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From Outer Space to Inner Dynamics: Rethinking Space Policy Using Discourse Network Analysis, Topic Modeling, and Policy Actor Affiliations

A DISSERTATION APPROVED

FOR THE DEPARTMENT OF POLITICAL SCIENCE

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List of Acronyms

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Acronym	Full Term
ACF	Advocacy Coalition Framework
APP	American Presidency Project
CAP	Comparative Agendas Project
CMSA	China Manned Space Agency
COPUOS	Committee on the Peaceful Uses of Outer Space (United Nations)
COTS	Commercial Orbital Transportation Services
CRS	Commercial Resupply Service
CSLA	Commercial Space Launch Act
DNA	Discourse Network Analysis
EO	Executive Order
FAA	Federal Aviation Administration
FREX	Frequency-Exclusivity (weighted term scoring)
FCC	Federal Communications Commission
IGO	Intergovernmental Organization
HLS	Human Landing System
ILRS	International Lunar Research Station
ISS	International Space Station
JWST	James Webb Space Telescope
LDA	Latent Dirichlet Allocation
LEO	Low Earth Orbit
NASA	National Aeronautics and Space Administration
NGO	Nongovernmental Organization
NPF	Narrative Policy Framework
OIG	Office of Inspector General

SDI	Strategic Defense Initiative
STEM	Science, Technology, Engineering, and Mathematics
STM	Structural Topic Modeling
UN	United Nations
UNOOSA	United Nations Office for Outer Space Affairs

Abstract

★★★

This dissertation examines the transformation of the U.S. space policy subsystem from a centralized, government-dominated domain into a collaborative, multi-sector governance arena. Drawing on the Advocacy Coalition Framework and the Comparative Agendas Project, three empirical studies trace how the subsystem's structure, belief content, and policy agenda evolved from 1958 to 2025. The first study applies discourse network analysis to congressional hearings across four policy eras and demonstrates that the subsystem underwent a typological transition driven by deliberate policy design, including the Commercial Space Launch Act of 1984, the COTS program, and the Artemis commercial partnership model, rather than by exogenous shocks alone. Shannon entropy in actor diversity nearly tripled, and commercial actors now hold the highest mean betweenness centrality in the network. The second study combines multi-stakeholder actor coding with community detection to show that organizational affiliation systematically shapes which policy core beliefs actors prioritize. Commercial actors shifted from infrastructural concerns to affordability and then to regulatory modernization; civil society actors expanded from narrow educational roles into the subsystem's largest coalitions. Low modularity and negative assortativity confirm that coalitions form around shared beliefs rather than organizational identity. The third study applies structural topic modeling to presidential documents, COPUOS proceedings, and congressional hearings, using the Comparative Agendas Project framework to measure how institutional attention to competing space policy priorities has been allocated and redistributed over time. Presidential discourse shifted from human spaceflight narratives to governance and institutional design; multilateral attention moved from treaty negotiation to cooperative security and sustainability; and congressional hearings concentrated increasingly on space science and Earth observation. Together, these studies contribute to policy process theory and space policy by treating subsystem typology as a dynamic outcome, linking actor affiliation to belief formation, and tracing how attention to space policy priorities has shifted across venues and eras as the subsystem diversified.

Foreword

Not Rocket Science, It's Political Science: Advocacy Coalitions, Discourse Networks, and Agenda Dynamics in U.S. Space Policy

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"This is not rocket science, this is political science, and the part that we're dealing with right now is political science."

— Rep. Ed Perlmutter, quoting astronaut Terry Virts, House Science, Space, and Technology Committee hearing

Space has always been political. The Apollo program was as much a Cold War demonstration of national capability as it was an engineering achievement. The Outer Space Treaty of 1967 was a product of diplomatic negotiation, not propulsion science. When astronaut Terry Virts told a member of Congress that the work before them was political science, not rocket science, he was not dismissing the technical complexity of spaceflight. He was pointing out that the harder problems, the ones that determine whether and how a nation sustains its presence beyond Earth, are problems of governance, resource allocation, coalition building, and institutional design.

What has changed is the pace. Rocket science remains necessary, but it is not sufficient to explain what is happening in the space domain. The policy environment surrounding space is now evolving as rapidly as the technology itself. Commercialization has drawn hundreds of private firms into a field once dominated by a handful of government agencies and has expanded low Earth orbit (LEO) activities. Geopolitical competition

between the United States and China has reintroduced a sense of urgency. Domestic priorities, from STEM workforce development to spectrum management to orbital debris mitigation, have multiplied the number of stakeholders with a claim on space policy outcomes. The result is a governance landscape of extraordinary complexity, one that demands the kind of systematic study that political science is equipped to provide. This dissertation is an attempt at that study.

The scope of the challenge is visible in the events unfolding as this dissertation was completed. Consider the trajectory of the Artemis program alone. NASA's Artemis II mission, the first crewed voyage beyond low Earth orbit (LEO) since Apollo 17 in 1972, launched after years of delays in April 2026 (NASA Office of Inspector General [OIG], 2024). The uncrewed Artemis I test flight in 2022 revealed unexpected damage to the Orion spacecraft's ablative heat shield, where charred material cracked and broke away during reentry in ways engineers had not anticipated (NASA, 2024a). Resolving that problem required more than 100 ground tests, an independent review, and ultimately a decision to modify the reentry trajectory rather than replace the shield (NASA, 2024b). But the heat shield was only one piece of a larger puzzle. In February 2026, NASA restructured the entire Artemis architecture, redesigning Artemis III from a crewed lunar landing into an LEO technology demonstration, adding a new mission to the sequence, and pushing the first crewed landing to Artemis IV in 2028 (NASA, 2026a). That restructuring was driven in part by delays in the development of SpaceX's Starship Human Landing System (HLS), which experienced multiple test failures in 2025, including a vehicle loss on May 27 due to a pressurization system failure (Federal Aviation Administration [FAA], 2025). Orbital refueling, the technology that the HLS depends on to reach the Moon, has not yet been

demonstrated. Each of these decisions, from the heat shield workaround to the mission resequencing, involved tradeoffs among technical risk, political timelines, commercial partnerships, and international commitments. They were, in the fullest sense, policy decisions.

The urgency of those decisions has been compounded by the acceleration of China's space program. In February 2026, China conducted a combined test in which its Long March 10 rocket performed a low-altitude demonstration flight while the Mengzhou crew capsule executed a maximum dynamic pressure abort test, the first time both capabilities were tested simultaneously (China Manned Space Agency [CMSA], 2026). The Lanyue lunar lander completed a full landing and takeoff simulation in 2025 (Xinhua, 2025). CMSA has confirmed that all primary prototype hardware for a crewed lunar landing is complete, with a target date of 2030. The Tiangong space station, now one of only two operational space stations in orbit, demonstrated its growing operational maturity by executing an emergency crew rescue in just 16 days after debris damaged a Shenzhou spacecraft's window (CMSA, 2025). Behind these headline achievements sits a rapidly expanding commercial sector: China conducted 92 orbital launches in 2025, a national record, with over 600 private firms now active in the industry (The Economist, 2026). The emergence of a genuine bilateral competition for the Moon has reshaped the political calculus of American space policy in ways that echo, but do not replicate, the dynamics of the original space race.

That competition extends beyond exploration to the governance of Earth's orbital environment. The number of active satellites has grown exponentially, driven by mega-constellations designed to provide global broadband coverage. A December 2025 study published in *Nature* found that if all proposed constellations are deployed, nearly 40 percent

of Hubble Space Telescope images and 96 percent of exposures from several other space telescopes could be contaminated by satellite trails (Borlaff et al., 2025). The regulatory response has struggled to keep pace: the Federal Communications Commission's (FCC) five-year deorbit rule, which took effect in September 2024, represents the strongest U.S. measure to date, but it addresses only one dimension of a multifaceted problem (FCC, 2022). At the international level, governance frameworks are fragmenting rather than converging. The Artemis Accords have grown to over 50 signatories (American Institute of Physics, 2024), establishing norms for transparency, interoperability, and resource utilization among partner nations. China and Russia, excluded from the Accords, have assembled a competing International Lunar Research Station (ILRS) coalition. The result is a bifurcation of international space governance into parallel frameworks at precisely the moment when the proliferation of actors, objects, and ambitions in orbit makes coordination most essential.

These are not isolated developments. They are interconnected expressions of the same underlying dynamic: a policy subsystem in which the number and diversity of actors, the range of competing priorities, and the speed of technological change have outpaced the institutional structures designed to manage them. Each of the events described involves the kinds of actor diversification, coalition realignment, and agenda competition that the following chapters of this dissertation examine empirically. The questions that animated the Cold War space race have not disappeared. They have multiplied, and the cast of characters attempting to answer them now includes commercial firms, nonprofit organizations, international partners, and regulatory bodies that did not exist, or did not participate in space policy, a generation ago.

Contributions to Policy Theory and Space Policy

This dissertation investigates how the U.S. space policy subsystem transformed from a centralized, government-dominated domain into a collaborative, multi-sector governance arena. Drawing on the Advocacy Coalition Framework, or ACF, (Sabatier, 1988; Sabatier & Jenkins-Smith, 1993) and the Comparative Agendas Project, or CAP, (Baumgartner & Jones, 1993), three empirical studies trace how the subsystem's structure, belief content, and policy agenda evolved from 1958 to 2025. The research advances policy theory and space policy scholarship in three dimensions.

First, it challenges the conventional practice of examining a policy subsystem at a single point in time (Nohrstedt et al., 2023). By applying discourse network analysis (Leifeld, 2016) to congressional hearings across four policy eras, the first study demonstrates that the space policy subsystem underwent a typological transition driven by deliberate policy design, including the Commercial Space Launch Act (CSLA) of 1984, the Commercial Orbital Transportation Services (COTS) program, and the Artemis commercial partnership model, rather than by exogenous shocks alone. Shannon entropy in actor diversity nearly tripled across the period of study, and commercial actors now hold the highest mean betweenness centrality in the subsystem's discourse network. This finding enriches our understanding of how structural governance changes can emerge from within systems through endogenous and exogenous feedback mechanisms (Schmid et al., 2020), rather than merely in response to external catalysts.

Second, the dissertation offers an analytical framework for understanding how organizational affiliation shapes coalition formation and belief prioritization. The second

study combines multi-stakeholder actor coding (Raymond and Denardis, 2015) with community detection to show that commercial actors shifted from infrastructural concerns to affordability and then to regulatory modernization, while civil society actors expanded from narrow educational roles into the subsystem's largest coalitions. Low modularity and negative assortativity confirm that coalitions form around shared beliefs rather than organizational identity (Weible & Sabatier, 2005; Zafonte & Sabatier, 1998). This approach provides insight into how consensus and conflict patterns shape policy trajectories over time in an area underexplored by policy process research.

Third, the dissertation examines the longitudinal evolution of the space policy agenda through structural topic modeling of presidential documents, proceedings of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), and congressional hearings, using the CAP framework to measure how institutional attention to competing priorities has been allocated and redistributed. Presidential discourse shifted from human spaceflight narratives to governance and institutional design. Multilateral attention moved from treaty negotiation to cooperative security and sustainability. Congressional hearings concentrated increasingly on space science and Earth observation. While domestic space policy priorities have undergone significant recalibration since the 1980s, limited research has investigated how these shifts have influenced the international policy landscape. This study identifies critical agenda topics in global space governance, tracks their evolution, and establishes a framework for understanding the intersections between national and international priorities.

Chapter Summaries

Chapter 1 traces the evolution of the space policy subsystem through the ACF's conceptual lens. Using DNA applied to congressional hearings across four policy eras (1960–1964, 1982–1986, 2011–2015, and 2017–2025), this study maps changes in coalition structures, organizational congruence, and the strategic framing of policy beliefs. It demonstrates that the subsystem transitioned from a government-dominated "iron triangle" (Lowi, 1979) into a collaborative network of diverse stakeholders, and that this transition was driven by endogenous policy shifts, specifically commercialization initiatives that deliberately expanded the range of actors participating in space policy discourse. The chapter assesses how subsystem types evolve with the introduction of new actors and beliefs, offering a structured framework for analyzing typological transformation in technical and evolving policy domains.

Chapter 2 investigates how the introduction of different actor types and their corresponding policy beliefs have shaped the focus and direction of the coalitions within the space policy subsystem. While Chapter 1 established that the subsystem diversified structurally, Chapter 2 examines the substantive content of that diversification through coalitions. Through comprehensive coding of congressional hearing testimony, this study assesses the extent to which participation has expanded beyond traditional government roles and traces how the thematic priorities of different actor types have changed over time. The analysis connects the structural findings of Chapter 1 to the belief content that organizes coalition activity, providing empirical evidence on how organizational affiliation systematically influences which policy core beliefs actors prioritize.

Chapter 3 evaluates the broader evolution of the space policy agenda through STM of international agreements, presidential executive orders (EOs), and congressional hearings, organized through the CAP coding framework. This chapter identifies dominant agenda topics in global space governance and examines their temporal evolution, clarifying the relationship between national policy changes and international agenda-setting processes. The analysis provides insight into how global governance structures adapt to emerging technological, economic, and strategic realities in the space domain.

Dissertation Overview

By integrating theoretical insights from policy process research with empirical analyses of discourse networks and agenda evolution, this dissertation contributes to a more comprehensive understanding of how the space policy subsystem has changed and why that change matters. It organizes and refines traditional explanations of subsystem evolution, introduces methodological approaches for analyzing coalition and subsystem dynamics over time, and provides both historical context and contemporary perspective on how space policy agendas develop across national and international domains. These findings hold relevance for scholars of space policy and public policy theory, as well as for policymakers navigating an increasingly complex governance environment. For a comprehensive overview of the dissertation's organization and the methodological approaches employed in each study, please refer to the *Overview of Dissertation Studies and Analytical Framework* table.

Foreword Table 1: Overview of Dissertation Studies and Analytical Framework

Aspect	Study 1	Study 2	Study 3
Title	Measuring Subsystem Typology Change: Discourse Networks and the Evolution of U.S. Space Policy	Belief Content, Actor Affiliation, and Coalition Structure in a Diversifying Policy Subsystem	Agenda Dynamics Across Institutional Venues: Space Policy Attention in Presidential Documents, Congressional Hearings, and COPUOS Proceedings
Research Questions	How has the U.S. space policy subsystem evolved in its typological structure over time, and how do changes in actor composition and belief heterogeneity correspond to transitions among subsystem types?	Three guiding questions: (1) How have policy agenda items in space changed with the introduction of different actor types? (2) How do policy beliefs differ thematically among actor affiliations? (3) How have coalitions evolved with the entry of new actors?	Two guiding questions: (1) How does the prevalence of space policy topics differ across domestic executive actions, congressional hearings, and multilateral diplomatic forums? (2) How has the thematic focus of space policy shifted over time across these institutional venues?
Main Themes	Advocacy Coalition Framework, Subsystem typology change, commercialization as endogenous driver, belief heterogeneity, actor diversification	Advocacy Coalition Framework, Actor affiliation and belief content, coalition formation and evolution, multi-stakeholder governance, policy-oriented learning	Comparative Agendas Project, Institutional venue comparison, punctuated attention, domestic-international agenda gap, sequential monopolization of agenda space
Methods	Longitudinal Discourse Network Analysis (DNA) of congressional hearings (n = 293) across four policy eras (1960–1964, 1982–1986, 2011–2015, 2017–2025); semi-automated text mining pipeline; Shannon entropy; chi-squared tests; network centrality measures	Discourse Network Analysis with community detection (Louvain algorithm); multi-stakeholder actor coding by organizational affiliation (state, firm, civil society); normalized congruence networks	Structural Topic Modeling (STM) of presidential documents (n = 890), COPUOS proceedings (n = 2,111), and congressional hearings (n = 587); Comparative Agendas Project (CAP) coding; cross-venue prevalence comparison
Concepts and Relationships Analyzed	Subsystem typology as dynamic outcome (unitary → collaborative), actor diversity and belief heterogeneity as dimensions of typological change, endogenous mechanisms of subsystem transition	Belief homophily hypothesis, correspondence between organizational affiliation and policy core beliefs, coalition modularity and integration, policy-oriented learning across eras	Policy attention as finite resource allocated across venues, domestic versus international agenda priorities, issue redefinition through actor entry, venue-specific patterns of agenda change

Main Findings	The space policy subsystem shifted from a tightly controlled, government-run arrangement to a broad, multi-sector network. In the early 1960s, over 91 percent of policy actors were state-affiliated; by the most recent era, commercial firms moved from the margins to structurally central positions, acting as brokers between coalitions. Belief diversity and participation both increased steadily across all four periods, consistent with a gradual transition from a unitary to a collaborative subsystem type under the ACF.	Where actors come from organizationally shapes what they advocate. Firm actors showed the most coherent evolution in beliefs, shifting from infrastructure concerns to economic viability to regulatory innovation. Coalitions moved from technical and administrative clusters toward a dual-track structure: a large security-focused coalition alongside a smaller commercial-regulatory coalition. Despite growing diversity, the network remained integrated rather than fragmented, with low modularity across all eras, indicating a collaborative rather than adversarial subsystem.	Commercialization became a dominant policy theme in both presidential and congressional records but is largely absent from the multilateral COPUOS record, revealing a significant gap between domestic priorities and international governance. The exploration agenda migrated from presidential attention during Apollo to congressional attention in the contemporary period. COPUOS displayed a pattern of sequential monopolization, where a single theme absorbed most agenda space before yielding to a successor, rather than the fragmentation seen domestically.
Main Theoretical Contributions	Advances the ACF by treating subsystem typology as a measurable, dynamic outcome rather than a fixed category. Proposes and tests a belief-centered, actor-driven model of typological transition. Demonstrates that endogenous policy design, not only external shocks, can drive subsystem-level structural change.	Extends the ACF by showing that organizational affiliation systematically conditions which policy beliefs actors express, a dimension the framework's emphasis on belief homophily has underspecified. Integrates multi-stakeholder governance with coalition analysis to connect institutional identity to belief content.	Bridges the Comparative Agendas Project with space governance scholarship. Demonstrates that domestic and international policy agendas follow distinct institutional logics rather than simple diffusion. Identifies venue-specific patterns of attention allocation that punctuated equilibrium and issue-attention cycle theories help explain.

Chapter 1

Measuring Subsystem Typology Change: Discourse Networks and the Evolution of U.S. Space Policy

★★★

Abstract

The Advocacy Coalition Framework classifies policy subsystems as unitary, adversarial, or collaborative, yet it offers limited guidance on how subsystems move among these forms. This study addresses that gap by treating typological change as the outcome to be explained rather than a background condition to be assumed. Drawing on Discourse Network Analysis of 293 congressional hearings spanning 1960–2025, it tracks actor composition and belief heterogeneity across four policy eras in the U.S. space domain. The final era, 2017–2025, covers a longer window than the preceding three to accommodate publication delays in the hearing record. The analysis shows a subsystem in sustained transition. Government actors accounted for 91 percent of policy discourse in the foundational era; by the contemporary period, commercial actors held the highest mean betweenness centrality and civil society actors generated nearly 20 percent of all discourse. Shannon entropy rose from 0.246 to 0.746, and a chi-squared test rejected the hypothesis of a stable underlying distribution of actor types. These shifts were not triggered by a single external disruption. They accumulated through a sequence of policy design choices, from the Commercial Space Launch Act of 1984 through the COTS and CRS programs to the Artemis architecture, each of which broadened the actor landscape and diversified the belief space. The study proposes a belief-centered, actor-driven model of subsystem typological transition, contributes a semi-automated measurement pipeline validated against hand-coded data, and offers a replicable quantitative framework for detecting when and how subsystem structure changes over time.

1. Introduction

Since the Apollo astronauts led visionary exploits to tread on the moon during the geopolitical tensions of the Cold War, the space policy subsystem, or the network of actors aligning through policy beliefs, has developed. Changes come from a wide array of influences, such as commercialization, increased international collaboration, militarization, economic developments, and the increasing number of policy actors. Because of this, activity in space continues to have implications for domestic affairs and international relations with

networks consisting of an increasingly diverse array of groups and individuals. These individuals, or policy actors, such as legislators, advocates, and their organizations, are multidimensional and represent a myriad of economic, political, and social interests. Given the evolution of the space policy subsystem, this dissertation chapter applies the Advocacy Coalition Framework, or ACF (Sabatier, 1988), to U.S. space policy to trace belief changes and actor entry over time and propose a new framework for understanding typological transitions from a government modality of decision making to a highly collaborative policy subsystem.

