis, foreign security and development partnerships has no support in South Africa and only weak support in Nigeria. Put differently, Nigeria's space program has been slightly more susceptible to foreign influence than South Africa's, but its level of foreign influence is still low. Among African countries, South Africa has exceptional domestic satellite development capacity and a multitude of international partners, both of which have prevented foreign influence by reducing South Africa's reliance on foreign space technology early and providing a competitive market of launch options to access space. Additionally, South Africa largely provides domestic funding for satellite development and launch costs, which further reduces opportunities for foreign influence.

Nigeria's space program, by contrast, has only recently begun to reduce its reliance on foreign space partners by taking ownership of satellite development and exploring launch technology. Nigeria has relied on foreign actors, especially China, for much of the funding for its satellite programs. This dynamic of long-term reliance on foreign funding and space technology in Nigeria has possibly shaped the trajectory of its program. Furthermore, Nigeria adopted security-focused objectives in the 2010s, when U.S. satellite imagery support for a terrorist kidnapping incident revealed the Nigerian space program's weakness in security applications. Still, Nigerian domestic actors have generally directed the space program's objectives with only limited foreign influence. Although foreign influence on African space programs is generally marginal, these results suggest that higher levels of space dependency increase the potential that foreign actors influence the trajectory of African space programs.

Second, the evidence in both case studies strongly supports the political prioritization hypothesis. South Africa's and Nigeria's space program objectives have consistently aligned with and directly supported broader domestic political priorities throughout their space histories. Only the political prioritization hypothesis can meaningfully explain the trajectory of both South Africa's and Nigeria's space programs and, more importantly, the specific timing of shifts in space program objectives. In South Africa, for example, the post-apartheid government established a powerful development agenda in the 1990s and 2000s that sparked a related push for development-focused space applications in the contemporary space program's formative years. Similarly, since the

1980s, the trajectory of Nigeria's space program matched the government's broad focus on socioeconomic development. Rising terrorist threats inspired a shift to develop a significant security agenda in addition to continued development efforts in the 2010s. Put simply, both space programs acted as one component of their respective governments' broader political agendas. The strength of the political prioritization hypothesis indicates that African governments maintain a high-degree of agency in directing their space programs, which thereby limits the influence of other space stakeholders.

Furthermore, while it is possible that political corruption and clientelism have also infected the space programs in South Africa and Nigeria, their impact seems limited. There are only a few reports of investigations into missing resources or politically-driven resourcing decisions in both space programs, which suggests that neither corruption nor clientelism are widespread in either case study. More importantly, the limited examples of potential corruption or clientelism do not appear to influence the trajectory of either space programs' policies. Thus, even if widespread political corruption or clientelism were well-shrouded in South Africa's or Nigeria's space program, there is no evidence that either practice guides the larger focus on security or development in African space programs.

Third, the bureaucratic institutions hypothesis has only weak support in both case studies. In South Africa, development-oriented institutions like the DST and DTI had the opportunity to establish the contemporary space program without significant interest from security-sector bureaucrats. More importantly, however, South African government officials deliberately created strong institutions with the explicit purpose of preventing bureaucratic influence early in the space program's formative years. Nigeria's space history, in comparison, includes clear examples of bureaucratic competition and interest in controlling specific elements of the space program, like communications satellites. Still, despite clear bureaucratic competition within the Nigerian space program, bureaucratic decision makers openly demonstrate their support for political priorities by providing detailed plans for space technology applications that directly contribute to political agendas. Thus, in Nigeria, space program bureaucrats broadly follow the country's political priorities, but they compete for resources and influence within the general bounds set by

politicians. It is interesting that two entirely different mechanisms—formal institutions and political pressure—yield the same result: weak support for this hypothesis.

Finally, neither case study provides support to the fourth hypothesis, economic capacity. This hypothesis predicts that economic incentives, specifically periods of economic restraint, guide a space program's security-development decisions, rather than specific actors like politicians or bureaucrats. In both South Africa and Nigeria, periods of reduced economic capacity—recessions or commodity price declines—were not frequent enough to account for long-term space policy decisions, and did not always align with pivotal moments in space history. More importantly, decreasing government revenue caused by recessions did not lead to funding shortages in either space program. In fact, both South Africa's and Nigeria's space programs maintained the same size or even grew during periods of economic recession. Even though politicians and bureaucrats sometimes argued that economic scarcity inhibited their country's space programs, both South Africa and Nigeria were able to at least sustain existing space projects during periods of economic constraint. These findings suggest that African EMSAs place significant value on their space programs, refusing to allow funding concerns to meaningfully influence space policy objectives because of the real benefits that space technology offers developing countries. Put simply, space programs are worth their costs to African EMSAs. It is also revealing that Nigeria has arguably less economic capacity than South Africa given its continued reliance on oil revenues and pervasive corruption, yet only the Nigerian space program diversified to include security goals.

B. IMPLICATIONS

In the introductory chapter, I offered three reasons why this research is important: (1) there are few studies that attempt to explain African decisions in the space sector; (2) the number, size, and capabilities of African space programs are rapidly growing; and (3) foreign space partnerships with African EMSAs may create both opportunities and threats to U.S. national interests. This section, in turn, explains how studying South Africa's and Nigeria's space involvement has advanced knowledge in these three areas of interest.

First, in seeking to understand African decisions in the space sector, this research clearly shows that the South African and Nigerian governments used their space programs as tools designed to assist domestic political objectives. This suggests that, despite dependence on foreign technologies and funding, African politicians and political institutions generally drive space decisions, and that African leaders have a high degree of agency and control over their space programs. While these findings align with Harding's general conclusion that an EMSA's space policies frequently reflect more terrestrial security and development priorities, they also illustrate several surprising discoveries in the African context.³⁹⁶ For example, previous studies demonstrate that EMSAs are extremely reliant on foreign partners, which provides opportunities for influence.³⁹⁷ For African EMSAs specifically, the prevalence of aid dependency, along with increased foreign involvement across the continent, anticipated that foreign partners could exert substantial influence over domestic space actors. Weak support for the foreign partnership hypothesis, however, suggests that opportunities for foreign influence in African EMSAs may be overstated, even for countries that are almost entirely reliant on international space assistance like Nigeria. Additionally, it is surprising that economic concerns were not a larger factor in limiting African space programs given the public perception that space programs divert scarce revenue from terrestrial programs designed to address the innumerable development challenges that African countries face. Instead of folding to public pressure, African politicians and bureaucrats continuously defended space spending as essential for development, frequently even championing increased space spending, despite relentless public critiques against the cost of space programs. In total, these findings reveal a high degree of political *pride* in African space programs, which contrasts sharply with the development and security challenges that are abundant in sub-Saharan Africa.

Second, the importance of domestic political priorities in African space programs provides insight into how the expanding African space sector will impact the space environment and international space fora. Considering that every African country has

³⁹⁶ Harding, *Space Policy in Developing Countries*, 13.

³⁹⁷ Wood and Weigel, "Charting the Evolution of Satellite Programs in Developing Countries."

expressed interest in establishing or developing space capacity, African countries could meaningfully contribute to the flood of spacecraft in the already crowded orbital environment in the coming decades. As of 2020, there are almost 2,800 operational satellites orbiting Earth, joined by over 3,000 additional defunct spacecraft and about 15,000 catalogued pieces of debris, which totals to over 21,000 catalogued objects in orbit.³⁹⁸ Given that sub-Saharan Africa is the largest bloc of countries currently without satellites, the continent's space ambitions stand to contribute hundreds of operational satellites and associated orbital debris to Earth's fragile space environment in the coming decades.³⁹⁹ The importance of political priorities in Africa's expanding space programs suggests that African politicians will likely continue advocating for measures that protect their space access rights, especially for the limited number of GEO slots, despite the risks that increasingly crowded orbits create.⁴⁰⁰ Put simply, African leaders want to assure their countries' ability to use space as a tool to help achieve crucial political objectives for decades to come. If African leaders manage to add hundreds of satellites to Earth's space environment despite continued resource constraints, they would meaningfully increase the threat of an exponential growth in orbital spacecraft and debris.⁴⁰¹ Any "cascading" orbital debris crisis would effectively cut off the use of space for all countries.