From the perspective of the ACF, public policy is analyzed through policy subsystems, which consist of coalitions composed of policy actors from multiple governmental and private organizations that engage in collective action to create conditions for policy change, to gain political influence, or modify existing institutions (Sabatier, 1988; Sabatier & Jenkins-Smith, 1993; Sabatier & Weible, 2007). Weible and Sabatier (2005) define policy subsystems as geographical or substantive domains involving hundreds of active stakeholders from all levels of government, interest groups, media, and research institutions participating in shaping policy internationally or domestically. This broad and inclusive definition can be applied to large-scale issues, such as state water policy (Munro, 1993), and oil and gas lease policy (Jenkins-Smith, St. Clair & Woods, 1991), as well as narrower policy matters, such as California's Marine Life Protection Act of 1999 (Weible & Sabatier, 2005). By breaking down complex policy issues into subsystems, the ACF allows for a more focused understanding of how specialized actors may influence policy processes in a particular topical area. Further, the diversity and complexity of modern policy issues necessitate specialization and expertise, which positions subsystem actors as key players in shaping public policy (Sabatier & Weible, 2007).

Given the breadth of potential issues falling under this definition, there is no singular, rigid template for defining policy subsystems, and imposing one would overly reduce its application as subsystems can range greatly in size and scope, thereby reflecting the fragmented and specialized nature of the policy process. In this same manner, the ACF's subsystem definition is purposefully flexible, acknowledging that subsystems may encompass broad or narrow topical issues, depending on the context. This flexibility is also extended to different governance levels, as subsystems can encompass policy issues at a local, national, or even international scope. Indeed, some policy problems do not fit neatly into any single subsystem's institutional jurisdiction, a condition Lewallen (2022) terms "ill-fitting problems" that engage multiple subsystems simultaneously. But, while this definition is flexible, there are still a myriad of subsystem types and their characteristics that need refinement, clarification, and organization to provide more use to researchers and encourage the expansion and application into underexplored policy areas, specifically ones in which public perceptions are not driving change, but changes are driven internally (Nohrstedt et al., 2023).

While subsystem characteristics and their type are arguably not static, they are posited to evolve over time as the issues, actors, and conditions surrounding the subsystem change. Therefore, this study applies the ACF to the U.S. space policy subsystem over the span of almost 60 years to organize subsystem typology definitions, examine policy subsystem dynamics, and define characteristics during these periods of change. The objective of this study is twofold. First, to examine how the measurement of policy beliefs within the U.S. space policy subsystem can illuminate changes in subsystem type from a unitary subsystem to a collaborative one and, second, to formalize hypotheses for how subsystem types evolve with the introduction of new actors and beliefs. While this organization effort may not perfectly align with every policy subsystem, it offers a structured template for researchers to

understand the underlying dynamics of subsystems. This inquiry is particularly insightful for research in highly-technical policy areas that have evolved from a nascent subsystem typology characterized by a government modality of decision making, or an "iron triangle" (Lowi, 1979), to a highly collaborative one characterized by public-private partnerships.

To assess subsystem types, the ACF provides a critical lens that begins with policy beliefs (Sabatier 1988). Shared beliefs, especially those at the policy core level, are the foundation upon which advocacy coalitions are formed. These coalitions, in turn, shape the structure and dynamics of policy subsystems through strategy coordination, venue influence, and defining the terms of debate. Subsystems, then, are not static arenas but dynamic political spaces whose type reflects the interaction and alignment of beliefs among coalitions over time. This study uses U.S. space policy as an ideal case for examining this process. Over the past 70 years, the space policy subsystem has undergone dramatic transformations by shifting from a unitary government-led domain to one increasingly shaped by diverse public, private, and nonprofit actors. This policy area offers a clearly demarcated set of eras tied to policy change, actor entry, and belief realignment. From Cold War state-driven exploration to the modern era of commercialization and privatization, each stage provides a window into how belief-driven coalitions reconfigure subsystem boundaries and interactions. This long and well-documented evolution allows for a detailed study of how policy subsystems change, not only in response to external shocks but through endogenous policy decisions that strategically invite new actors and reconfigure coalition structures. Unlike many policy domains where subsystem change may be diffuse or incremental, space policy offers a rich empirical terrain to analyze typological shifts over time.

2. Background

2.1 Policy Actors within a policy subsystem

Policy actors are individuals who consistently attempt to shape the direction of a policy subsystem, whether through direct or indirect means. They contribute to both change and continuity within the subsystem, often by forming advocacy coalitions or by assuming other roles, such as that of "policy brokers," who work to resolve disputes and facilitate compromise among opposing sides (Sabatier and Jenkins-Smith 1993; Ingold and Varone 2012). Policy actors encompass a broad range of people and organizations, including government officials at any level, private sector representatives, members of non-profit organizations, journalists, academic experts, independent consultants, and even judicial actors. Naturally, the degree to which these individuals and groups participate in and influence the policy process varies depending on the subsystem.

Policy actors within the ACF use beliefs as foundational tools to coordinate strategies, influence policy outcomes, and navigate subsystem dynamics (Sabatier 1988; Weible, 2010 and Ingold, 2011). Their interactions are structured around three hierarchical belief levels (deep core, policy core, and secondary) which guide coalition formation, policy engagement, and subsystem typology (Sabatier 1988). Further, this belief hierarchy is used by policy actors as cognitive filters for decision making, organizing, and guiding policy goals. At the base of this three-tiered belief system, deep core beliefs consist of fundamental values (e.g., ideology, views on human rights, perceptions of equity) that transcend specific policy areas. These entrenched beliefs rarely change but shape actors' worldviews.

Policy core beliefs, on the other hand, are mid-level beliefs specific to a policy arena (e.g., climate change causes, healthcare priorities, water management necessities). They determine coalition membership, define problem severity, and outline preferred solutions. For example, actors sharing a belief in market-driven environmental solutions form coalitions

advocating deregulation. Finally, secondary beliefs are narrow, empirical assumptions about policy implementation, for example, those on the technical details of implementing carbon pricing policies. This level of beliefs are more flexible and actively adapt to new evidence or negotiation.

As actors' beliefs serve as coordination mechanisms that lead to coalition formation, where actors with aligned policy core beliefs unite to amplify their influence, coalitions use shared policy core beliefs to frame issues, mobilize resources, and counter opponents. In these coalitions, belief congruence and low levels of conflict enables consistent messaging and collective lobbying in strategic actions (Zafonte and Sabatier, 1998). Standardized measures of this congruence, such as the Advocacy Coalition Index, have demonstrated the empirical link between belief similarity and coordinated action (Satoh, Gronow, & Ylä-Anttila, 2023). Actors also engage in policy learning by reinterpreting or reinforcing beliefs based on new data or subsystem feedback (Sabatier and Jenkins-Smith, 1993; Weible, Oloffson and Heikkla, 2023). Further, divergent policy core beliefs fuel subsystem conflicts and the ability for actors to achieve policy goals.

Understanding the belief systems and strategic behaviors of policy actors requires situating them within the broader institutional and organizational context of the policy subsystem. While *Section 2.1* outlines how actors use hierarchical beliefs to coordinate action and form coalitions, the next section turns to the typologies of these subsystems themselves by highlighting the arenas typologies in which these actors operate, interact, and ways they ultimately seek to influence policy outcomes.

2.2. Subsystem Typologies

Policy actors learn and adapt to their policy environment and seek to have some effect on the policy subsystems they operate within. These subsystems, which sometimes coincide with other subsystems, are the arenas where policy decision making, political activities, and

organization of policy actors occur. A policy subsystem's boundaries are defined by its geographical elements, topical breadth, and endurance over decades of time (Sabatier and Jenkins-Smith, 1993). Its use as a concept provides clarification to a complex system of governance and serves as a template for identifying networks of policy actors influencing policy decision making and change. These boundaries are subject to be blurred in areas where policy issues are contested and are defined by the scope of conflict and jurisdiction of policy actors (Schattschneider, 1960). Subsystems have been useful as a lens to assess concepts like opportunity structures and strategy choices in climate-change policies (Aamodt & Stensdal, 2017), and awareness of opposing coalitions within a subsystem (Merry, 2019).

The type and characteristics of a subsystem have been continually elaborated under the ACF. These typologies exist, and change, depending on policy actors' beliefs and interactions within the subsystem. Therefore, the characterization of policy actor interactions determines the typology of a subsystem. For example, when there is belief homophily in a subsystem actors share similar beliefs and coordinate political activities (Sabatier, 1998). Methodological approaches, such as text analysis, comparative research designs, network analysis, and survey methods, are used in studies seeking to further understanding of policy subsystem dynamics and the coalitions within them (e.g., Sabtier and Weible, 2007; Ingold et al., 2016; Henry et al., 2022).

The ACF's subsystem concept, however, did not emerge in isolation. It belongs to a longer lineage of related constructs in American political science, each of which attempted to describe how policy decisions are made within bounded arenas of specialized actors. Freeman (1965) introduced the concept of the political "sub-government" to describe the stable, relatively autonomous clusters of legislators, bureaucrats, and interest group representatives that controlled routine policy decisions in specific functional areas. Lowi (1979) extended this logic with the "iron triangle", emphasizing the self-reinforcing character

of these arrangements: committees, agencies, and organized interests developed mutually beneficial relationships that insulated policy decisions from broader public scrutiny. These early formulations shared a common structural premise, that policy arenas tend toward closure, with a small set of actors exercising disproportionate control. What distinguishes the ACF's treatment of subsystems from these predecessors is its emphasis on beliefs as the primary organizing principle. Where the iron triangle and sub-government literature focused on institutional position, the ACF treats shared policy core beliefs as the mechanism that binds actors into coalitions and gives subsystems their characteristic structure (Sabatier, 1988; Sabatier and Jenkins-Smith, 1993). This distinction is consequential for empirical research as understanding subsystem dynamics requires measuring not only who participates and what institutional roles they occupy, but what they believe about the policy domain and how those beliefs align or diverge across actor groups.

The ACF categorizes policy subsystems along a continuum of conflict, distinguishing among *collaborative*, *adversarial*, and *unitary* types (Jenkins-Smith and Sabatier, 1999) and the longevity of the subsystem as either *nascent* or *mature*. Collaborative subsystems are characterized by low to moderate levels of conflict and the presence of cooperative coalitions (Calanni et al. 2015; Koebele et al. 2020). In contrast, adversarial subsystems involve high levels of conflict, with competing coalitions vying for influence (Ingold and Leifeld, 2016). Unitary subsystems exhibit minimal conflict, typically dominated by a single coalition with little or no organized opposition (Weible, 2008; Heinmiller et al. 2021). At their core, subsystem types are determined by the presence of contention in a subsystem and the role of coordination, shared beliefs, and divergent policy positions, specifically in the willingness to compromise within it (Sabatier and Weible, 2007).

While this typology is increasingly used to inform empirical research and theoretical development, greater attention is still needed to explore how these subsystem forms shape

policy processes and outcomes over time. The following sections delve into each subsystem type in detail, illustrating how their structural features influence coalition behavior, conflict dynamics, and policy change trajectories, and how the U.S. space policy system can be used as a case study to illustrate typology change, thereby positing how subsystem types affect policy discussions and their outcomes overtime.

When considering the longevity of a subsystem, nascent ones emerge when a new issue enters the policy agenda and cannot be easily integrated into existing structures. These early-stage subsystems often lack stable coalitions, institutional venues, or clearly defined policy goals and jurisdictions (Beverwijk et al. 2008; Bandelow and Kundolf 2011; Stritch 2015; McGee and Jones 2019; Weible et al. 2020; Ingold et al. 2025). Therefore, they offer valuable insights into how actors begin to coordinate and construct belief systems in uncertain and contested policy environments. In contrast, a mature subsystem has persisted for a "decade or so" and policy actors have had ample time to form and instill belief systems in decision making (Sabatier, 2007). The solidification of these beliefs results in the mobilization and maintenance of coalitions characterized by support or opposition of policies and programs (Nohrstedt et al., 2023). Eventually, nascent subsystems may become integrated into existing mature ones through coalition's belief systems (Kefeli et al., 2023).

An adversarial policy subsystem is defined by high levels of conflict and intense competition between opposing coalitions. These coalitions hold deeply polarized beliefs and engage in minimal coordination with one another, instead competing vigorously to shape policy outcomes in line with their values (Sabatier and Jenkins-Smith, 1993; Weible et al., 2020). Authority within the subsystem is often fragmented, as government agencies or actors align with different sides, reinforcing divisions. Coalitions engage in extensive venue shopping, strategically targeting courts, legislatures, or administrative bodies to gain advantages over their rivals (Pralle, 2003). Policy outcomes in such subsystems are

frequently zero-sum, producing clear winners and losers with limited potential for compromise. The exchange of technical and political information becomes highly politicized, contributing to a fragmented network structure (Leifeld and Schneider, 2012; Park, Liu, and Vedlitz, 2022). Learning tends to occur within coalitions rather than across them, and cross-coalition coordination remains scarce, further entrenching adversarial dynamics (Weible and Sabatier, 2009; Weible, Olofsson, and Heikkila, 2023). These characteristics contribute to periods of policy gridlock and make significant policy changes difficult without external shocks or major shifts in coalition power. The adversarial nature of these subsystems contrasts with collaborative or unitary subsystems, where there is more cooperation or a single dominant coalition, respectively.

A unitary policy subsystem is marked by the dominance of a single advocacy coalition with ample resources that effectively steers the policymaking process while weakening any opposition (Weible et al., 2010). Resources used by the dominant single coalition include things such as funding, leadership, and public support to shape policy outcomes. As a result, conflict within the subsystem is minimal, since most actors share similar policy core beliefs. Decision-making authority is centralized, reducing the likelihood of fragmentation or strategic venue shopping. This cohesion fosters a high degree of policy stability, with changes occurring incrementally unless disrupted by major external events. Overall, unitary subsystems represent a streamlined and low-conflict policy environment, standing in contrast to the contested dynamics of adversarial or collaborative subsystems.

A collaborative policy subsystem under the ACF refers to a policymaking environment where multiple advocacy coalitions with differing beliefs engage in negotiation and coordination to achieve incremental or major policy changes (Nohrstedt et al., 2023). Unlike adversarial or unitary subsystems, collaborative subsystems emphasize finding common ground despite disagreements, often facilitated by intermediaries like policy

brokers. Collaborative subsystems are defined by the presence of multiple coalitions, negotiations and cross-coalition coordination, the lack of a centralized authority, and mixed motivations characterized by beliefs and strategic interests (Wesche et al., 2025). These multiple coalitions within the subsystem are composed of diverse groups (e.g., environmentalists, industry representatives, policymakers) that coexist, disagree on policy core beliefs, but still seek compromise. These compromises are sought through negotiated agreements in which policy actors prioritize "win-win" solutions through consensus-driven processes, though outcomes may involve trade-offs. Policy brokers help to mediate these interactions by enabling short-term alliances or enduring partnerships that facilitate cross coalition coordination. In a collaborative subsystem, there is not a centralized authority held by a single coalition, rather, decision-making venues are accessible to various stakeholders with mixed motivations and strategic interests (e.g., resource access, political survival). These applications show collaborative subsystems facilitate policy change through negotiation, though outcomes may remain contested. The ACF highlights that such subsystems are prone to both breakthroughs and stalemates, depending on trust levels and broker effectiveness.

2.3 Measuring beliefs within a subsystem

Beliefs within the ACF are measured using a range of methodological approaches, including both traditional and network-based techniques. Common methods involve surveys and structured interviews designed to assess deep core, policy core, and secondary beliefs, helping researchers identify shared values and priorities among coalition members (Henry et al., 2022). These instruments often include questions about problem severity, preferred policy solutions, and ideological leanings specific to the subsystem. Document analysis is another widely used approach, where researchers examine policy documents, public statements, and organizational reports to infer belief systems and assess alignment or divergence across actors. The Advocacy Coalition Index has also proven useful as it offers a standardized way

to quantify belief similarity and coordinated action among actors, providing a basis for identifying coalitions and their internal dynamics (Satoh, Gronow and Ylä-Anttila, 2021). Beyond these direct methods, network analysis offers additional tools for measuring beliefs through the relationships among policy actors.

Discourse Network Analysis (DNA) measures beliefs within ACF by combining qualitative content analysis with network analysis to systematically examine the relationships between policy actors and their expressed beliefs (Leifeld, 2013; 2017; 2020). The process begins with collecting textual data such as speeches, media coverage, parliamentary debates, or social media posts where actors articulate their positions, arguments, or normative claims. Through qualitative coding, researchers identify actors, beliefs, and the nature of their relationships (e.g., agreement or disagreement). This coded data is then used to construct networks that visualize these relationships. In actor congruence networks, actors are linked based on shared policy stances, while concept congruence networks connect beliefs or concepts that are co-mentioned by actors. Affiliation networks link actors directly to the beliefs they express, helping to map out the structure of advocacy coalitions. Once these networks are established, researchers apply network analysis to identify clusters of aligned actors, levels of polarization or consensus, and the centrality of beliefs in shaping discourse. Longitudinal applications of DNA further allow for tracking how belief systems and coalitions evolve over time while offering a robust methodological tool for capturing how beliefs structure policy discourse, coalition behavior, and subsystem dynamics within the ACF.

Underlying this approach is the ACF's central theoretical claim that belief systems not only structure coalition membership but also shape the broader configuration of policy subsystems. While subsystems are defined by the full range of actors engaged in a policy domain, coalitions represent the belief-based alignments within them. Subsystem change,

therefore, is not solely the product of shifts in institutional arrangements or external shocks but can also result from transformations in coalition structure and belief alignment over time. This distinction underscores the value of belief-centered methods like DNA: by visualizing how belief systems evolve, researchers can better detect when and how a subsystem transitions from one typological form to another. Tracking these internal dynamics is particularly important in subsystems undergoing endogenous change, such as U.S. space policy, where policy design itself enables the entry of new actors and the emergence of new coalitions.

The central goal of this study is to examine how the measurement of policy beliefs within the U.S. space policy subsystem can illuminate changes in subsystem typology over time. While the ACF has long provided a robust foundation for analyzing policy change through coalition dynamics, it lacks formalized understanding for how subsystem typologies evolve, particularly when such transformations are driven by policy change that move the subsystem from a unitary type to one with highly diverse policy actors and beliefs. This study addresses that gap by operationalizing belief systems through DNA and related methods to trace how the entrance of new policy actors, particularly from the commercial and nonprofit sectors, alters belief alignments and coalition structures within the subsystem. I argue that the incorporation of new actors following major policy initiatives reshapes belief networks and, in doing so, initiates a shift in the subsystem's type. More specifically, this research proposes a framework for hypothesizing that policy change, facilitated by the strategic introduction of new actors, drives the transition from a historically nascent or unitary one to a mature adversarial subsystem or more collaborative one. In doing so, this study contributes to the theoretical development of the ACF by offering a belief-based mechanism for understanding and anticipating subsystem type change.

2.4 The Space Policy Subsystem

This study defines the U.S. space policy subsystem as the set of actors who regularly seek to influence the authoritative allocation of values governing space activities within and from the United States, consistent with the ACF's specification that subsystem boundaries are demarcated by mapping those actors who participate in a policy process over sustained periods of time (Sabatier & Jenkins-Smith, 1993; Sabatier & Weible, 2007). The subsystem's topical scope encompasses civilian space exploration, national security space operations, commercial space transportation and services, satellite communications and spectrum management, space situational awareness and orbital debris mitigation, and the international legal and diplomatic frameworks that govern these activities. Its principal state actors include the National Aeronautics and Space Administration, the Department of Defense and its component U.S. Space Force, the Federal Aviation Administration's Office of Commercial Space Transportation, the Federal Communications Commission, the Department of Commerce's Office of Space Commerce, and the congressional committees with authorizing and appropriating jurisdiction over these agencies, most notably the House Committee on Science, Space, and Technology and the Senate Commerce Committee's Subcommittee on Space (Chapman, 2020; Whitman Cobb & Frazier, 2024). Firm actors range from legacy prime contractors such as Boeing and Lockheed Martin to commercial entrants including SpaceX, Blue Origin, and Rocket Lab, whose participation expanded substantially following the policy design choices described further in Section 2.6.2 (Melamed et al., 2024; Zancan & Paravano, 2024). Civil society actors include academic research institutions, industry associations such as the Commercial Spaceflight Federation and the Satellite Industry Association, policy research organizations such as the Secure World Foundation and the Aerospace Corporation, and public interest groups such as the Planetary Society (Sadeh, 2010; Whitman Cobb & Frazier, 2024). Narrative analyses of legislative testimony

surrounding the establishment of the U.S. Space Force illustrate how these diverse actors deploy measurably different narrative elements even when converging on shared policy outcomes (Ruff, Stelmach, and Jones, 2022; Lantis, 2025). At the international level, the subsystem intersects with multilateral governance through the United Nations Committee on the Peaceful Uses of Outer Space and through bilateral and plurilateral instruments such as the Artemis Accords, though these international dimensions are examined more fully in Chapter 3. Because space policy spans national security, science and technology, transportation, commerce, and foreign affairs, the subsystem's boundaries are inherently cross-cutting; the ACF literature recognizes that policy subsystems may overlap with or nest within adjacent domains, and this characteristic is a feature of the space case rather than a limitation of the analytical framework (Nohrstedt & Weible, 2010; Weible et al., 2020).