Notably, the African Union established a continental African Space Agency in 2017, but poor funding and debates about the agency's purpose and scope have delayed its

³⁹⁸ "UCS Satellite Database," Union of Concerned Scientists, August 1, 2020, <https://ucsusa.org/resources/satellite-database>; and NASA, "Satellite Box Score," *Orbital Debris Quarterly News* 24, no. 4 (November 2020): 12.

³⁹⁹ This is a modest projection considering that progress in satellite miniaturization and falling commercial launch costs have made satellites affordable for almost any country. For a useful global graphic on satellite ownership by country, see Union of Concerned Scientists, "UCS Satellite Database."

⁴⁰⁰ At least two multinational efforts – in 1976 and 2012 – with support from African countries, have expressed concerns with international space norms and laws about continued space access for EMSAs. Froehlich and Siebrits, *Space Supporting Africa*, 171–72.

⁴⁰¹ James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed. (Stanford, California: Stanford University Press, 2019), 53.

continued implementation.⁴⁰² Should the African Space Agency fully materialize, it could reduce the potential orbital footprint of many African countries by consolidating satellite constellations; however, it must first overcome the significant hurdles posed by individual countries pushing to ensure their diverse domestic political benefits before committing to funding.⁴⁰³ Historically, African countries have cooperated in space, with multiple examples of mutually beneficial space institutions and satellite constellations within Africa. Space cooperation between African countries is likely to continue when domestic political goals align; however, the diversity of African political goals will almost certainly inspire additional unilateral space programs and may spoil international norm building efforts. In other words, these diverse political objectives add to the existing challenges that the United Nations Committee on the Peaceful Uses of Outer Space faces in creating new international space law and norms. U.S. officials interested in establishing new international space norms could use an African country's domestic political priorities to anticipate how African EMSAs might respond to a proposal.

Third, Africa's foreign space partners may be able to strengthen geopolitical relationships by supporting African countries' existing space objectives. It remains unlikely that foreign space partners could substantially influence the objectives of an African country's space policy; however, they could earn political capital by providing space technology, satellite data, space services, human capital development, or launch capacity to existing programs.⁴⁰⁴ Considering that African space programs serve key domestic political objectives, it is likely that African leaders perceive foreign assistance in the space sector as a genuine effort to help African nations *develop* the capacity to overcome persistent security or development challenges.

⁴⁰² Munyaradzi Makoni, "Plans for African Space Agency Jeopardized by Lack of Progress," *Physics World*, February 24, 2020, <https://physicsworld.com/a/plans-for-african-space-agency-jeopardized-by-lack-of-progress/>.

⁴⁰³ Makoni.

⁴⁰⁴ Judd Devermont and Temidayo Oniosun, "Is the United States Losing the African Space Race?," *War on the Rocks*, June 23, 2020, <https://warontherocks.com/2020/06/is-the-united-states-losing-the-african-space-race/>.

Russia and China are pursuing this approach, at least to some extent. As evidenced by this research, China and Russia are extensively involved in the African space sector. Specifically, Russia has launched the most African satellites of any foreign partner, and Russian state-owned companies in the space industry help to bolster “geopolitical influence and surveillance capacity in the region.”⁴⁰⁵ Russia’s involvement with defense applications in South Africa’s space program, however, may backfire if South African leaders perceive an unwelcome Russian push for additional security programs or for more Russian control. Similarly, the Chinese government, which is heavily involved in African satellite development, typically establishes space partnerships only with African countries that agree to “the highest level of bilateral relations, which involve the full pursuit of cooperation, development, and coordination on regional and international affairs.”⁴⁰⁶ In other words, China uses space partnerships as one piece of a larger strategy to establish a strategic partnership with more general political cooperation. In these foreign space partnerships, African countries have thus far retained significant agency over their space policies, but may be open to broader political influence.

C. POLICY RECOMMENDATIONS

Although the U.S. has lagged behind Chinese and Russian involvement in Africa’s space programs over the last two decades, there remain plenty of opportunities to quickly reverse this trend. Space cooperation with South Africa and Nigeria, in particular, could strengthen U.S. relations with two strategic partners and regional leaders. Considering that South Africa and Nigeria will likely maintain their regional power statuses in the coming decades, advancing space policy cooperation with both countries may expand America’s geopolitical influence on the continent.⁴⁰⁷ The U.S. should increase space cooperation with African countries in three ways: (1) incentivize trade in satellite technology and launch

⁴⁰⁵ Klinger, “China, Africa, and the Rest: Recent Trends in Space Science, Technology, and Satellite Development,” 5; and Devermont and Oniosun, “Is the United States Losing the African Space Race?”

⁴⁰⁶ Klinger, “China, Africa, and the Rest: Recent Trends in Space Science, Technology, and Satellite Development,” 4.

⁴⁰⁷ Cilliers, Schünemann, and Moyer, *Power and Influence in Africa*, 1–2.

services between the U.S. and African partners through the Prosper Africa initiative, (2) offer collaborative space solutions to African and international problems, and (3) initiate a guest astronaut program. I discuss each in turn.

First, and most importantly, the U.S. should foster trade between its commercial space industry and the African space sector. As a global leader in the space sector, U.S. space technology and services are poised to provide unique capabilities to African space programs. Trade incentives like reduced tariffs, taxes, and duties would help U.S. space goods and services become more competitive in the African market, thereby delivering meaningful benefits to African governments and businesses. Such a proposal may harm domestic African space producers by further increasing international competition, but advanced U.S. space technologies would likely fill a different niche than the emerging African commercial space industry can provide. More importantly, increased commercial competition would benefit Africa's space consumers by providing unique goods and services at a cheaper price. The nascent Prosper Africa initiative already has the objectives, tools, and incentives in place "to substantially increase two-way trade and investment between the United States and Africa."⁴⁰⁸ By simply applying Prosper Africa incentives to space trade specifically, and launching a small awareness campaign that targets the U.S. commercial space industry, the U.S. could drastically improve its involvement in African space programs. In return, the U.S. would increase exports to strategically important countries, likely strengthen diplomatic partnerships with a multitude of African countries, and possibly gain access to data from African satellites. Moreover, space trade could advance U.S. influence as it relates to GPC dynamics in Africa.

The second policy recommendation focuses on helping African countries develop space capacity to ameliorate their domestic development and security challenges. When feasible, U.S. officials should consider collaborating with African space agencies to help African countries address their most pressing development and security concerns. For example, NASA and SANSa could sign a memorandum of understanding to share all

⁴⁰⁸ "The Prosper Africa Initiative Drives U.S. Investment in Africa," U.S. Department of State, October 15, 2020, <https://www.state.gov/the-prosper-africa-initiative-drives-u-s-investment-in-africa/>.

existing and future satellite data on climate change. Considering South Africa's repeated water crises and relative scarcity of satellite data on climate change, SANSA would disproportionately benefit from such an agreement in the short-term. Despite this short-term asymmetry, such an agreement would be incredibly cheap to implement, grant the U.S. access to more advanced South African satellite data in the future, limit regional instability associated with resource scarcity-related migration, and improve a strategically important bilateral relationship that counters GPC adversaries' efforts.

In Nigeria's security sector, the Department of Defense could similarly initiate an International Military Education and Training (IMET) space program to help Nigeria better counter regional terrorism, even though IMET funding to Nigeria has remained around only \$1 million since 2017.⁴⁰⁹ Supplementing NASRDA's efforts to train the Nigerian military on security-related satellite applications, the U.S. could offer a short course on a specific topic like imagery analysis. Such an IMET program could easily scale to accommodate existing budgetary restrictions, and would once again provide a host of mutual benefits like increased pressure on regional terrorist organizations and improved relations with the Nigerian government. Security-focused space cooperation with Nigeria could further expand by accepting Nigerian military officers into the Naval Postgraduate School's international space systems operations degree program. The program would help Nigeria's military maximize the utility of existing space assets and inform recommendations for acquiring future space systems, while also strengthening bilateral military relationships.