2.4.1 Early Stages

The U.S. space policy subsystem has undergone significant transformation from a government modality in which only a few government agencies and large contractors participated in decision making processes. The subsystem today is characterized by increased resources, private-public partnerships, participation in policy discussions of nonprofits, academics, NGOs, national labs, private firms of varying size, and other types of policy actors. The early founding of NASA in 1958 under President Eisenhower's National Aeronautics and Space Act set forth the framework for provisions to be made for both civilian and defense space and aeronautical activities (Pub. L. 85-568, 72 Stat. 426). In the 1950s and 1960s, U.S. space policy decisions were primarily driven by presidential leadership, particularly during the Eisenhower and Kennedy administrations, with significant influence from Cold War dynamics. President Kennedy escalated space ambitions in response to Soviet achievements, notably committing to the Apollo Moon landing program in 1961. Kennedy's administration secured congressional support for aggressive funding, framing

space exploration as a Cold War prestige project. At this time, Vice President Lyndon Johnson played a critical role as chair of the National Aeronautics and Space Council under Kennedy, advocating for NASA's expansion and later continuing this focus during his own presidency. Coinciding with these events, NASA's use of private contractors began with Project Mercury (1961), America's first human spaceflight program.

While early space policy was dominated by presidential initiatives, Congress continually gained influence as NASA's infrastructure and contractor networks became entrenched in specific states, incentivizing legislative engagement through funding and oversight. Coinciding with Congress, during the 1950s–1960s, executive branch leadership remained paramount in setting strategic goals, often prioritizing geopolitical competition over purely scientific or economic objectives.

2.4.2 The Era of Commercialization Policies

Though NASA's early use of prime contractors such as McDonnell Aircraft Corporation and Convair Astronautics Division began with Project Mercury in 1961 (NASA, 2025), the 1984 Commercial Space Launch Act (CSLA) marked early efforts to regulate and encourage private sector participation in launch services. The CSLA represented a deliberate policy choice to harness private enterprise for national competitiveness, and its economic effects have been documented in subsequent analyses of the commercial space industry (George, 2019). This marked the beginning of policy actors outside of the unified subsystem to increasingly begin to participate in policy discussions, form interests in the space economy, and form beliefs on the nature of the regulatory environment they were operating in. Into the 2000s, the subsystem continued to allow the entrance of new actors seeking to influence it. Policy changes that shaped the subsystem include the 2004 Commercial Space Launch Amendments Act (Pub. L. 108-492) providing regulatory foundations for commercial human spaceflight; the Commercial Orbital Transportation Services (COTS) and Commercial

Resupply Services (CRS) programs (2006–2008) incentivizing private companies to deliver cargo to the International Space Station (ISS) thereby reducing NASA's operational costs; and the 2010 National Space Policy prioritizing public-private partnerships (P3s) in areas of space situational awareness (SSA) by acquiring space related goods and services to government agencies for communication, launch systems, and space exploration. Finally, continual and anticipated growth of the global space economy (McKinsey, 2024), the Space Technology Mission Directorate promoting "spin-in" technologies from manufacturing to advance space research, and the Artemis Program (2017) accelerated collaboration through outsourcing of lunar lander development to private firms like SpaceX's Starship.

The U.S. space policy subsystem demonstrates how endogenous forces, particularly internally driven policy decisions and the role of the state in the economy, can reshape subsystem boundaries, actor composition, and ultimately typology. Across the four policy eras analyzed in this study (1960–1964, 1982–1986, 2001–2015, and 2017–present), each period reflects proactive institutional and policy choices rather than reactive adaptations to exogenous events. These shifts facilitated the entrance of new policy actors including commercial firms, nonprofit organizations, and nontraditional government partners who brought with them distinct belief systems and policy preferences. Such internal restructuring challenged the earlier unitary form of the subsystem, which had been dominated by a centralized coalition of government actors with aligned beliefs and clear jurisdictional authority. The deliberate inclusion of new actors via legislation, program design (e.g., COTS, CRS), and funding realignment diffused authority and increased belief heterogeneity, introducing conditions more characteristic of collaborative or adversarial subsystems. These transformations provide a compelling case for reconceptualizing subsystem typology change as a function of internal political strategy, institutional redesign, and coalition reconfiguration, rather than solely the product of external shocks and longevity. This

perspective enables a more nuanced understanding of policy change by shifting focus from typological confirmation to transition. Instead of merely identifying whether a subsystem conforms to existing typologies, this study traces how and why those typologies evolve in response to endogenous political engineering. By mapping these changes over time and linking them to belief structures using DNA, this project contributes to ACF theory by offering a belief-driven, actor-centered account of typology transition. In doing so, it highlights the flexibility of the space policy subsystem and the utility of subsystem typologies for explaining not just the presence of coalitions, but the mechanisms of transformation itself.

2.5 Expectations on Subsystem Typology Change in U.S. Space Policy

This study highlights how endogenous mechanisms, particularly intentional policy design, institutional restructuring, and actor recruitment, may also drive changes in subsystem typology. The U.S. space policy subsystem is uniquely well-suited to explore this theoretical gap, as it has experienced several major transitions triggered by internal choices to reorganize authority and redistribute policy capacity.

A clarification is necessary regarding what "endogenous" means in this context. The ACF already recognizes "internal events" as one pathway to major policy change, alongside external shocks and negotiated agreements (Sabatier and Weible, 2007). Internal events, such as policy failures or scandals within the subsystem, can shift coalitional power and open windows for policy revision. The endogenous mechanism proposed here is related but distinct. It refers not to events that happen to occur within the subsystem's boundaries, but to deliberate policy design choices that alter who participates in the subsystem and on what terms. When Congress passed the CSLA or when NASA structured the COTS program to solicit competitive bids from private firms, these were not responses to internal crises. They were strategic decisions by actors within the existing coalition structure to reshape that structure by inviting new participants. This approach is consistent with previous research, as

prior policy outputs should be distinguished from truly exogenous factors when explaining coalition change because the feedback loop from policy to politics operates through identifiable causal mechanisms rather than through unpredictable external disruptions (Schmid, Sewerin, and Schmidt 2020). The space policy case follows a similar logic. The policies that diversified the subsystem were themselves products of prior coalitional activity, and their effects on subsystem structure accumulated through feedback rather than rupture.

Across the four policy eras analyzed (1960–1964, 1982–1986, 2011–2015, and 2017–present), there is observable movement in both belief heterogeneity and coalitional structure, which together provide the conditions under which typological transitions may occur. The deliberate inclusion of new actors (e.g., via the CSLA or COTS) expanded the belief space and created both opportunities and tensions that were previously absent in the subsystem. These transitions, from unitary to potentially adversarial or collaborative forms, further demonstrates that typology is not static, but evolves through the interactions between actor entry, belief realignment, and subsystem composition.

Existing evidence on partisanship in space policy supports the expectation that this subsystem is more likely to follow a collaborative than an adversarial trajectory, even as belief heterogeneity increases. Research on public attitudes toward space funding has found that, while Republicans are somewhat more inclined to support military space expenditures and Democrats tend to favor civil and scientific programs, broad bipartisan majorities and the public continue to view NASA as essential and to endorse space exploration more generally (Black, 2025; Burbach, 2019; Johnson, 2019; Whitman Cobb, 2011). At the elite level, partisan differences manifest less in outright opposition than in framing: Ruff, Stelmach, and Jones (2022) demonstrate through a Narrative Policy Framework (NPF) analysis of congressional testimony on the U.S. Space Force that Republicans and Democrats deployed measurably different narrative elements, including distinct settings, characters, and morals,

yet converged on the underlying policy outcome. Republicans were more likely to frame space as a warfighting domain and to identify China and Russia as explicit adversaries, while Democrats favored descriptions of space as contested and emphasized bureaucratic reform and international cooperation. Despite these rhetorical differences, the final vote establishing the Space Force passed with overwhelming bipartisan margins in both chambers (S. Res. 1790, 2019). Executive-level National Space Policies have followed a similar pattern, with Republican administrations emphasizing American primacy and military presence while Democratic administrations have prioritized cooperative language and multilateral engagement (Johnson-Freese, 2017), yet each successive administration has largely preserved the institutional structures and commercial partnerships established by its predecessor.

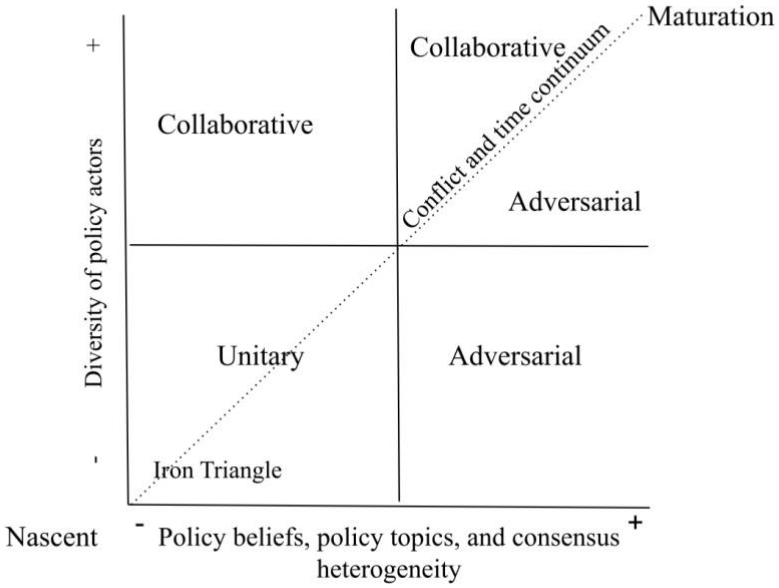
These perceptual differences are consequential for understanding what conflict looks like within the space policy subsystem. Unlike domains such as energy and environmental policy, where partisan divisions routinely produce sustained adversarial coalitions organized around incompatible core beliefs (Nam, Weible, and Park, 2022; Yordy et al., 2019), the partisan cleavages in space policy tend to operate at the level of what the ACF would classify as policy core or secondary aspects: disagreements over the appropriate framing of threats, the balance between military and diplomatic instruments, and the relative emphasis on commercial versus international partnerships. The deeper normative commitment to maintaining U.S. leadership in space and investing in the capabilities to do so appears to function as a shared deep core belief that cuts across party lines (Burbach, 2019). This configuration is more consistent with a collaborative subsystem dynamic, in which multiple coalitions hold distinguishable but not irreconcilable beliefs and can negotiate shared policy outputs, than with an adversarial subsystem in which coalitions pursue mutually exclusive goals. The expectation, then, is that the diversification documented in Section 2.6 has

produced greater belief heterogeneity without generating the kind of zero-sum conflict orientation that characterizes adversarial subsystem types.

This leads to a shift in focus from typology as a descriptive category to typology as a dynamic outcome. Most ACF studies classify subsystems into one of several typologies (unitary, adversarial, collaborative) at a single point in time. By contrast, this study examines the evolution of a subsystem over time. In doing so, it contributes to theory-building by proposing a belief-centered, actor-driven explanation of typology change. To explore these dynamics, this study maps how the space policy subsystem moves among typological categories over time, using both belief congruence and actor composition as the key indicators of change. Visualizations developed using Discourse Network Analysis (DNA) show shifts in subsystem structure, actor centrality, and belief diversity across eras. These maps allow for the tracing of subsystem movement along major dimensions of conflict orientation, diversification of beliefs, and subsystem maturity.

Figure 1 conceptualizes subsystem typology as a function of actor diversity (y-axis) and belief heterogeneity (x-axis).

Figure 1: Development of Policy Subsystem Typology and Conflict Grid



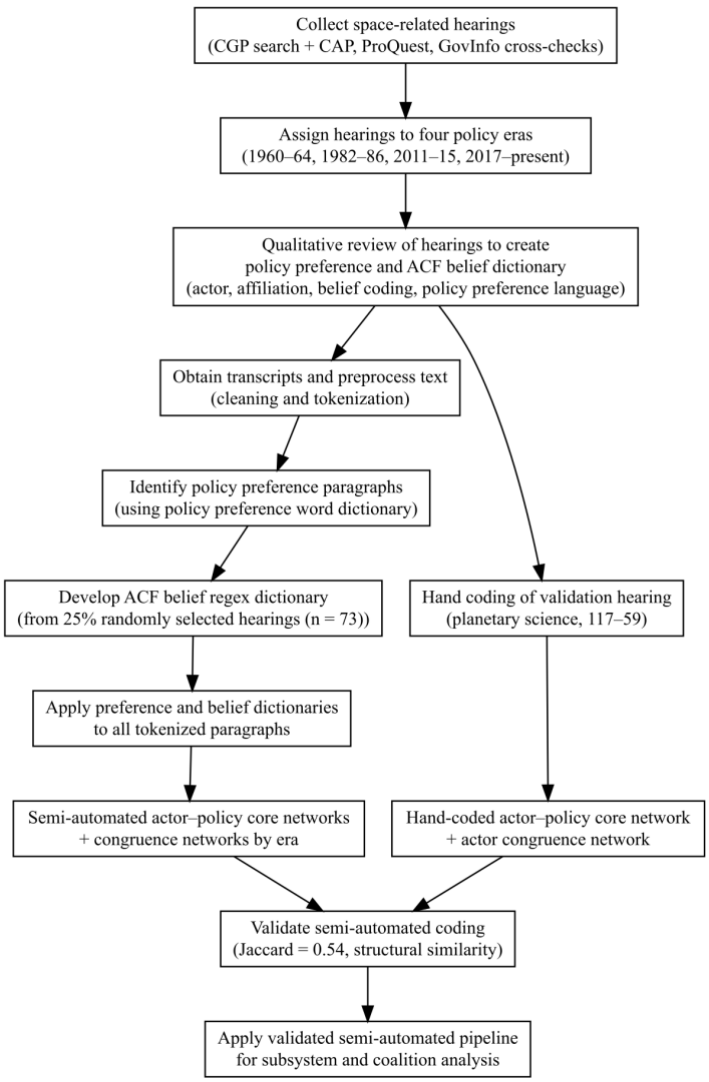
The conflict continuum (dotted diagonal) illustrates the increasing potential for adversarial dynamics as both dimensions grow overtime. The U.S. space policy subsystem originated in the bottom-left quadrant as an elite unitary structure, and has since moved toward the upper-right, reflecting rising pluralism and collaboration. This grid provides a visual foundation for modeling subsystem transitions in highly-technical and less polarized issues over time, while highlighting the role of institutional and strategic change bringing in more policy actors that drive typological evolution. The process of assessing subsystem typology evolution and the organization around actor beliefs in the space policy subsystem is discussed further in the next section.

3. Data and Methods

3.1 Research Design

This study followed a structured data-processing and coding pipeline. The process began with the collection of space-related congressional hearings through searches of the Catalog of U.S. Government Publications and cross-checks with the Comparative Agendas Project, ProQuest, and GovInfo. Hearings were then assigned to four policy eras. A qualitative review of a subset of hearings followed to identify policy preference language and to construct the ACF-based belief dictionary. Afterward, all transcripts were obtained, cleaned, and tokenized into speaker-level paragraphs. Policy-relevant paragraphs were identified using a curated policy preference word dictionary, and an ACF belief dictionary was developed from the training hearings. These dictionaries were applied to all tokenized paragraphs to generate semi-automated actor–policy core networks and congruence networks by era. In parallel, a validation hearing was fully hand-coded to produce a hand-coded actor–policy core network and congruence network. The semi-automated coding was then evaluated against the hand-coded network using structural comparison and the Jaccard similarity coefficient. The validated semi-automated pipeline was subsequently used to analyze subsystem dynamics and coalition structure across the full corpus. For an overview of the data acquisition process, dictionary formation, and manual verification, see *Figure 2*.

Figure 2: Overview of Data Processing and Coding Pipeline

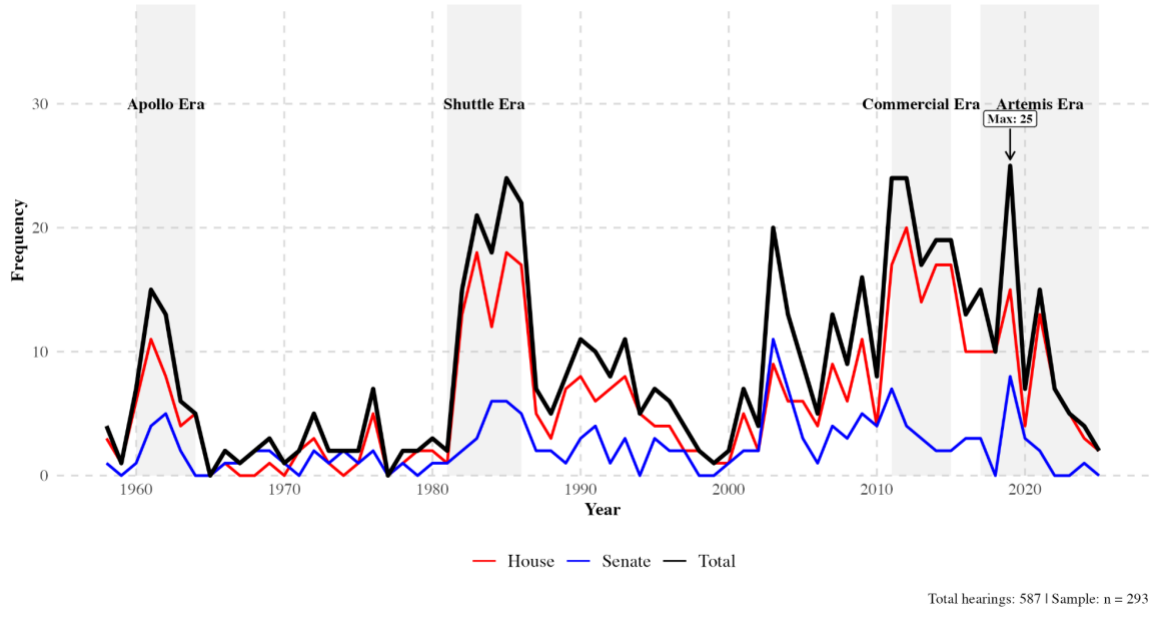


3.2 Data Collection

U.S. congressional hearings were used to measure the organization of beliefs in space policy over time. Hearings provided extended text on policy discussions, including witness testimonies, requested materials, committee member statements, and procedural information. Witnesses were invited by committee members, interviewed prior to appearing, and drawn from diverse affiliations including interest groups, private firms, government agencies, academia, and the general public. Committees typically sought a range of perspectives relevant to the hearing topic (Congressional Research Service 2017). Hearings were identified through searches of the Catalog of U.S. Government Publications database in

January and December 2025. Publication keywords included “space”, “outer space”, “space exploration”, “astronautics,” “National Aeronautics and Space Administration”, “space flight”, with titles included the term “hearing.” Search results were reviewed for duplicates, metadata-only entries, and non-hearing materials. Relevant listings were then cross-checked with the Comparative Agendas Project hearings database, ProQuest, and through the GovInfo API. The final sample consisted of 293 congressional hearings. *Figure 3* demonstrates the collected sample and the frequency of hearings in either the House or Senate. It should be noted that while many relevant hearings were identified, not all text was available for addition to the sample corpus[1], *Figure 3* shows availability by plotting the total collected and available to be added to the corpus, and how these break down by House and Senate.

Figure 3: **Congressional Hearings on Space Policy**



[1] Several factors account for the unavailability of complete hearing texts. Older congressional records may lack digitized transcripts or exist solely as metadata within indexing systems. Additionally, space policy frequently intersects with national security and defense initiatives. Hearings addressing these sensitive topics, particularly those conducted by intelligence or armed services committees, may be classified or held in closed sessions. Finally, administrative delays in official publication by the Government Publishing Office or incomplete archival digitization contribute to gaps in the accessible text corpus.

Hearings were grouped into four policy eras based on historical punctuations in U.S. space policy decision making: 1960–1964, 1982–1986, 2011–2015, and 2017–2025. These eras captured key transitions in subsystem structure, including the early years of NASA and Apollo program; the onset of commercialization following the Commercial Space Launch Act; the end of the shuttle era; and recent large-scale commercialization. The most recent era (2017–2025) spanned a longer interval to account for delays in online publication of hearings while still capturing contemporary topics under active discussion. The 1960–1964 era reflected early debates surrounding NASA's establishment, the space race, and Apollo 11 planning. The 1982–1986 era captures the emergence of commercialization. The 2011–2015 era captured debate following shuttle program disasters and subsequent policy agenda shifts. Finally, the 2017–2025 era encompassed modern debates on Moon and Mars initiatives, SpaceX's first non-governmental orbital launch, and the use of Dragon C2+ to resupply the ISS. Across eras, the dataset allowed the observation of changes in policy actors, belief coordination, and discourse networks during major commercial, international, technological, and economic shifts.

3.3 Policy Statements Coding

Discourse network analysis was used to map congruence networks that linked policy actors based on shared policy concepts. Actors discussing the same concepts were connected with edge weights proportional to the frequency of shared statements (Leifeld 2017). Consistent with previous research approaches, subgroups of actors with similar profiles of policy statements were treated as advocacy coalitions. In this study, "statements" are defined as speaker-level paragraphs in the transcript, which are coded for expressed policy beliefs.

Following the ACF belief hierarchy, the coding scheme distinguished deep core beliefs, policy core beliefs, and secondary beliefs. Policy core beliefs were used as the key measure of coordinated activity because deep core beliefs were not always specific to space

policy, and secondary beliefs were often short-lived (Weible et al. 2009). Speaker-level paragraphs in each transcript served as the unit of analysis and these statements could receive multiple codes when they expressed multiple belief types. A full description of the coding scheme is provided in *Appendix Entry 1*. Below, *Table 1* illustrates the statement-level coding process using a hearing on spectrum management. The qualitative coding process of policy beliefs was used to generate two dictionaries used to identify recurring policy core and deep core beliefs, topical areas of debate, relevant actor categories, and commonly used linguistic patterns associated with policy preferences.

Table 1: ACF Coding Procedure Example

Quote	Coding	Coded as	Description
"So first I appreciate that we're considering H.R. 675, the Secure Space Act, bipartisan legislation that I reintroduced with Chairwoman Rodgers last week. This bill would extend the Secure and Trusted Communications Network Act Framework to the U.S. licensing of nongeostationary orbit satellites to protect the public from untrusted entities and foreign adversaries. As innovations flourish, we must protect the satellite marketplace and its role in the supply chain from threats by nontrusted actors. We can't risk our satellite networks facing the same challenges as our other communications networks here and	Actor	Frank Pallone Jr.	Policy Actor stating policy preference
	Affiliation	U.S. House of Representatives	Organization Affiliation
	Actor Position	Support	Support, Oppose, or Neutral to the policy preference being discussed
	Deep Core Belief	Anti-Authoritarianism	Fundamentally normative and ontological axioms

globally.	Policy Core Belief	Counter Adversaries in Space	Definition, importance, and/or cause of the problem. Position to achieve core belief
	Secondary Belief	Pass the Secure Space Act	Instrumental decisions to achieve the policy core belief
	Actor Type	State	Actor type of state, IGO, firm, civil society, or multiple affiliations
Source: Liftoff: Unleashing Innovation in Satellite Communications Technologies. (2023). https://www.congress.gov/event/118th-congress/house-event/115337/text			

3.4 Text Mining and Semi-Automation

Text mining techniques were used to identify relevant statements due to the volume of text in the corpus. Hearing transcripts were tokenized into speaker-level paragraphs, and paragraphs containing policy-relevant verbs from *Table 2* were extracted. This policy preference dictionary included terms that typically preceded or accompanied policy preferences and was compiled through a qualitative review of hearings supplemented with additional terms that appeared across contexts.

Table 2: Policy preference words used to pull tokenized policy paragraphs for coding
"accept", "adopt", "against", "agree", "align", "allow", "amend", "appropriate", "assert", "believe", "beneficial", "benefit", "can", "compromise", "condemn", "condone", "consider", "consistent", "contend", "concur", "condemn", "critical", "crucial", "demand", "deny", "desire", "detriment", "do", "effective", "emphasize", "encourage", "endorse", "enact", "expedite", "facilitate", "fail", "favor", "feasible", "feel", "help", "highlight", "implement", "imperative", "important", "improve", "justify", "levy", "like", "maintain", "must", "necessary", "negotiate", "negative", "necessity", "permit", "positive", "prefer", "prioritize", "propose", "prohibit", "promote", "propose", "pursue", "ratify", "realistic", "reject", "rebut", "refute", "recommend", "require", "retain", "revise", "reject", "should", "suggest", "suit", "success", "support", "think", "underscore", "urge", "veto", "viable", "want"

The policy preference dictionary was paired with an ACF policy belief dictionary containing deep core and policy core categories. Deep core beliefs captured broad normative commitments such as accountability, collaboration, national security, and technological advancement. Policy core beliefs captured subsystem-specific priorities such as assured access to space, planetary and deep space exploration, public–private partnerships, industrial base and supply chain security, Moon-to-Mars exploration, and international collaboration.

Secondary beliefs, which described operational or implementation-level details, were initially included in the automation attempt. However, their linguistic variation was too great for reliable pattern-based identification, and they were excluded from the automated coding while remaining part of the hand-coded validation network. This approach remained consistent with prior work emphasizing policy core beliefs as the primary link between actors in coalitions (Weible et al. 2009).

Regular expression patterns were developed through qualitative review of hearings to identify the language most frequently associated with each belief category. This qualitative review included a full manual coding of 25% randomly selected congressional hearings from the sample paired with a full qualitative review of congressional hearing manifests, opening statements, and closing statements. After this review, a regex dictionary was created to

capture the diversification of policy beliefs while accounting for variation in how those beliefs were expressed over time. This regex dictionary was created to measure positions towards a policy belief and the policy belief itself through a comprehensive review of the congressional hearing sample. These patterns captured explicit policy terminology, common phrasing used by political actors, and variations in technical or programmatic language. Statements were allowed to receive multiple belief codes when appropriate. This procedure enabled the reconstruction of actor–belief relationships in a manner consistent with the manual coding logic while maintaining consistency across the full corpus. For an overview on the developed regex dictionary, please see *Appendix Entry 2*.

3.5 Manual Verification of Semi-Automated Network

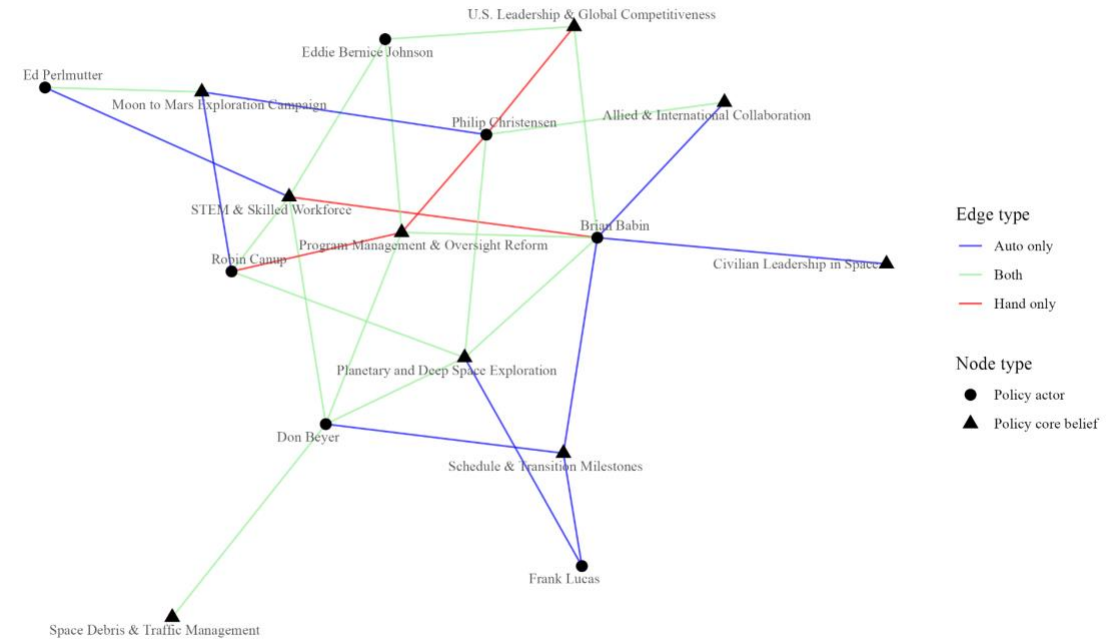
A fully hand-coded discourse network served as the validation benchmark. The manual network was constructed from a 98-page hearing transcript on the decadal strategy for planetary science (serial number 117-59) using the full a priori coding scheme that distinguished deep core, policy core, and secondary beliefs. Statements were coded for the policy actor, the actor's organizational affiliation, and the associated belief category. Using the same coding scheme, a semi-automated network was generated using the curated policy language dictionary and the ACF belief dictionary. Policy core bipartite networks created through full manual coding and semi-automation were then compared directly. The two networks had a structural similarity where 53.6% of edges appeared in both networks, 14.3% appeared only in the manual network, and 32.1% appeared only in the semi-automated network. The Jaccard similarity coefficient for the edge sets was 0.54, indicating a strong degree of overlap for text-based policy coding.

Visual inspection confirmed that major belief linkages, such as U.S. leadership, allied collaboration, planetary exploration, and program management, were captured consistently across both networks. As shown in *Figure 4*, the semi-automated procedure successfully

reproduced core relational structures present in the manual coding while enabling scalable network construction across the full corpus of hearings. This outcome is robust because it ensures that essential core relational structures are consistently captured across both coding methods, and the semi-automated procedure faithfully reproduces the validation benchmark while enabling necessary scalability across the full corpus.

Figure 4: Comparison of policy core network coding approaches

Green = both, Red = hand-coding, Blue = semi-automated coding



3.6 Tests and identification of subsystem evolution

Previous research applying the ACF typically measures policy subsystems by identifying the advocacy coalitions operating within them. Scholars often rely on cross-sectional survey data, qualitative document analysis, or static network snapshots to map belief congruence and pinpoint coalition boundaries (Henry et al., 2022; Nohrstedt et al., 2023). While identifying coalitions is essential for understanding actor alignment, measuring a coalition is fundamentally different from measuring an entire subsystem. Coalition

measurement focuses on the meso-level properties of specific actor groups, such as their internal cohesion and shared policy core beliefs. In contrast, measuring a subsystem requires assessing the macro-level structural properties of the entire policy domain. This entails evaluating the aggregate distribution of beliefs, the total diversity of participating actors, and the overall level of conflict or coordination across all groups, rather than examining only the ties within discrete factions.

To measure the space policy subsystem and its evolutionary typology, this study utilizes longitudinal Discourse Network Analysis (DNA) to capture macro-level network characteristics across four distinct policy eras. Rather than solely isolating coalition clusters, this approach quantifies subsystem-wide metrics, specifically actor diversity, belief heterogeneity, and network modularity. Actor diversity is measured by tracking the entry and proportional representation of state, commercial, and nonprofit actors over time. Belief heterogeneity is assessed by calculating the variance in policy core beliefs expressed across the entire discourse network. Additionally, network modularity serves to gauge the degree of polarization or collaboration across the subsystem, indicating whether the network is fragmented into camps or unified through shared concepts. By semi-automating the extraction of these macro-level network properties across six decades of congressional hearings, this approach provides a novel, quantifiable framework for tracking how a subsystem dynamically transitions among unitary, collaborative, and adversarial typologies.

To ensure comparability across policy actors within hearings, networks were normalized before analysis. Analyzing raw counts of policy statements often skews results toward highly verbose actors or specific, lengthy hearings. Normalizing the data, where a speaker receives credit for a policy core belief only once per hearing, regardless of how many times they repeat it, provides a clearer measure of broad thematic participation rather than

sheer rhetorical volume. This approach controls repetitive testimony and reveals the underlying structure of subsystem presence and policy priorities.

Two additional measures assess the macro-level structural properties of each era. The first is a normalized Shannon entropy index, which quantifies the evenness of participation across actor types within a given policy era. Shannon entropy was originally developed in information theory to measure the uncertainty associated with predicting the next element in a sequence (Shannon 1948). In ecology, the same formula became a standard tool for measuring species diversity within communities, where it captures both richness (the number of types present) and evenness (how uniformly individuals are distributed among those types). The application here follows the same logic. Each policy era constitutes a community of actors, and the four affiliation categories (state, firm, civil society, and intergovernmental organization) function as the types whose relative representation the index summarizes. A subsystem dominated by a single actor type will produce entropy near zero; a subsystem in which multiple actor types contribute roughly equal shares of policy discourse will produce entropy near one.

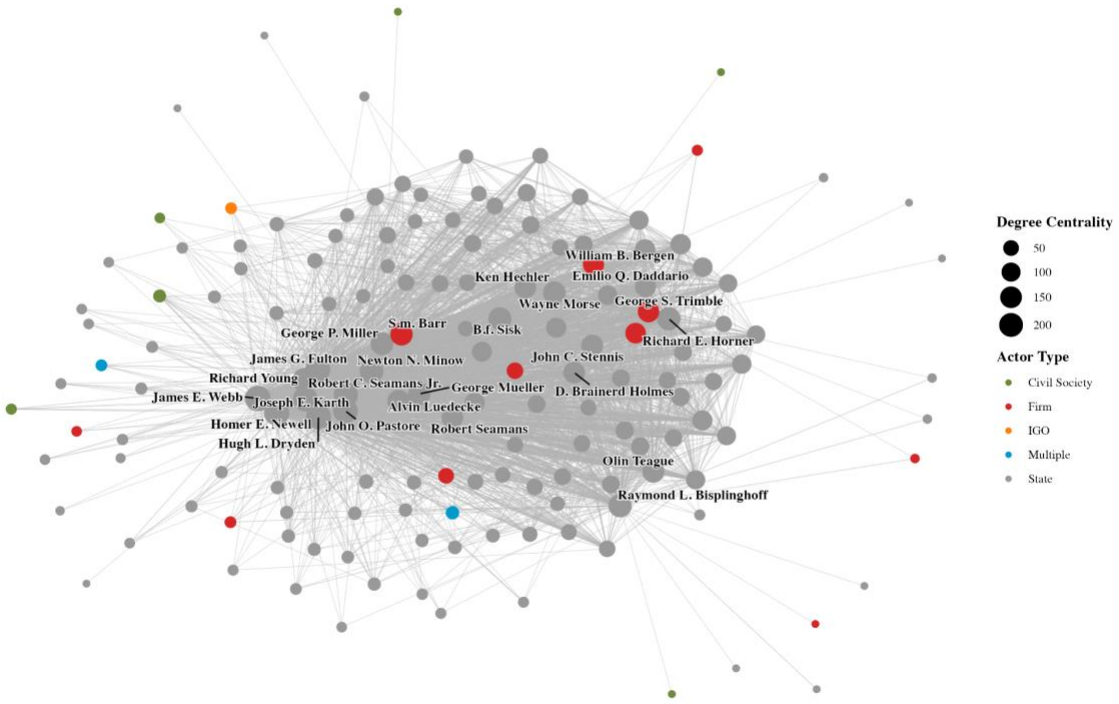
Formally, the index is computed as $H = -\Sigma(p_i \times \ln p_i) / \ln(k)$, where p_i is the proportional voice share of actor type and i and k are the number of actor types with positive representation in that era. Dividing by $\ln(k)$ normalizes the index to a zero-to-one scale regardless of how many categories carry positive weight. This normalization addresses a potential concern about comparability across eras: because the fourth era (2017–2025) spans eight years rather than five and may contain a different total number of hearings or witnesses, one might worry that differences in corpus size drive differences in the entropy scores. They do not. The index operates entirely on proportions, not on raw counts. Whether an era contains 300 actors or 3,000, the entropy value depends only on the relative distribution of

voice share among the four affiliation categories. A larger corpus does not, by itself, produce higher or lower entropy.

4. Results

Figure 5 displays the policy belief network for Group 1, in which nodes represent individual actors and edges connect actors who share more than two policy core beliefs. Node size is scaled to degree centrality, and node color distinguishes actor types: gray for state, red for firm, green for civil society, orange for IGO, and blue for actors with multiple affiliations. In this network, state actors NASA Administrator James E. Webb and Senator John O. Pastore shared the highest degree centrality (0.9576) as their policy beliefs aligned with the widest variety of network participants. Dr. Homer E. Newell, a leading NASA scientist, followed closely (0.9548), along with Richard Young (0.9463) and Robert C. Seamans Jr. (0.9435). State actors, like Richard Young, held the highest betweenness score (0.0144). James E. Webb (0.0114), Homer E. Newell (0.0112), and John O. Pastore (0.0108) also scored highly in betweenness. In the early 1960s congressional hearings, these actors facilitated the flow of technical information and political consensus across a diverse array of policy topics and isolated actor groups. The network structure confirms that the early space policy subsystem was highly centralized, relying on a small core of leaders to maintain cohesion.

Figure 5: Group 1 Network Structure (1960s)
N = 155 Actors | Layout: Kamada-Kawai



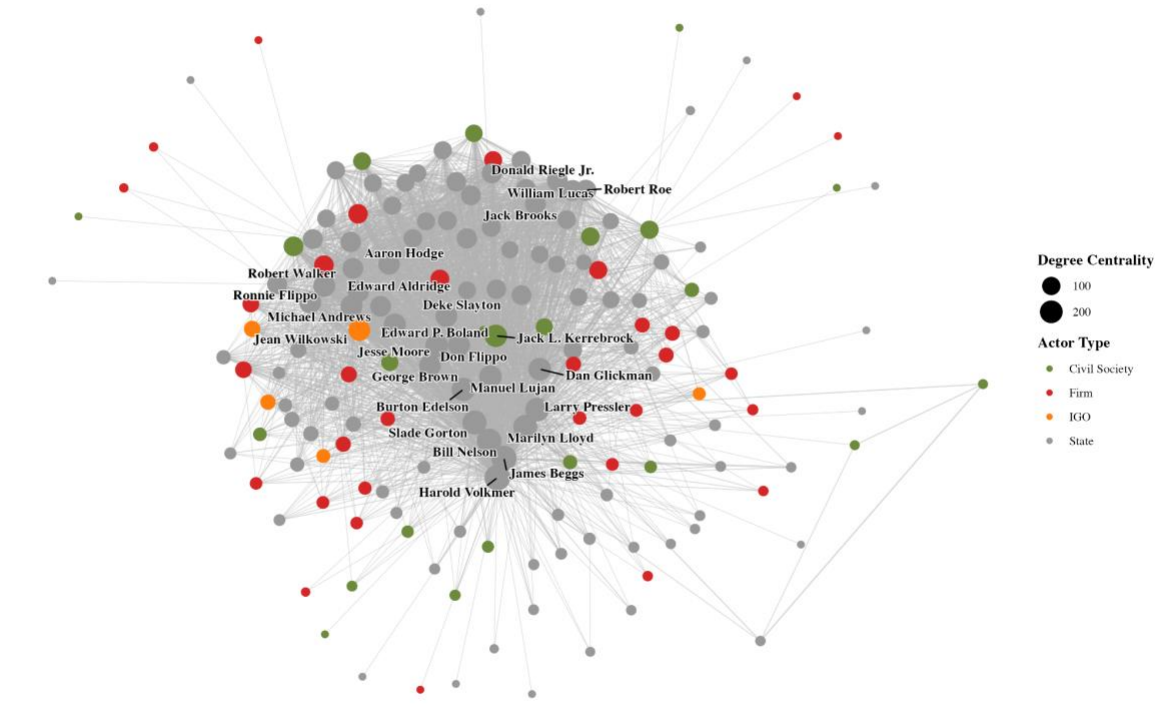
Note: Edges represent shared Policy Core Beliefs. Data is normalized to count unique beliefs per hearing to prevent verbosity bias. Only ties with > 3 shared beliefs are shown.

Firm actors in group 1 hold a mean normalized betweenness of 0.003, compared to 0.004 for state actors, but this average is inflated by a small number of commercially positioned witnesses; S.M. Barr of Western Union (0.018) accounts for the bulk of firm-sector brokerage, while the remaining eleven firm actors fall at or near zero. Civil society actors are almost entirely absent from brokerage roles, with a mean betweenness of 0.00004 as these were typically university scientists and other non-governmental participants connected to the subsystem through narrow topical channels.