Finally, the U.S. should commence a guest astronaut program as a useful tool to improve bilateral relations with strategically important countries. In the late 1980s the Soviet Union used their "guest cosmonaut" program to bolster relationships with allied countries by taking select foreign nationals into orbit.⁴¹⁰ With rapidly falling commercial space launch costs, the U.S. could feasibly create a similar program that allows strategically important allies to send their "best and brightest" to a compressed astronaut training

⁴⁰⁹ Husted and Blanchard, *Nigeria: Current Issues and U.S. Policy*, 17.

⁴¹⁰ Moltz, *The Politics of Space Security*, 209, 218.

program and subsequent limited rotation on the International Space Station. Such a program could also include opportunities for advanced STEM education in the U.S. to help develop the human capital required to conduct scientific experiments in the space environment. Nigeria's goal to orbit a Nigerian astronaut and strategic relationship with the U.S. provide a perfect initial trial run for this policy recommendation. A guest astronaut program could increase U.S. political influence in a country through at least two mechanisms. First, the guest astronaut would likely become a national hero in their home country—similar to John Glenn in the U.S. and Yuri Gagarin in the Soviet Union—in large part thanks to U.S. support. This individual may be able to use their newfound fame to influence the national policy process, and would likely feel some sense of debt to the United States. More importantly, however, a U.S. guest astronaut program would place several African EMSAs on the short list of countries with experienced astronauts. In other words, every country selected for the guest astronaut program would earn a prestigious political victory. This space cooperation could thus create opportunities for further cooperation outside of the space sector by initiating high-level discussions among each nation's political elite on a variety of issues. Put simply, a guest astronaut program may allow the U.S. to increase its broader influence in select African countries for a relatively cheap price.

D. AREAS OF FUTURE RESEARCH

African space programs are an understudied area of research, and thus, there are many unanswered questions that provide ample opportunities for future research. This research focused on the two largest and oldest space programs in sub-Saharan Africa, both of which had significant development-focused objectives. Do the results of this research hold for African EMSAs with newer space programs? What about African EMSAs that largely favor security-focused space objectives? Specifically, Angola, the DRC, Ethiopia, Kenya, Sudan, Ghana, and Rwanda are promising candidates for this second question.⁴¹¹ The South African and Nigerian case studies favored the African countries with the most economic capacity, which might have biased the weak results of the economic capacity hypothesis. As such, it would also be useful to apply this research's framework to African

⁴¹¹ Oyewole, "The Quest for Space Capabilities and Military Security in Africa," 163.

EMSAs with extremely low economic capacity. This framework could further expand beyond sub-Saharan Africa to include EMSAs spread across the globe. An expanded study could help explain which characteristics of an EMSA's space policy are unique to the African experience. Furthermore, future studies could examine the influence of national and political pride as an additional hypothesis for driving African space programs. It would also be useful to assess how well African space programs have met their political objectives over time. Finally, and perhaps most importantly, it is critical to understand how space cooperation leads to broader political influence in the current GPC environment within Africa.

Answers to these critical questions could motivate the U.S. to alter its foreign policy in Africa. Instead of focusing largely on responding to African crises with foreign aid or security assistance, a significant investment in African space programs might provide some of the requisite tools to prevent future crises in the first place. There is no illusion, however, that African space programs will provide a panacea to all African problems. In all likelihood, African space programs will simply be one key part to a broader solution for the continent's socioeconomic and security challenges. Still, space cooperation can provide the U.S. with a crucial counterbalance to Chinese and Russian interests in Africa—one that focuses on optimistic opportunities rather than persistent obstacles. Africa's growing population and economy create an opportune moment to seize economic and competitive advantages that African space programs are likely to offer.

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