Figure 6 displays the policy belief network for Group 2. State actor and U.S. House member Harold Volkmer had the highest degree centrality (0.8653), as their policy beliefs aligned with the widest variety of network participants. Former NASA administrators James Beggs (0.6970) and Bill Nelson (0.6633), as well as U.S. Senator Slade Gorton (0.6532) followed closely, all state actors. Volkmer also held the highest betweenness score (0.1930),

followed by civil society actor William Rogers (0.0603) and civil society actor Hans Mark (0.0420). In the 1980s congressional hearings, state actors continued to dominate the flow of technical information and political consensus, though civil society participants began to assume limited bridging roles alongside them.

Figure 6: Group 3 Network Structure (1980s)
N = 171 Actors | Layout: Kamada-Kawai

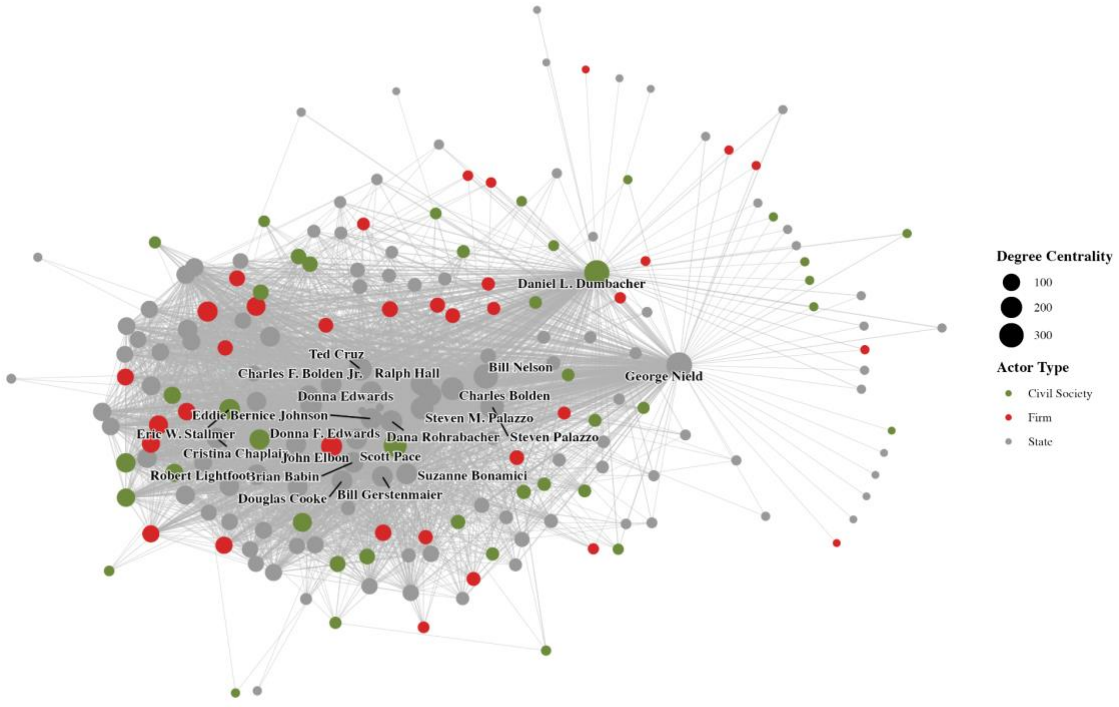


Note: Edges represent shared Policy Core Beliefs. Data is normalized to count unique beliefs per hearing to prevent verbosity bias. Only ties with > 3 shared beliefs are shown.

Firm actors in Group 2 hold a mean normalized betweenness of 0.0006, compared to 0.0041 for both state and civil society actors. This gap reflects the comparatively peripheral position of commercially affiliated witnesses during this period. William Hughes (0.0402), Deke Slayton (0.0038), and Tracie Monk (0.0020) account for the bulk of firm-sector brokerage, while the remaining firm actors fall at or near zero. Civil society actors, though marginal in belief share, achieved a mean betweenness comparable to state actors, suggesting that a small number of non-governmental participants had begun to occupy meaningful bridging positions within the subsystem.

In the policy belief network for Group 3, demonstrated in *Figure 7*, state actor George Nield of the FAA and civil society actor Daniel Dumbacher, formerly of NASA, shared the highest degree centrality (0.8784 and 0.8423, respectively), as their policy beliefs aligned with the widest variety of network participants. State actors Senator Bill Nelson and Representative Steven Palazzo followed closely (0.8333 each), along with civil society actor Scott Pace of the George Washington University Space Policy Institute (0.7613). Nield also held the highest betweenness score (0.1356), followed by Dumbacher (0.1119) and Palazzo (0.0488). Compared to the subsystems of the 1960s and 1980s, the network structure of the space policy subsystem in this period had begun to diversify beyond its state-centric origins, with civil society actors assuming prominent bridging roles alongside traditional government participants.

Figure 7: Group 3 Network Structure (2010s)
N = 194 Actors | Layout: Kamada-Kawai



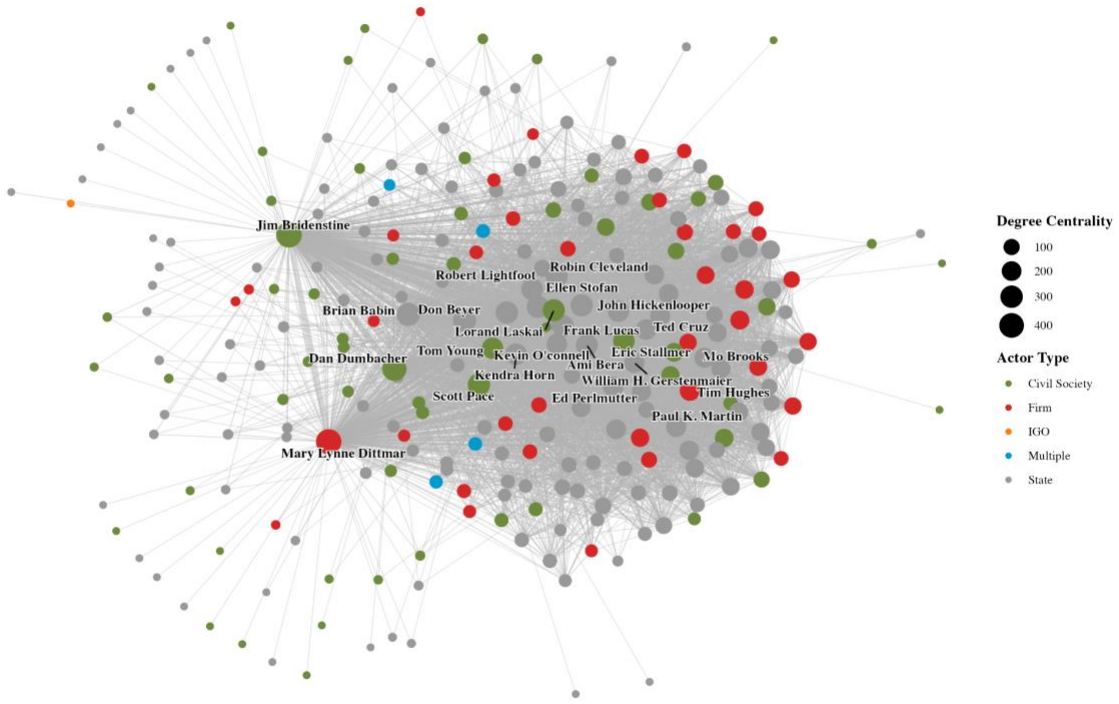
Note: Edges represent shared Policy Core Beliefs. Data is normalized to count unique beliefs per hearing to prevent verbosity bias. Only ties with > 3 shared beliefs are shown.

Firm actors in Group 3 hold a mean normalized betweenness of 0.0008, compared to 0.0043 for state actors and 0.0034 for civil society actors. This gap reflects the comparatively

peripheral position of commercially affiliated witnesses during this period, though a small number of firm actors did occupy meaningful brokerage positions. John Elbon of the United Launch Alliance (0.0088), Jeffery Thornburg of Interstellar Technologies Corp. (0.0036), and Frank Culbertson of Northrop Grumman(0.0035) account for the bulk of firm-sector brokerage, while the remaining firm actors fall at or near zero.

Figure 8 displays the policy belief network for Group 4 of congressional hearings. In this contemporary network, former NASA Administrator Jim Bridenstine (coded as a civil society actor) and firm actor Mary Lynne Dittmar from Axiom Space shared the highest degree centrality (0.8733 and 0.8533, respectively). Their policy beliefs aligned with the widest variety of network participants. U.S. House Representatives and state actors Brian Babin (0.7400) and Don Beyer (0.7233) followed closely. Dittmar also held the highest betweenness score (0.1482), followed by Bridenstine (0.1443) and state actor Ellen Stofan (0.0546). In the 2020s congressional hearings, these non-state actors facilitated the flow of technical information and political consensus across a diverse array of policy topics and isolated actor groups.

Figure 8: Group 4 Network Structure (2020s)
N = 261 Actors | Layout: Kamada-Kawai



Note: Edges represent shared Policy Core Beliefs. Data is normalized to count unique beliefs per hearing to prevent verbosity bias. Only ties with > 3 shared beliefs are shown.

Firm actors in Group 4 hold a mean normalized betweenness of 0.0047, compared to 0.0035 for civil society actors and 0.0023 for state actors. This average reflects the growing integration of commercially positioned witnesses in subsystem brokerage with actors such as Mary Lynne Dittmar (0.1482), A. Thomas Young (0.0126), and Tim Hughes (0.0068) accounting for a significant portion of firm-sector brokerage. Civil society actors have also shifted away from the narrow topical channels of the 1960s to assume prominent bridging roles across the subsystem.

Table 3 presents the distribution of policy actor affiliations and share of voice across hearing groups. The data for Group 1 reveal that the foundational space policy subsystem in the early 1960s operated strictly as a government modality. State-affiliated actors dominated the network, accounting for 91.0 percent of the voice share among the 352 unique actors coded. Private firms constituted 7.9 percent of the discourse, while civil society representatives accounted for 1.1 percent and intergovernmental organizations at 0.1 percent.

Table 3: Comparison of Policy Actor Affiliations and Share of Voice

	Group 1 (1960s)		Group 2 (1980s)		Group 3 (2010s)		Group 4 (2020s)	
Actor Type	**N Actors**	**Voice Share (%)**	**N Actors**	**Voice Share (%)**	**N Actors**	**Voice Share (%)**	**N Actors**	**Voice Share (%)**
State	306	91.0	309	77.8	186	75.6	258	69.2
Firm	32	7.9	87	11.5	48	8.4	46	11.1
Civil Society	13	1.1	68	8.2	66	16.0	94	19.7
IGO	1	0.1	7	2.4	1	0.0	0	0.0
Total (N)	352	—	471	—	301	—	398	—

N Actors = unique speakers per affiliation type within the hearing group. *Voice Share* = percentage of coded policy core belief sentences attributed to that actor type.

The data for Group 2 reveal that the space policy subsystem in the 1980s remained heavily state-centric, though with modest diversification relative to the foundational period. Among 471 unique actors, state-affiliated actors produced 77.8 percent of all voice share, while private firms contributed 11.5 percent, civil society representatives 8.2 percent, and intergovernmental organizations 2.4 percent. In Group 3 hearings, state actors continued to dominate the substantive discourse, producing 75.6 percent of all voice share among 301 unique actors. Civil society actors contributed 16.0 percent and private firms 8.4 percent.

The Group 4 network demonstrates that the modern space policy subsystem has evolved significantly from its foundational government modality. Among 398 unique actors, state-affiliated actors remain prominent but account for a smaller proportion of overall discourse, producing 69.2 percent of the voice share. Civil society representatives now generate 19.7 percent of the discourse and private firms constitute 11.1 percent, while intergovernmental organizations are absent from the record.

Table 4 presents statistical tests of subsystem structure. The Shannon entropy scores trace a clear trajectory of increasing participation diversity across the four periods: H = 0.246 in Group 1 (low diversity), H = 0.533 in Group 2 (moderate diversity), H = 0.516 in Group 3 (moderate diversity), and H = 0.746 in Group 4 (high diversity). The modest decline between Groups 2 and 3 notwithstanding, the overall pattern demonstrates a sustained opening of the subsystem to non-state actors over time.

Table 4: Statistical Tests of Subsystem Structure

Metric	Statistic	Result
Shannon Entropy (H)		
Group 1 (1960s)	0.246	Low Diversity
Group 2 (1980s)	0.533	Moderate Diversity
Group 3 (2010s)	0.516	Moderate Diversity
Group 4 (2020s)	0.746	High Diversity
Chi-Squared Test		
Independence of Actor Types Across Groups	$\chi^2 = 1772.93$, $df = 9$	$p < 0.001^{***}$

Shannon Entropy (H) computed over the distribution of policy core beliefs across actor types within each hearing group using the natural logarithm. Chi-squared test evaluates whether the distribution of actor types is independent of time period.
*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

The chi-squared test of independence assesses whether the proportion of actor types observed in each hearing group could have arisen from a single, stable underlying distribution. The result rejects that possibility, indicating that the compositional shifts across groups reflect a genuine structural change in subsystem participation rather than random variation in who happened to testify.

Taken together, the network analyses across four periods of congressional hearings reveal a space policy subsystem in gradual but measurable transition. The foundational period of the early 1960s was defined by tight state centralization, with a small core of government actors controlling both the flow of information and the breadth of belief coalitions. That structure persisted into the 1980s, though civil society actors began to assume limited bridging roles alongside dominant state participants. By the 2010s, civil society had grown into a genuine structural presence, with non-governmental actors matching or exceeding state actors on several centrality measures. The contemporary period marks the clearest departure from the subsystem's origins: firm actors now hold the highest mean betweenness, civil society generates nearly a fifth of all voice share, and Shannon entropy has nearly tripled

since the foundational period. The chi-squared results confirm that these shifts reflect genuine structural change rather than sampling noise. What began as a closed governmental domain has opened, incrementally but persistently, into a more pluralistic subsystem in which non-state actors play consequential roles in shaping and brokering space policy.

5. Discussion

The results of this study provide systematic empirical support for a theoretical claim that has long remained underspecified in the ACF literature: that subsystem typology is not a fixed categorical condition but a dynamic outcome that can be driven by internal political processes. Across four policy eras spanning more than six decades, the U.S. space policy subsystem moved from a tightly centralized, government-dominated structure toward a more pluralistic and broker-dependent network. Shannon entropy nearly tripled between the foundational period and the contemporary era, firm actors achieved the highest mean betweenness centrality in the most recent period, and the chi-squared results confirm that these compositional shifts reflect genuine structural change rather than sampling variation. These findings are not simply descriptive. They speak directly to the ACF's theoretical treatment of subsystems and the conditions under which those subsystems change.

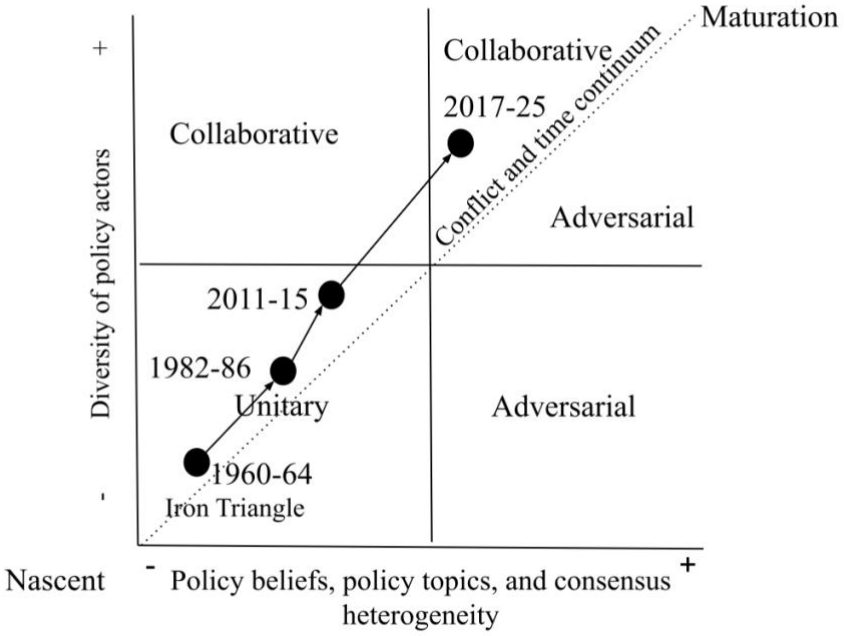
The ACF identifies subsystem typology as a key structural variable, distinguishing between unitary, adversarial, and collaborative arrangements based on the distribution of coalitional power, the degree of belief heterogeneity, and the character of intercoalition relations (Weible et al., 2020; Nohrstedt et al., 2023). Yet the framework has historically treated typology as a relatively stable background condition, offering limited theoretical scaffolding for understanding how and why subsystems transition from one typological form to another. Weible (2008) advanced propositions about the conditions that produce shifts between typological forms, and Funke et al. (2021) tested those propositions in a South

African case, proposing additional shift mechanisms including the loss of participation diversity as a driver of collaborative-to-unitary transitions. But these remain among the few studies that treat typological change as an empirical outcome rather than a classificatory exercise.

This study addresses that gap directly. By tracing belief network evolution and actor composition changes across four discrete policy eras, it demonstrates that the space policy subsystem underwent a transition from an elite unitary form to a more collaborative and potentially adversarial configuration, and that this transition was driven by deliberate policy choices, such as the CSLA of 1984, that expanded the actor landscape and diversified the policy beliefs. The broader theoretical implication is significant. Most ACF research begins after a subsystem has already achieved its mature form and treats typology as context rather than outcome. This study inverts that logic, treating typological change itself as the dependent variable and identifying the internal mechanisms that produce it.

Returning to the typological grid introduced in *Figure 1*, the empirical trajectory documented here can be mapped onto the framework's two dimensions. Shown in *Figure 9*, The space policy subsystem originated in the lower-left quadrant– an iron triangle characterized by low actor diversity and low belief heterogeneity, situated at the nascent end of the conflict and time continuum. Each successive policy era shifted the subsystem toward the upper-right quadrant as both dimensions expanded. Shannon entropy rose from 0.246 to 0.746, and the range of policy core beliefs expressed in congressional hearings broadened from a narrow set of government priorities to a diverse array of commercial, scientific, and regulatory concerns.

Figure 9: Development of Policy Subsystem Typology and Conflict Grid with Empirical Trajectory of the U.S. Space Policy Subsystem



The question this trajectory raises is not simply where the subsystem is headed but why it moves at all. Subsystems evolve because the conditions that sustain any given typological form are inherently unstable. A unitary subsystem persists only so long as a dominant coalition can control entry, suppress competing beliefs, and maintain the institutional arrangements that concentrate authority. When the policy domain generates demands that exceed the capacity of that coalition, whether through technological change, economic opportunity, or strategic competition, the coalition faces a choice between accommodating new actors and resisting their entry. In the space policy case, successive coalitions chose accommodation, and each act of accommodation altered the structural conditions that defined the subsystem's type. Full maturation, as the figure implies, would represent a subsystem in which the conflict and time continuum has been traversed: actor diversity is high, belief heterogeneity is substantial, and the coalitional structure has stabilized into a recognizable collaborative or adversarial pattern. The space policy subsystem has not yet reached that terminal point. Its low modularity and negative assortativity suggest

that coalitions remain fluid and belief-based rather than organizationally entrenched, which is consistent with a subsystem still consolidating its mature form. The figure, then, should be read not as a static classification but as a map of a process that the empirical results of this study trace in measurable terms.

5.1 Contribution to the ACF Literature

This study makes three distinct contributions to the ACF as a theoretical framework. First, it advances the ACF's treatment of subsystem typology by proposing and testing a belief-centered, actor-driven mechanism of typological transition. Prior work on subsystem typology has generally focused on classification: determining whether a given policy domain resembles a unitary, adversarial, or collaborative form at a single point in time (Heinmiller et al., 2021; Stritch, 2015). Weible and Sabatier (2009) provided an important exception, using longitudinal questionnaire data spanning 1984 to 2001 in the Lake Tahoe Basin to study a shift from adversarial to collaborative dynamics. Koebele and Crow (2023) documented a similar trajectory over a decade in Colorado water governance, finding that negotiated agreement was reached despite persistent belief divergence. But these studies remain uncommon, and none has measured typological change through network-level indicators applied across four or more discrete time periods.

While this work has been valuable for establishing typological categories, it leaves open the question of how subsystems move among them. This study argues that typological transitions occur when policy design deliberately introduces new actors whose entry diversifies the belief space, disrupts the dominance of existing coalitions, and restructures the network's organizational logic. The four eras analyzed here trace exactly this process. The Commercial Space Launch Act of 1984, the COTS and CRS programs, and subsequent commercialization policy initiatives each functioned as institutional mechanisms of actor recruitment, and the network data show their cumulative effect on subsystem structure. This

provides the ACF with a more explicit theory of typological change, grounded in identifiable policy design choices rather than only external shocks.

Second, this study builds on the ACF's emerging attention to nascent and transitional subsystems (Ingold et al., 2025; Bandelow and Kundolf, 2011; Beverwijk et al., 2008). The ACF has historically concentrated on mature subsystems where coalitions are well-formed and beliefs are entrenched. Nascent subsystem research has shown that the dynamics of coalition formation and belief alignment look meaningfully different in early-stage or rapidly changing policy domains. For example, Garic and Leifeld (2025) propose a three-stage maturation model: problem discovery, in which one large and loosely connected issue network forms; differentiation, as divisions emerge within previously homogeneous groups; and consolidation, as coalitions stabilize and network polarization increases. Further, Pozzi, Zufall, Gmoser-Daskalakis, and Vantaggiato (2024) identify core-periphery structures as a characteristic feature of nascent subsystems. This study extends that insight by demonstrating that a subsystem can simultaneously be mature in institutional terms while still evolving in its coalition structure, as the commercial and nonprofit sectors entered a long-established domain and altered the landscape of beliefs without dismantling existing governmental coalitions. The space policy case thus suggests that subsystem maturity and coalition maturity may need to be distinguished conceptually and treated as separate dimensions of analysis.

Third, this study contributes to ACF theory by linking actor-level entry to subsystem-level structural outcomes in a formally measurable way. The ACF has long recognized that new actors can alter coalitional dynamics, but it has not developed systematic tools for detecting when actor entry crosses a threshold sufficient to reclassify subsystem typology. The use of Shannon entropy, actor voice share, and network modularity across longitudinal periods provides a replicable framework for doing precisely that. The gradual increase in entropy from 0.246 in the foundational period to 0.746 in the contemporary era, combined

with the shift in betweenness centrality from exclusively state-affiliated actors to firm and civil society actors, offers a quantifiable signature of typological transition. This operationalization could be applied to other subsystems to detect where and when typological change is occurring or has occurred.

5.2 Contributions to the Understanding of Space Policy

Beyond its implications for policy theory, this study generates substantive contributions to the empirical literature on space policy. The space policy domain has historically received limited attention from policy process scholars, despite its considerable institutional complexity, its multi-sector composition, and its role as a site of significant public investment and international competition. Applications of the Narrative Policy Framework (NPF) have been made to the creation of the U.S. Space Force (Lantis, 2025; Ruff, 2022) but these remain isolated applications and there is a lack of ACF applications to space policy outside of observing NASA and the role of brokers (Bosso and Kay, 2004). The limited scholarly attention to space policy as a policy subsystem, rather than as an object of historical or strategic analysis, has left important questions about its governance structure unresolved. This study provides the first longitudinal, quantitative account of how the composition of the U.S. space policy subsystem has changed over more than six decades, using a systematically gathered corpus of congressional hearings spanning 1958 to 2025.

The findings document several features of space policy evolution that have not been previously established through systematic empirical analysis. The shift from a state-dominated network in which 91 percent of voice share was generated by government actors in the early 1960s to a more distributed structure in which civil society actors now generate nearly one-fifth of all discourse and firm actors hold the highest betweenness centrality represents a fundamental transformation of the subsystem's organizational architecture.

Melamed et al. (2024) use an opportunity-willingness framework to explain the integration of New Space companies into government programs, warning that partnerships empower commercial firms to potentially diverge from state policy objectives. The network evidence presented here provides empirical grounding for that concern. Firm actors do not merely participate but now occupy the brokerage positions that control information flow across the subsystem.

This transformation did not occur uniformly or as a sudden rupture. It unfolded incrementally and in response to identifiable policy decisions. The 1984 Commercial Space Launch Act, the COTS and CRS programs, and the Artemis Program's outsourcing of lunar lander development each functioned as deliberate structural interventions that expanded the range of actors with legitimate standing in the policy arena. Overall, change in the space policy subsystem has been driven by deliberate policy design choices rather than exogenous shocks such as Sputnik or the Challenger disaster alone, which prior analyses have tended to treat as the primary catalysts for change.

The study also establishes a more granular picture of how different actor types have occupied structurally distinct roles within the subsystem across eras. In the foundational period, state actors not only dominated the voice share and held disproportionate brokerage positions, reflecting the closed, government-modality character of the early subsystem. By the contemporary period, that brokerage function has shifted. Firm actors now hold the highest mean betweenness centrality, and civil society actors have moved from marginal participants connected through narrow topical channels to structurally central brokers capable of spanning coalitions.

This trajectory aligns with findings from other policy domains where market liberalization reshaped network structure. For example, Fischer, Ingold, Sciarini, and Varone

(2012) demonstrated in Swiss telecommunications that market liberalization caused private-sector actors to gain increasingly central positions, fundamentally reorganizing the network's relational patterns. Christopoulos and Ingold (2015) differentiated policy brokers from policy entrepreneurs using betweenness centrality and structural measures, again finding commercially affiliated actors in pivotal positions. The findings of this study, coupled with previous research, demonstrates that understanding the space policy subsystem requires attention to what structural roles different actor categories occupy, and how those roles have changed, as much as to who participates.

5.3 Methodological Contribution to the Measurement of a Policy Subsystem

This study makes a methodological contribution that extends beyond the space policy case and bears directly on how scholars measure and analyze policy subsystems over time. Previous research applying the ACF has typically measured subsystems through one of two approaches: cross-sectional surveys of coalition members and their beliefs, or qualitative document analysis that identifies actor positions and coalitional alignments at a given moment. Both approaches are well-suited to studying coalition-level dynamics but are less effective for measuring subsystem-level structural properties across extended time periods. The primary distinction is one of scale: coalition measurement focuses on the meso-level properties of specific actor groups, including their internal cohesion and shared policy core beliefs, while subsystem measurement requires characterizing the macro-level distribution of beliefs, actor diversity, and conflict or coordination across the entire policy domain.

This study proposes a semi-automated DNA pipeline designed to address this gap. The approach has three elements that are each methodologically novel in combination. First, it operationalizes subsystem-level properties using network metrics applied to the full actor-belief graph, rather than examining individual coalitions in isolation. Actor diversity is tracked through proportional representation of actor types, belief heterogeneity is assessed

through the variance in policy core beliefs expressed across the discourse network, and network modularity captures the degree of polarization or coordination across the entire subsystem. Second, it applies these measures longitudinally across four policy eras, enabling the detection of directional change in subsystem structure. Third, it scales the measurement process through semi-automation while maintaining methodological rigor through formal validation.

The semi-automated procedure used a curated policy preference word dictionary and an ACF belief dictionary constructed through qualitative review of a training sample of hearings. The validated pipeline was then applied to the full corpus. A comparison of the semi-automated network against a fully hand-coded 98-page hearing yielded a Jaccard similarity coefficient of 0.54, indicating a strong degree of structural overlap between the two approaches for text-based policy coding. Visual inspection confirmed that major belief linkages central to the space policy subsystem, including U.S. leadership, allied collaboration, planetary exploration, and program management, were captured consistently across both networks. This validation result is significant for the broader literature because it demonstrates that semi-automated discourse network construction can faithfully reproduce the relational structure of a manually coded network while enabling scalability across a corpus that would be infeasible to hand-code in full.

This methodological framework is broadly portable. Congressional hearings represent one of the most consistently structured and widely available sources of policy discourse in the United States, spanning decades and covering virtually every major policy domain. The approach developed here could be adapted to analyze subsystem structure in health policy, environmental policy, defense policy, or any other domain in which hearing records provide a longitudinal record of actor participation and belief expression. The policy preference word dictionary and ACF belief coding scheme would require domain-specific adaptation, but the

underlying pipeline and the subsystem-level metrics it produces could be applied with modification.

5.4 Limitations

There is, however, an important caveat regarding what congressional hearings can and cannot tell us about subsystem structure. Hearings are public, curated venues. Witnesses are invited by committees, their statements are audience-aware, and the full range of actors influencing policy extends beyond those who testify. Hearings therefore provide a representative rather than exhaustive account of subsystem participation, and the patterns identified here should be understood as reflecting observable discourse network structure rather than the complete architecture of policy making activity. This does not diminish the contribution of the pipeline or the findings it produces, but it does suggest that future work should examine how discourse-based subsystem measures correspond to other sources of evidence about actor participation and coalition alignment.

Using congressional hearings to assess the space policy subsystem and its discourse networks involves several limitations that bear on the interpretation of the findings. Although the hearings used in this study are publicly available and systematically gathered, publication delays of up to two years and the closure of some materials in the National Archives mean that the corpus is unlikely to be fully comprehensive, particularly for the most recent era. Additionally, the hearings capture only one venue of policy discourse and cannot account for the full range of actors and organizations that influence space policy through lobbying, executive-branch engagement, or international negotiations. Discussions and decisions regarding space governance occur across a wide variety of domestic and international forums, and the congressional record, while extensive, represents only a portion of that activity. Finally, public testimony is strategically produced. Witnesses are aware of their audience and may frame their statements in ways that do not fully reveal their underlying beliefs or

coalitional allegiances. Despite these limitations, congressional hearings provide one of the most systematically available and longitudinally consistent records of policy discourse in the United States, and the findings reported here offer a reliable foundation for understanding how the observable structure of the space policy subsystem has changed over time.

6. Conclusion

The U.S. space policy subsystem began as a tightly controlled policy domain. For its first two decades, it was organized around a small core of government actors, centralized executive authority, and a unified belief system shaped by Cold War imperatives. That arrangement has not persisted. Over more than six decades, the subsystem has opened, diversified, and reorganized around a broader and more heterogeneous coalition of state, commercial, and civil society actors. The evidence presented in this study demonstrates that this transformation was not incidental, and it was not primarily the product of external disruptions. It was the cumulative consequence of deliberate policy choices that redesigned the institutional terrain of space governance and recruited new classes of actors into it.

Space policy is no longer a domain governed primarily by scientists and government officials discussing launch contracts and planetary priorities. It is now a multi-sector policy arena in which commercial firms hold significant brokerage positions, civil society organizations generate substantial shares of the policy discourse, and the boundaries between public mission and private interest are pursued in ways they were not during the Apollo era. The findings of this study provide the first longitudinal, quantitative account of how that transformation unfolded, documenting when the subsystem changed, at what pace, and through what mechanisms.

The practical significance of this transformation is considerable. As commercial actors have moved from peripheral contractors to central brokers, the presence of technical

expertise and operational capacity in space governance has shifted substantially outside of government. Firm actors now hold higher mean betweenness centrality than state actors in the contemporary period, which means that the actors best positioned to broker information and connect otherwise disconnected parts of the policy network are disproportionately commercially affiliated. This has implications for regulatory design, for the management of dual-use technologies, and for the coordination of space situational awareness and debris mitigation, all of which depend on information flows across actor boundaries. A subsystem in which the most central brokers have private interests is a different governance environment than one in which government actors occupy those positions, and policymakers should account for that structural reality.

The commercialization trajectory documented here also has implications for international space governance. The Artemis Accords, the growth of commercial launch providers operating across national boundaries, and the increasing involvement of private firms in activities that were once the exclusive domain of state space agencies create governance challenges that existing international legal frameworks were not designed to address. The 1967 Outer Space Treaty and the Liability Convention were drafted in an era when the U.S. space policy subsystem was still in its unitary government-modality form, and those agreements reflect the institutional assumptions of that era. As the domestic subsystem has diversified, the mismatch between the actors shaping national space policy and the state-centric framework of international space law has grown.

More broadly, the space policy case demonstrates that domains characterized by rapid technological change, high barriers to entry, and significant state involvement in market creation are potentially susceptible to the kind of endogenous subsystem transformation documented here. Policymakers and analysts working in analogous emerging domains, including artificial intelligence governance, quantum computing, and commercial

biotechnology, may find the space policy trajectory instructive. In each of these cases, the government has significant capacity to shape who enters the policy arena through procurement decisions, regulatory frameworks, and research funding, and those entry decisions carry long-run consequences for subsystem structure and coalition dynamics.

The ACF was developed to explain policy change in mature, contentious subsystems where competing coalitions hold entrenched beliefs and change occurs either through external shocks or through the slow accumulation of policy-oriented learning. That theoretical architecture has proven durable and has been applied across an impressive range of policy domains and national contexts. However, it reflects a particular set of assumptions about what subsystems look like and how they work: assumptions of coalitional stability, belief entrenchment, and change as episodic rather than gradual. This study addresses those assumptions, not by rejecting the ACF, but by extending it.

The central contribution to policy process theory is the demonstration that subsystem typology is a dynamic outcome rather than a stable condition. By treating typological change as the dependent variable and tracing the mechanisms that produced it across four policy eras, this study offers a framework for understanding how subsystems evolve even in the absence of the kinds of exogenous punctuations traditionally emphasized. The policy design choices documented here, including the Commercial Space Launch Act, the COTS and CRS programs, and the Artemis Program's commercialization strategy, functioned as endogenous drivers of structural change. Each of them altered the institutional rules governing who could participate in space policy, what resources they could bring to bear, and what kinds of beliefs were represented in the subsystem. The cumulative effect was a typological transition that unfolded incrementally over decades.

This finding has implications for how policy process scholars periodize and study change. If typological transitions can occur endogenously and gradually, then the practice of

selecting cases at a single point in time and classifying their subsystem type risks mischaracterizing the underlying process. A subsystem that appears collaborative at one moment may have been unitary a decade earlier and may become adversarial a decade later because the actor composition and belief structure have been quietly reorganized through policy design, without any dramatic external trigger. Capturing these dynamics requires longitudinal methods and a willingness to treat typology as something that requires explanation rather than something that provides it.

The study also speaks to debates about the role of institutional design in shaping coalition dynamics. The ACF has generally treated institutions as part of the relatively stable parameters within which coalitions operate, rather than as variables that coalitions and policymakers actively reshape. The space policy case complicates this picture. The institutional changes that drove subsystem transformation were themselves the products of deliberate political choices by actors within the subsystem, particularly congressional advocates of commercialization and executive branch officials seeking to reduce NASA's operational footprint. This suggests a more recursive relationship between institutions and coalitions than the standard ACF model implies as coalitions do operate within institutional constraints while they also redesign those constraints in ways that reshape the coalitional landscape for subsequent periods.

From this study, there are a few areas of future research. The first concerns the conditions under which policy subsystems transition from unitary to collaborative or adversarial forms in the absence of external shocks. This study has documented that such transitions occur and identified a plausible mechanism, namely policy-induced actor entry and the resulting diversification of beliefs. However, it has not tested whether this mechanism generalizes beyond the space policy case, nor has it identified the specific conditions under which actor entry produces collaborative rather than adversarial dynamics. The two outcomes

are theoretically distinct: collaborative subsystems are characterized by cross-coalition coordination and negotiated compromise, while adversarial subsystems are characterized by polarization and zero-sum conflict. The space policy subsystem appears to be moving toward a collaborative form, at least in the contemporary period, but the conditions that determine which typological destination follows from actor diversification remain unclear. Comparative subsystem analysis across domains that have experienced similar patterns of deliberate actor recruitment would allow for the identification of the moderating conditions, including the character of the beliefs new actors bring, the resources they command, and the institutional rules governing access to decision-making venues.

The second question concerns how belief structures evolve across transitions in subsystem typology. This study measures belief heterogeneity and actor diversity as aggregate subsystem properties, but it does not trace the internal dynamics of belief change at the level of individual actors or coalitions. The ACF's theory of policy-oriented learning predicts that beliefs change most readily at the secondary level and most rarely at the deep core, with policy core beliefs somewhere in between. What remains less understood is how the introduction of new actors with distinct belief profiles affects the belief trajectories of established actors. Do incumbents adapt their expressed beliefs in response to new entrants, or do they entrench? Does the entry of commercial actors into a previously government-dominated subsystem lead to the diffusion of market-oriented beliefs among state actors, or does it simply add a new cluster to an otherwise unchanged network? Tracing belief evolution at the actor level across typological transitions would require combining the network-level methods used here with actor-level longitudinal data, possibly through the integration of survey or interview evidence with the computational approaches developed in this study.

The third and most forward-looking question concerns the extent to which belief network data can predict future subsystem typology or conflict potential. The quantitative framework developed here, comprising entropy scores, centrality distributions, and modularity measures, provides a snapshot of subsystem structure at each of four policy eras. But the logic of the framework implies a predictive application: if typological transitions are preceded by identifiable changes in belief heterogeneity and actor diversity, then monitoring those indicators in real time should allow for the anticipation of structural change before it fully materializes. A subsystem in which entropy is rising, betweenness centrality is shifting toward non-state actors, and modularity is increasing may be approaching a typological threshold, and identifying that trajectory early would be of practical value to policymakers and governance designers. Developing this predictive capacity would require both theoretical work to specify the threshold conditions under which transitions occur and empirical work to validate those thresholds against historical cases in which the timing of transitions is independently known. The space policy subsystem provides one such case. Extending the analysis to other domains with well-documented histories of structural change would allow for the testing and refinement of a genuinely predictive model of subsystem evolution.

The opening decades of the space age were governed by a handful of people in government agencies and the contractors that served them. The contemporary space policy subsystem bears little resemblance to that arrangement. It now encompasses hundreds of actors across the state, commercial, and civil society sectors, organized around diverse beliefs about what space is for, who should govern it, and what obligations the actors operating in it carry. That transformation was not inevitable. It was the product of political choices, and understanding it requires the kind of systematic, longitudinal, and theory-grounded analysis that this study has attempted to provide.

The ACF offers powerful tools for understanding why policy subsystems look the way they do at any given moment. This study has sought to extend those tools toward an equally important question: how do subsystems come to look the way they do, and what does the trajectory of their development tell us about where they are headed? The space policy case suggests that the answer lies not only in the external environment but in the design of institutions, the strategic choices of actors operating within them, and the cumulative effects of those choices on who enters the arena of governance and what beliefs they bring with them. Tracing that process across the arc of the space age offers a perspective on subsystem evolution that is both theoretically instructive and, given the pace of change in contemporary space governance, practically urgent.

Chapter 2

Belief Content, Actor Affiliation, and Coalition Structure in a Diversifying Policy Subsystem

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Abstract

The Advocacy Coalition Framework predicts that actors with shared policy core beliefs will coordinate their behavior and form coalitions, yet the framework has devoted less attention to how organizational affiliation shapes which beliefs actors prioritize in the first place. This study investigates how the entry of commercial firms and civil society organizations into the U.S. space policy subsystem has altered the thematic content of policy discourse and the structure of advocacy coalitions over time. Drawing on discourse network analysis of congressional hearing testimony spanning 1958 to 2025, the study codes policy core beliefs through a semi-automated regex-based dictionary and categorizes actors by organizational affiliation (state, firm, and civil society) following a multi-stakeholder governance typology. Community detection via the Louvain algorithm identifies coalitions across four policy eras. The results reveal that firm actors exhibit a coherent evolutionary trajectory in their core beliefs, shifting from infrastructural concerns to affordability and then to regulatory modernization. State actors distribute their attention broadly across dominant subsystem themes and civil society actors expanded from marginal educational roles in the 1960s to substantial coalition participants in the contemporary period. Across all four eras, coalition networks display consistently low modularity and negative assortativity, indicating that coalitions form around shared beliefs rather than organizational identity alone. The subsystem is more integrated than segmented, and the diversification of its participant base has changed not only who participates in space policy but what the policy conversation is about.

1. Introduction

The composition of a policy subsystem shapes both its agenda and its outputs. When a narrow set of actors dominates a policy domain, the range of beliefs expressed in formal deliberation tends to be correspondingly narrow; when new categories of actors gain access, the belief landscape diversifies and the conditions for coalition formation change (Sabatier & Weible, 2007; Weible et al., 2020). The Advocacy Coalition Framework (ACF) has long recognized this relationship between actor composition and policy dynamics, yet most

empirical applications of the framework capture subsystem structure at a single point in time rather than tracing how the entry of new actors reshapes the thematic content of policy discourse and the organization of coalitions around policy core beliefs (Pierce et al., 2017; Weible et al., 2009). This temporal limitation leaves an important question unanswered: when a subsystem that was once dominated by government actors opens to include commercial firms, civil society organizations, and other nonstate participants, how do the policy preferences expressed in formal venues change, and how do the coalitions that form around those preferences reorganize?

U.S. space policy provides an instructive setting in which to investigate these questions. As documented in Chapter 1 of this dissertation, the space policy subsystem has undergone a structural transformation from a unitary, government-dominated arrangement to a collaborative, multi-stakeholder configuration over approximately six decades. This trajectory is consistent with broader accounts of the sector's evolution from centralized state control to an increasingly commercialized and diversified operating environment (Weinzierl, 2018; Paikowsky, 2017). That transformation was driven not by dramatic external shocks but by deliberate policy design choices, including the Commercial Space Launch Act of 1984, the Commercial Orbital Transportation Services (COTS) program, and the Artemis program's commercial partnership model, that recruited new classes of actors into the subsystem. Chapter 1 traced the structural dimensions of that transformation: the growth of actor diversity, the shifting centrality of different actor types within discourse networks, and the changing modularity and assortativity of the subsystem across four policy eras. What Chapter 1 did not examine in detail, however, is the thematic content of the beliefs that these actors express, the degree to which specific policy preferences cluster by actor type, or the extent to which certain agenda items have become shared across organizational categories while others remain tethered to particular kinds of actors.

This chapter addresses that gap. Its objective is to investigate how the introduction of different actor types and their corresponding policy beliefs have contributed to the focus and direction of the U.S. space policy subsystem over time. Where Chapter 1 asked whether and how the subsystem changed structurally, this chapter asks what the coalitions within the subsystem talk about, who talks about it, and whether the thematic organization of policy discourse has shifted as the participant base has diversified. The study pairs multi-stakeholder coding (Raymond and Denardis, 2015) with a longitudinal analysis of actor beliefs coded through a regex-based dictionary applied to U.S. congressional hearing testimony spanning from 1958 to 2025. This combined approach permits an assessment of how policy core beliefs cluster among different actor types, including state actors, firms, and civil society organizations, and how those clustering patterns have changed across the same four policy eras examined in Chapter 1.

The novelty of this study lies in three contributions. First, it extends ACF research by examining how the thematic content of policy discourse varies systematically by actor affiliation, a dimension that the framework's traditional emphasis on belief homophily within coalitions has tended to underspecify (Nohrstedt et al., 2023; Weible et al., 2020). Actors do not simply share or contest beliefs in the abstract; their organizational roles, resource constraints, and institutional mandates shape which beliefs they prioritize and how they express them. Second, this chapter provides one of the few longitudinal analyses of policy preference organization within a rapidly evolving, technically complex subsystem. Space policy is characterized by deep collaboration through public-private partnerships, yet certain policy objectives enter the collective agenda while others remain specific to particular actor types. Understanding that distinction matters for theory, practice, and expansion of methodological approaches in space policy (Pomeroy, 2019). Third, the study connects the structural findings from Chapter 1 to the substantive content of policy discourse,

demonstrating that the coalitions identified through network analysis reflect meaningful differences in what actors advocate for through coalitions within the subsystem.

Three central research questions guide this inquiry:

> RQ1: How have policy agenda items in space changed with the introduction of different actor types outside of the government?
>
> RQ2: How do policy topics differ thematically among different types of actors?
>
> RQ3: How have the coalitions within the U.S. space policy system evolved with the introduction of new policy actors attempting to influence the policy agenda?

The results, previewed briefly here, reveal that while some policy core beliefs, such as countering adversaries in space, persist across all four eras and all actor types, the entry of commercial and civil society actors has introduced new thematic emphases and reshaped the distribution of beliefs within coalition networks. Firm actors demonstrate a clear evolutionary trajectory in their core beliefs, shifting from infrastructural concerns in the 1960s to affordability and reusability in the 1980s and then to scheduling and regulatory modernization in the contemporary period. State actors distribute their attention broadly across whatever issues dominate each era, consistent with the ACF's expectation that governmental authorities serve as brokers between competing coalitions. Civil society actors, once marginal participants focused on education and workforce development, have expanded dramatically and now constitute a substantial share of the largest coalitions in the subsystem. The network properties of these coalitions, including consistently low modularity and negative assortativity, indicate that the space policy subsystem is more integrated than segmented and that coalitions form around shared beliefs rather than organizational identity

alone. These findings offer new insights into discourse alignment and the structural evolution of governance in a technically complex and rapidly changing policy domain.

Chapter 1 of this dissertation established that the U.S. space policy subsystem has undergone a typological transition, moving from a unitary, government-dominated arrangement to a collaborative, multi-stakeholder configuration. That chapter measured the structural properties of this transition through network-level indicators: actor diversity, betweenness centrality distributions, modularity scores, and assortativity coefficients. The findings confirmed that the subsystem has diversified, that commercial actors now occupy central brokerage positions, and that coalition boundaries are porous rather than rigid. What Chapter 1 did not examine, however, is the substantive content of the discourse that produces these structural patterns. A modularity score tells us that coalitions exist; it does not tell us what those coalitions advocate. A betweenness centrality distribution tells us which actors occupy brokerage positions; it does not tell us what beliefs those actors are brokering. An assortativity coefficient tells us that coalitions form around beliefs rather than organizational identity; it does not tell us which beliefs are shared across organizational types and which are exclusive to particular categories of actors.

This chapter fills that gap by shifting the analytical focus from network structure to belief content. It asks not whether the subsystem has changed, which Chapter 1 has already demonstrated, but what the coalitions within the subsystem talk about and how the thematic profile of policy core beliefs has shifted with the entry of new actor types. This question is consequential for both theory and practice. From a theoretical perspective, understanding how belief content varies by actor type and era provides a richer account of coalition

formation than structural measures alone. If commercial actors consistently advocate for different policy core beliefs than state actors, then the diversification of the subsystem is changing what the conversation is about. From a practical perspective, identifying which policy preferences are shared across actor types and which remain organizationally specific has implications for coalition building, policy design, and the management of conflict within the subsystem.

2. Background

The governance of U.S. space policy is transitioning from a state-centric modality to a multi-stakeholder network. To understand this transition and its implications for how policy preferences are organized within the subsystem, this study bridges two analytical traditions: the ACF and multi-stakeholder governance theory. The ACF provides the theoretical architecture for understanding how actors organize around shared beliefs and form coalitions that compete to influence policy. Multi-stakeholder governance offers a complementary lens for categorizing actors by their structural roles and institutional power rather than solely by their cognitive beliefs. Together, these frameworks provide a comprehensive model of how diverse actors operate, form coalitions, and influence the thematic direction of a policy subsystem.

The ACF defines policy actors by their shared belief systems and posits that these actors participate in the policy process by forming advocacy coalitions to translate their core beliefs into tangible policy outcomes (Sabatier, 1988; Sabatier & Jenkins-Smith, 1993). However, an actor's beliefs and the intensity with which those beliefs are expressed are heavily influenced by the organizational context in which the actor operates (Pattison, 2018). The strategic allocation of resources further alters both the capacity of individual actors and

the stability of their overarching coalitions (Sabatier & Weible, 2007; Malen & Cochran, 2015). Traditional ACF scholarship has mapped macro-level coalition stability with considerable success, yet it has less frequently examined how specific institutional affiliations drive belief variation among individual actors. Actors do not simply share beliefs; their organizational constraints dictate how they prioritize and act upon those beliefs. This chapter addresses that limitation by examining how actor type, defined by organizational affiliation, corresponds to the specific policy core beliefs expressed in congressional testimony.

2.1 The Advocacy Coalition Framework and the Measurement of Coalitions over Time

The Advocacy Coalition Framework, introduced by Sabatier (1988) and elaborated across subsequent decades (Sabatier & Jenkins-Smith, 1993; Sabatier & Weible, 2007; Jenkins-Smith et al., 2014; Weible et al., 2020), offers a structured account of how policy actors, organized into advocacy coalitions around shared belief systems, compete within policy subsystems to shape public policy. The framework rests on several foundational premises. Policy subsystems, rather than the political system as a whole, are the primary unit of analysis. Within these subsystems, actors from diverse institutional positions, including elected officials, agency personnel, interest group leaders, researchers, and journalists, form coalitions based on shared beliefs that span a three-tiered hierarchy: deep core beliefs, which reflect fundamental normative commitments and are highly resistant to change; policy core beliefs, which concern the proper scope and instruments of policy within a given domain and change only under significant pressure; and secondary beliefs, which address specific implementation choices and are the most susceptible to revision through learning and negotiation (Sabatier & Weible, 2007; Jenkins-Smith et al., 2014).

Coalitions are one of the most studied components of the ACF (Weible et al., 2009; Pierce et al., 2017). The framework posits that policy actors form coalitions while repeatedly engaging in policy issues over time, organizing their beliefs, coordinating based on those beliefs to influence policy, and providing indicators of both the intensity of conflict and the likelihood of policy change (Weible et al., 2020). Two principal analytical approaches to coalitions have emerged in the literature. The first examines coalitions through their internal and external power, focusing on resource mobilization and conflict structures as determinants of policy change (Henry et al., 2022). The second approach, and the one more central to this study, focuses on identifying, describing, and understanding the creation, structure, and evolution of coalitions over time (Nohrstedt et al., 2023). This second approach requires longitudinal data and methods capable of tracing how coalition membership and belief profiles shift as subsystem conditions change.

The ACF identifies four primary pathways through which policy change occurs: external perturbations that redistribute resources among subsystem actors, internal events that highlight policy failures, policy-oriented learning in which coalitions revise their secondary or policy core beliefs in response to new information and negotiated agreements between previously opposed coalitions (Jenkins-Smith et al., 2014; Pierce et al., 2020). Each pathway has received empirical support, though reviews of ACF applications have found that most studies identify at least one coalition but far fewer analyze either policy change or learning in depth (Pierce et al., 2017). Policy-oriented learning is of particular relevance to this study because it provides a mechanism through which the entry of new actors with distinct belief profiles can alter the beliefs of established actors and coalitions. The ACF predicts that learning is most likely to affect secondary beliefs and least likely to affect deep core beliefs,

with policy core beliefs occupying an intermediate position (Sabatier, 1988). However, the space policy case, as documented in Chapter 1, suggests that the sustained entry of commercial actors over several decades has produced changes at the policy core level, not through a single learning episode but through the cumulative reorganization of what beliefs are salient within the subsystem.

Measuring coalitions over time presents both theoretical and methodological challenges. The ACF recommends a time horizon of a decade or more to capture the dynamics of coalition formation, stability, and change (Sabatier, 1988). Yet most empirical applications examine a single period or, at most, compare two periods (Weible et al., 2009; Pierce et al., 2017). Discourse network analysis (DNA) has emerged as a methodological tool well-suited to longitudinal coalition identification because it relies on archival data, such as congressional hearing transcripts, that can be collected consistently across extended time periods (Leifeld, 2017). DNA combines content analysis with network analysis, treating the policy positions expressed by actors in text sources as the basis for constructing congruence and conflict networks. Actors who share policy positions are connected in a congruence network, and community detection algorithms can then identify clusters that correspond to advocacy coalitions (Leifeld, 2013). The advantage of this approach over survey-based methods is that it permits the analysis of coalition dynamics from a longitudinal perspective using data that were not produced for research purposes and are therefore not subject to the response biases associated with self-reported network ties (Leifeld, 2017).

Despite the growth of DNA as a method for identifying coalitions, relatively few studies have applied it across the extended time horizons that the ACF's own theory

demands. This study addresses that gap by using a semi-automated coding procedure, implemented through a regex-based dictionary applied to congressional hearing testimony from 1958 to 2025, to identify policy core beliefs and construct discourse networks across four policy eras. The resulting networks permit an assessment not only of which coalitions exist in each era but of how the thematic content of those coalitions, specifically the policy core beliefs around which they organize, has shifted with the diversification of the subsystem's participant base.

2.2 Deepening Actor Typologies: The Need for Affiliation-Based Analysis

A persistent limitation of ACF research, identified in recent theoretical reviews, is the relative under specification of actor typologies (Nohrstedt et al., 2023; Weible et al., 2020). The framework has traditionally categorized actors by their coalition membership, their institutional position (elected official, agency bureaucrat, interest group representative), or their role within a coalition such as a broker, entrepreneur, or objective technician (Sabatier & Weible, 2007; Ingold & Varone, 2012; Jenkins-Smith, 1990). Sabatier and Weible (2007) introduced a typology of six coalition resources, including formal legal authority, public opinion, information, mobilizable supporters, financial resources, and skillful leadership, that actors bring to bear on the policy process. Ingold and Varone (2012) elaborated on the brokerage function, while Mintrom and Vergari (1996) examined the entrepreneurial role and Jenkins-Smith (1990) introduced the concept of the objective technician.

What these share, however, is a focus on what actors do within coalitions rather than on how their organizational affiliations shape what they believe. The growing diversity of participants in space governance, sometimes described as the "New Space" phenomenon

(Paikowsky, 2017), underscores the importance of this distinction. As commercial startups established defense contractors, and civil society organizations increasingly participate in the same policy venues, the organizational sources of their expressed beliefs become analytically consequential. The ACF's belief homophily hypothesis predicts that actors who share policy core beliefs will coordinate their behavior and form coalitions (Sabatier & Jenkins-Smith, 1993; Calanni et al., 2015). This prediction has been broadly confirmed across diverse empirical settings. Yet the hypothesis does not specify whether the beliefs that actors bring to a subsystem are shaped primarily by the policy domain itself, by the actor's institutional identity, or by some interaction between the two. An actor affiliated with a commercial aerospace firm may share certain policy core beliefs with a NASA administrator (for example, supporting assured access to space) while diverging sharply on others (such as the relative priority of public versus private funding mechanisms). The organizational affiliation, in other words, generates systematic variation in belief profiles that the standard coalition-identification approach tends to aggregate away.

Recent scholarship has begun to address this limitation by arguing for deepening and broadening actor typologies to capture dimensions of actor identity that shape belief expression and coalition behavior (Nohrstedt et al., 2023). Satoh, Gronow, and Ylä-Anttila (2023) developed the Advocacy Coalition Index to provide a standardized method for measuring belief similarity and coordination, making it possible to assess how individual actors contribute to coalition formation. Wesche et al. (2025) systematically reviewed coordination patterns within and between coalitions and found that actors' sectoral backgrounds significantly influenced coalition dynamics, particularly in nascent and evolving subsystems.

The ACF's belief homophily hypothesis predicts that shared policy core beliefs produce coordinated coalition behavior (Sabatier & Jenkins-Smith, 1993; Calanni et al., 2015), but it does not distinguish between the mechanisms by which actors *form* beliefs and those by which actors *express* beliefs in particular institutional settings. Congressional hearings are strategic communication environments. Committee chairs and their professional staff exercise significant control over who is invited to testify, what topics are addressed, and, by extension, which dimensions of policy receive public elaboration (Holyoke, 2008; Curry, 2019). Witnesses, in turn, are not passive transmitters of their full belief systems. Interest group research has established that organized advocates strategically select which aspects of a policy issue to emphasize and which to leave unstated, tailoring their testimony to the institutional context, the preferences of the committee, and the competitive dynamics of the hearing itself (Baumgartner & Mahoney, 2008; De Bruycker, 2017; Holyoke, 2009). Holyoke (2003) found that interest groups may even alter their stated positions on legislation in order to secure invitations to testify, particularly before committees whose ideological orientations favor certain policy frames. Holyoke (2019) further demonstrated that lobbyists strategically choose whether to support or oppose legislation based not only on their members' preferences and on the need to maintain credibility with legislative allies. This strategic dimension of testimony means that the beliefs observed in hearing transcripts may reflect both what actors believe and what they calculate will be most persuasive in each venue.

This distinction between belief formation and belief expression has consequences for interpreting the patterns documented in the present study. When firm actors in the contemporary era concentrate their testimony around scheduling milestones and regulatory modernization, this pattern may reflect a genuine policy core belief rooted in their

commercial operating environment, or it may reflect a strategic emphasis on the dimension of policy where their testimony is most likely to influence committee deliberations, or both. The ACF has acknowledged that actors process information through the lens of their existing beliefs (Sabatier, 1988; Jenkins-Smith et al., 2014), and recent work has shown that beliefs tend toward reinforcement rather than revision through repeated engagement with policy issues (Weible, Olofsson, & Heikkila, 2023). But the framework has given less systematic attention to the possibility that the observable expression of beliefs in policy venues is itself shaped by the strategic incentives of the venue. In technically complex subsystems like space policy, where the same firm actor may testify before both a science committee and an armed services subcommittee, the beliefs that actor chooses to foreground may differ by venue even if the underlying belief system remains constant. Moltz (2019) observed that commercial space actors expanded the range of stakeholders with interests in space access, but he also noted that their ability to influence policy depended on the receptivity of the institutional settings in which they operated. The data employed in this study cannot fully adjudicate between the belief-formation and belief-expression interpretations, because the corpus captures what actors said in hearings, not the complete set of beliefs they hold. This limitation is acknowledged explicitly, and the results should be read with the understanding that the belief profiles documented here represent the publicly expressed beliefs of actors operating in a curated, audience-aware deliberative venue rather than the totality of their policy preferences.

Using congressional hearings, this study builds on developments in the ACF by expanding its analytical frame to observe how organizational affiliation type corresponds to the policy core beliefs actors express and how those correspondences change over time.

Rather than treating coalition membership as the sole unit of analysis, this chapter examines the distribution of policy core beliefs across three primary affiliation categories: state actors, firm actors, and civil society actors. The expectation, grounded in both ACF theory and the multi-stakeholder governance literature, is that actors from different organizational categories will exhibit systematically different belief profiles that reflect their institutional mandates, resource constraints, and strategic incentives.

2.3 Multi-Stakeholder Governance and U.S. Space Policy

Multi-stakeholder governance theory (Raymond and Denardis, 2015) complements the ACF by categorizing actors according to their structural roles and institutional power rather than solely by their cognitive beliefs. Multi-stakeholder governance theory offers more than a classification scheme for sorting actors into state, firm, and civil society categories. It theorizes about the distribution of authority, the sources of legitimacy, and the accountability structures that differ systematically across actor types, and it generates predictions about how those differences shape participation in governance venues (Raymond & DeNardis, 2015; Abbott & Snidal, 2009; Bäckstrand, 2006). Raymond and DeNardis (2015) demonstrated that multi-stakeholder arrangements vary substantially in both the combinations of actor classes entitled to participate and the nature of authority relations among them, distinguishing among homogeneous and heterogeneous arrangements, hierarchies and polyarchies, and different allocations of formal and informal authority. A central finding of their comparative analysis is that multi-stakeholder governance frequently fails to live up to its own participatory rhetoric: formal inclusion of diverse actor types does not guarantee effective voice, and the procedural rules governing multi-stakeholder processes allocate authority unevenly across

actor types (Raymond & DeNardis, 2015; Mena & Palazzo, 2012; Fransen & Kolk, 2007). Abbott and Snidal (2009) formalized these asymmetries through the governance triangle, which maps the distribution of governance competencies, including operational capacity, independence, representativeness, and expertise, across states, firms, and NGOs. Their framework posits that each actor type brings distinct competencies and characteristic deficits: states possess formal authority and broad representativeness but may lack technical agility; firms command proprietary information and implementation capacity but face accountability deficits rooted in commercial incentives; and civil society actors contribute normative pressure and independent analysis but confront resource constraints that limit sustained participation in technically complex venues (Abbott & Snidal, 2009; Bäckstrand, 2006; Benner, Reinicke, & Witte, 2004). Zancan and Paravano (2024) document this evolution in their analysis of NASA-led programs, tracing how governance structures have shifted from legacy cost-plus contracting arrangements to public-private partnerships that redistribute design authority and financial risk toward commercial participants.

These theoretical propositions generate specific expectations for the space policy case. Extending Abbott and Snidal's (2009) competency framework to domestic legislative venues, firm actors should concentrate their expressed beliefs around dimensions where their technical expertise and operational knowledge are most persuasive. State actors should distribute attention broadly, not from ideological indifference but because the institutional mandate to mediate among competing claims requires engagement across the full scope of the subsystem, a prediction consistent with the ACF's broker concept (Sabatier & Weible, 2007; Ingold & Varone, 2012) but grounded here in the structural competency of regulatory authority rather than cognitive orientation. Civil society actors should face the most

significant barriers to sustained participation and should enter through issue dimensions where their normative legitimacy is least contested, expanding into other dimensions only as the subsystem grows large enough to sustain their presence (Abbott & Snidal, 2009; Bäckstrand, 2006). And the formal structure of authority relations within the venue itself should shape the content of discourse: because congressional hearings are settings in which committee leadership controls witness selection and agenda definition, the belief profiles observed in testimony reflect not only what actors want to say but what the venue allows and incentivizes them to say (Raymond & DeNardis, 2015; Holyoke, 2008). Combining the ACF's belief-centered account of coalition formation with the multi-stakeholder framework's structural account of authority relations provides a richer theoretical architecture than either framework offers alone, and the results section assesses the degree to which the empirical patterns observed across the four policy eras conform to or complicate these predictions.

U.S. space policy began almost exclusively as a government modality. During its first two decades, the subsystem was organized around a small core of state actors: NASA, the Department of Defense, congressional committees with jurisdiction over space activities, and a limited number of government contractors operating under cost-plus arrangements. Congress remained a central state actor throughout this period, and House and Senate committees steered space objectives in close coordination with the executive branch. Committee membership and constituency representation dictated how localized economic interests shaped national space agendas. Private firms participated, but they did so within the confines of traditional government contracting relationships, where the state defined requirements, bore most financial risk, and maintained close oversight of program execution.

Legislative milestones fundamentally altered this arrangement. The Commercial Space Launch Act of 1984 opened the domestic launch market to private providers and established a regulatory framework for commercial space transportation. The Commercial Orbital Transportation Services (COTS) program, initiated in 2006, went further by using funded Space Act Agreements rather than traditional contracts to develop commercial cargo delivery to the International Space Station, shifting substantial design authority and financial risk to private firms. The Commercial Crew Program extended this model to human spaceflight. The cumulative effect of these policies was to introduce significant market power into a subsystem that had previously operated on the logic of government procurement. Firms that had once been government contractors became independent commercial entities with their own strategic agendas, investor bases, and policy preferences.

Non-governmental actors have also expanded their presence and influence. Academic institutions drive policy initiatives through university research centers, supplying the technical and strategic analysis that informs advocacy. Nonprofit organizations, including industry associations and public interest groups, have grown in both number and influence. Civil society participation in congressional hearings has increased dramatically, as documented in Chapter 1. This expansion signals a quantitative increase in participation and a potential qualitative shift in who is contributing to the formation of the space policy agenda.

Applying the multi-stakeholder lens to U.S. space policy clarifies what the ACF's coalition analysis measures and what it may miss. The ACF groups actors by shared beliefs; the multi-stakeholder framework groups them by institutional identity. When these two dimensions are combined, it becomes possible to ask whether actors who share coalition

membership also share organizational affiliations, and conversely, whether actors from the same organizational category but different coalitions hold systematically different beliefs. The results of this study, discussed in Section 4, suggest that the answer to both questions is nuanced: coalitions in the space policy subsystem form around beliefs rather than organizational identity, yet the specific beliefs that actors prioritize are significantly shaped by their organizational type.

3. Data and Methods

This study uses the same data infrastructure, coding procedures, and validation approach developed in Chapter 1. The core elements of that research design are summarized here; readers seeking a complete account of data collection, dictionary construction, and semi-automated coding validation should consult Chapter 1, Section 3, and the accompanying appendices.

3.1 Data Sources and Corpus Construction

The analysis draws on the same corpus of U.S. congressional hearings described in Chapter 1. Hearings were identified through searches of the Catalog of U.S. Government Publications and cross-referenced with the Comparative Agendas Project hearings database, ProQuest, and GovInfo. The final sample consists of 293 space-related hearings grouped into four policy eras that correspond to historically significant punctuations in U.S. space policy: 1960–1964 (the early NASA and Apollo era), 1982–1986 (the onset of commercialization following the Commercial Space Launch Act), 2011–2015 (the post-Shuttle transition to commercial cargo and crew), and 2017–2025 (the contemporary era of large-scale commercial partnerships and the Artemis program). The rationale for these periodization

choices, including the longer span of the final era to accommodate publication lags in the hearing record, is provided in Chapter 1, Section 3.2.

3.2 Coding Procedure and Semi-Automated Pipeline

Policy core beliefs were identified using the semi-automated coding pipeline developed and validated in Chapter 1. Hearing transcripts were tokenized into speaker-level paragraphs and filtered using a curated policy preference word dictionary that captured verbs and modifiers commonly associated with the expression of policy positions. A regex-based ACF belief dictionary, constructed through qualitative review of the hearing sample, was then applied to code each filtered paragraph for one or more policy core belief categories. Statements could receive multiple codes when they expressed multiple belief types. The semi-automated pipeline was validated against a fully hand-coded discourse network derived from a 98-page hearing transcript (serial number 117-59). Structural comparison yielded a Jaccard similarity coefficient of 0.54 for the edge sets, and visual inspection confirmed that the semi-automated procedure captured the major relational structures present in the manual coding. For a detailed description of the dictionary, the validation procedure, and the coding scheme, see Chapter 1, Sections 3.3 through 3.5 and Appendix Entries 1 and 2.

3.3 Multi-Stakeholder Actor Coding

Where this chapter departs from Chapter 1 is in how actors are classified and how coalitions are identified and analyzed. Chapter 1 tracked actor diversity at the aggregate level, measuring the proportional representation of actor types across eras. This chapter disaggregates belief profiles by organizational affiliation to examine how actor type corresponds to the specific policy core beliefs expressed in congressional testimony. Each

actor in the corpus was coded into one of three primary affiliation categories following the multi-stakeholder governance categorization (Raymond and Denardis, 2015): state actors, including elected officials, executive branch appointees, and agency personnel; firm actors, including representatives of commercial aerospace companies and industry associations; and civil society actors, including representatives of nonprofit organizations, academic institutions, and advocacy groups. Actors with affiliations spanning multiple categories were coded according to the organizational capacity in which they testified. This classification scheme permits an analysis of how the beliefs expressed in formal policy discourse vary systematically by the institutional identity of the actor expressing them, a dimension that the ACF's traditional emphasis on belief homophily within coalitions has tended to underspecify (Nohrstedt et al., 2023; Weible et al., 2020).

3.4 Coalition Identification through Community Detection

Coalitions were identified by applying community detection to the normalized congruence networks constructed for each policy era. Discourse network analysis treats the policy positions expressed by actors in text sources as the basis for constructing networks in which actors who share policy positions are connected (Leifeld, 2013, 2017). This approach provides an intertemporal measurement of coalition alignment at the level of policy beliefs, with the advantage over survey-based methods that it permits longitudinal analysis using archival data not subject to the response biases of self-reported network ties (Leifeld, 2017). Congruence networks were normalized so that a speaker received credit for a policy core belief only once per hearing, regardless of repetition, following the procedure described in Chapter 1, Section 3.6. This normalization controls for variation in testimony length and

ensures that the resulting networks reflect the breadth of an actor's policy engagement rather than rhetorical emphasis on a single point.

Community structure within each era's congruence network was detected using the Louvain algorithm (Blondel et al., 2008), a modularity-optimization heuristic widely used in network science and increasingly applied to the identification of advocacy coalitions in ACF research (Leifeld, 2013; Leifeld, 2016). The Louvain algorithm iteratively assigns nodes to communities by maximizing the modularity function Q, which measures the density of edges within communities relative to edges between them. The algorithm is well suited to the present application because it handles weighted networks, scales efficiently to the network sizes observed in this study and produces a partition in which each actor belongs to exactly one community, corresponding to the ACF's assumption that actors hold primary coalition membership (Sabatier & Jenkins-Smith, 1993). Coalitions identified through this procedure were labeled according to the policy core belief that constituted the thematic center of gravity for the cluster's members. Two structural properties of the resulting networks are reported for each era. Modularity (Q) indicates the strength of the community structure; values between 0.10 and 0.30 indicate weak but detectable partitioning. Assortativity by actor type indicates whether actors preferentially connect with others of the same organizational affiliation or across affiliations. These measures, combined with the actor-type composition of each coalition, permit an assessment of whether coalitions in the space policy subsystem organize around shared beliefs or around organizational identity.

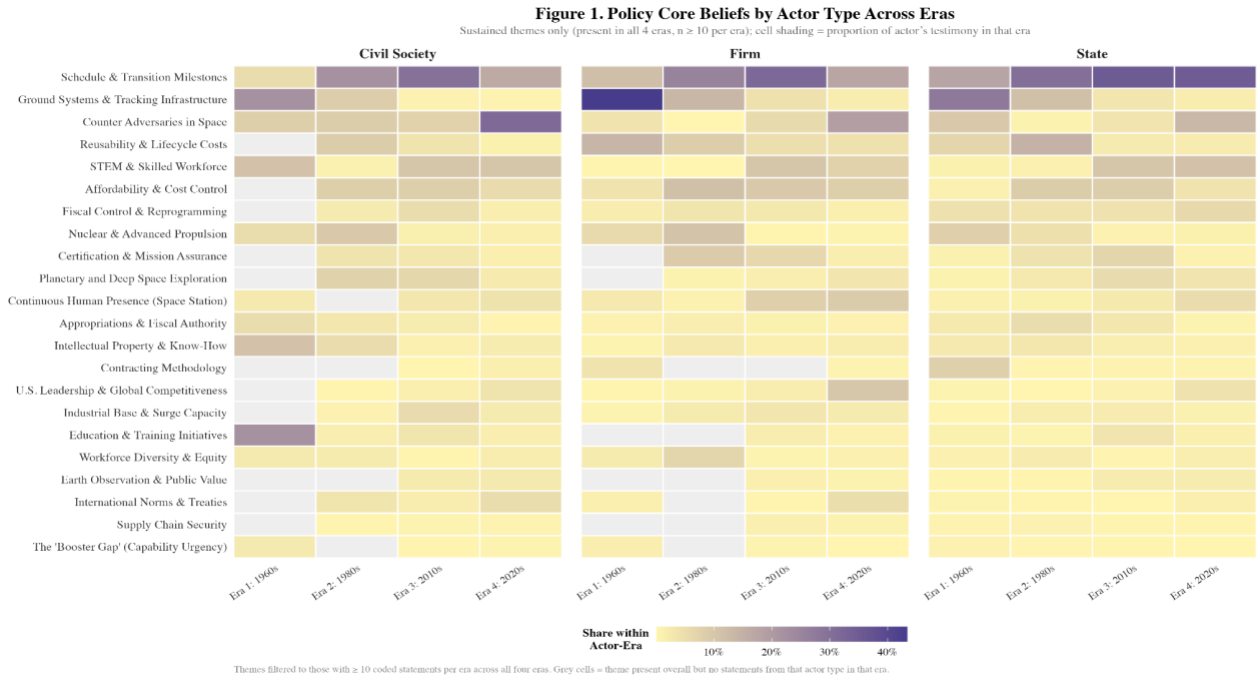
3.5 Analytical Strategy

The analysis proceeds in three stages, corresponding to the three research questions. First, the distribution of policy core beliefs is examined across the four eras, disaggregated by

actor type, to assess how the thematic content of the policy agenda has changed with the introduction of actors from outside the government (RQ1). Second, the belief profiles of state, firm, and civil society actors are compared within each era to identify systematic differences in what actors from different organizational categories advocate (RQ2). Third, coalition networks are constructed for each era using the Louvain algorithm, and the composition, thematic content, and structural properties of the resulting coalitions are traced across time to assess how the organization of advocacy coalitions has evolved with the diversification of the subsystem's participant base (RQ3). This three-stage design connects the structural findings from Chapter 1 to the substantive belief content that organizes coalition activity, providing a more complete account of how the space policy subsystem has changed and what that change means for the organization of policy discourse.

4. Results

Under the ACF, policy core beliefs provide the fundamental glue that binds coalitions together and guides their behavior within a policy subsystem (Sabatier & Weible, 2007). *Figure 1* demonstrates both the rigid stability of certain priorities and the dynamic evolution of actor-specific policy core beliefs over sixty years of U.S. space policymaking. Geopolitical and infrastructural beliefs dominated early subsystem discourse. "Ground Systems & Tracking Infrastructure" served as a primary focus for both State and Firm actors during the 1960s but steadily diminished in prominence as baseline national capabilities were established. Conversely, "Counter Adversaries in Space" maintains a persistent presence across all four eras, surging notably among Civil Society and State actors in the 2020s as renewed great power competition in orbit reshaped the policy landscape.



"Education & Training Initiatives" registers its highest concentration among Civil Society actors in the 1960s, reflecting the workforce mobilization campaigns of the early space age, and then all but disappears from Civil Society discourse in later eras. "U.S. Leadership & Global Competitiveness" intensifies among Firm actors in the most recent era, a pattern consistent with the growing role of American commercial launch providers in international markets and the broader rhetoric of space as a domain of strategic economic competition. These patterns suggest that while some policy core beliefs are stable features of the subsystem, others are responsive to particular historical moments and the institutional interests of distinct actor types.

Firm actors demonstrate a clear evolution in their core beliefs, indicating policy-oriented learning and adaptation as the commercial space sector matured. Their focus shifted from foundational infrastructure in the 1960s to economic viability in the 1980s, marked by the rise of "Affordability & Cost Control" and "Reusability & Lifecycle Costs." These beliefs did not emerge in a vacuum. The Shuttle program's escalating costs and the Challenger disaster in 1986 created the conditions for what the ACF describes as policy-oriented

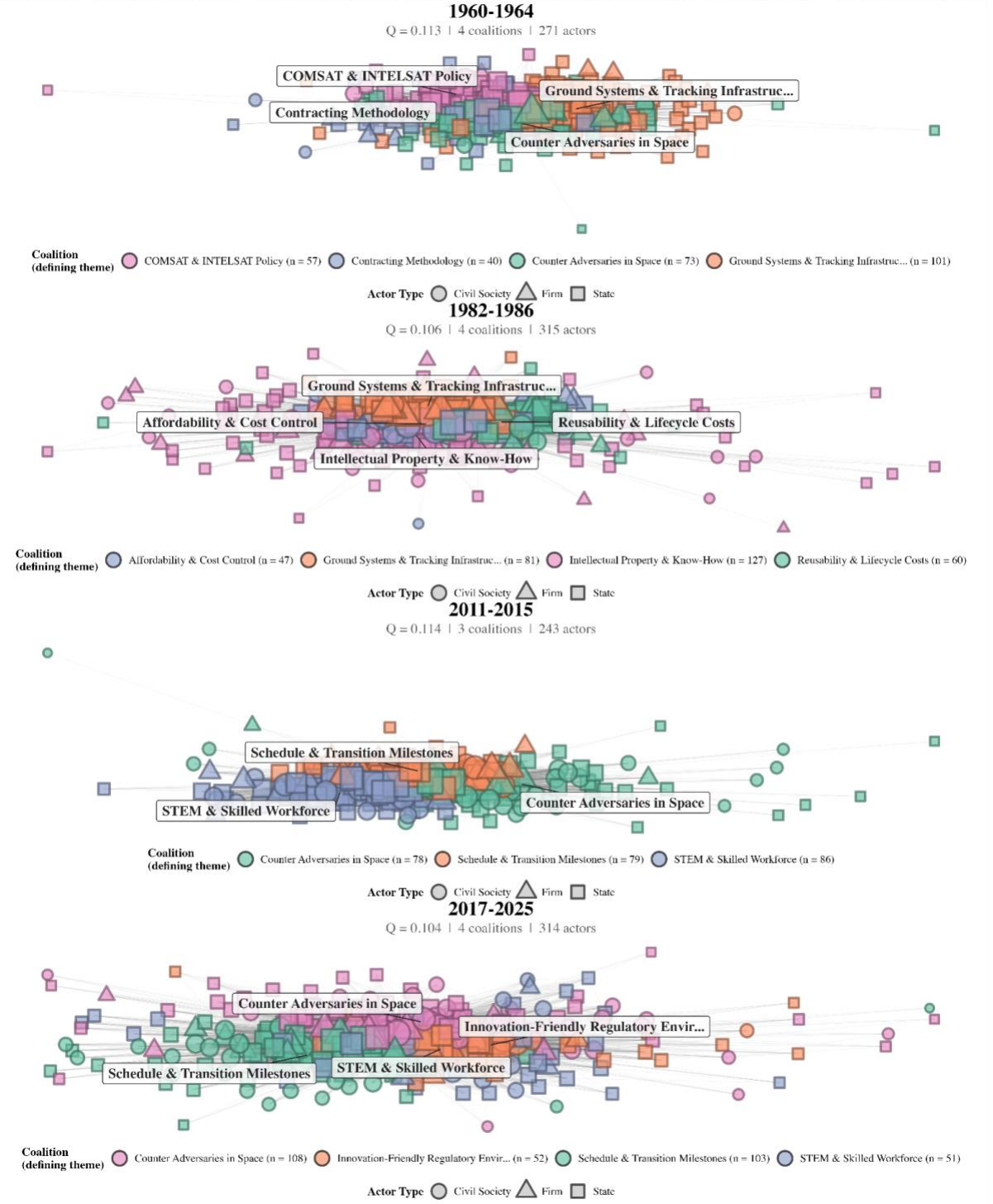
learning: new technical and analytical information forced a reassessment of means-ends relationships within the subsystem (Sabatier, 1988). By the modern eras, commercial attention pivoted heavily toward "Schedule & Transition Milestones," a shift that coincided with NASA's reliance on private providers for cargo and crew services following the Shuttle's retirement in 2011.

State actors exhibit an exceptionally broad distribution of beliefs compared to Firm or Civil Society actors. However, their highest concentrations align closely with the dominant themes of the prevailing coalitions (discussed in *Figure 2*) in each era. This breadth captures the state's institutional role in mediating subsystem disputes and absorbing external perturbations (Weible et al., 2009). State actors, in other words, do not rally around a narrow set of beliefs the way Firm actors do. Instead, they distribute their attention across whatever issues the subsystem places at the center of policy debate, a finding consistent with the ACF's expectation that governmental authorities often serve as brokers or mediators between competing coalitions (Sabatier & Weible, 2007).

Shared policy core beliefs compel actors to coordinate their behavior, forming distinct advocacy coalitions that compete to translate those beliefs into formal policy (Sabatier & Jenkins-Smith, 1993). *Figure 2* applies community detection to network these actors based on shared beliefs, mapping how coalitions restructured within the U.S. space policy subsystem over the four eras examined here.

Figure 2. Coalition Networks by Policy Era

Node shape = actor type. Node color = coalition (Louvain), labeled by most distinctive policy core theme (TF-IDF). Edge weight = number of shared theme



Edge threshold: minimum 2 shared themes (1 where data are sparse). Coalition labels placed at group centroids. Node borders are darkened shades of the fill color.

The early subsystem of the 1960s was characterized by tightly bound coalitions focused on technical and administrative establishment. The presence of a "Ground Systems &

Tracking Infrastructure" coalition (n = 101 actors) alongside "Counter Adversaries in Space" (n = 73) highlights a subsystem driven by the dual imperatives of capacity building for the Apollo program and early Cold War competition. The "COMSAT & INTELSAT Policy" coalition (n = 57) directly reflects the specialized legislative debates surrounding the Communications Satellite Act of 1962, which established the framework for U.S. participation in satellite communications and created the quasi-public Communications Satellite Corporation. Notably, as *Table 1* shows, all four coalitions in this era were overwhelmingly populated by State actors, with Firm and Civil Society participation remaining marginal. This composition is characteristic of what the ACF literature describes as an early, state-dominated subsystem in which nongovernmental actors have yet to mobilize around policy core beliefs at scale (Weible et al., 2009).

Table 1: Coalition Composition by Actor Type and Era

Era	Coalition	State	Firm	Civil Society
1960–1964	Counter Adversaries in Space	61	8	4
	Ground Systems and Tracking Infrastructure	93	5	3
	Contracting Methodology	35	3	2
	COMSAT and INTELSAT	50	5	2
1982–1986	Reusability and Lifecycle Costs	46	10	4
	Ground Systems and Tracking Infrastructure	54	21	6
	Affordability and Cost Control	21	14	12
	Intellectual Property and Know-How	84	25	18
2011–2015	Counter Adversaries in Space	43	9	26
	Schedule and Transition Milestones	47	17	15
	STEM and Skilled Workforce	57	12	17
2017–2025	Schedule and Transition Milestones	60	11	32
	Innovation-Friendly Regulatory Environment	33	13	6
	STEM and Skilled Workforce	39	3	9
	Counter Adversaries in Space	57	16	35

Note: Cell values represent the number of unique actors in each coalition-type cell. Coalition numbering corresponds to Louvain community detection assignments and is not comparable across eras.

Following a period of significant subsystem perturbation, the network consolidated from four coalitions to three in the 2011-2015 era. The "Schedule & Transition Milestones" coalition (n = 79) dominated this period, reflecting the intense congressional debate and policy turbulence surrounding the retirement of the Space Shuttle program in 2011 and the transition to commercial cargo and crew providers under NASA's Commercial Orbital Transportation Services and Commercial Crew programs. The reduction from four coalitions to three is itself analytically significant. The ACF posits that major external perturbations can collapse coalition boundaries by forcing actors to reconfigure around a smaller number of urgent priorities (Sabatier & Weible, 2007). The Shuttle's retirement constituted such a perturbation, concentrating subsystem attention on the practical question of how the United States would maintain human access to space. *Table 1* also reveals a dramatic increase in Civil Society participation during this era: the "Counter Adversaries in Space" coalition contains 26 Civil Society actors, compared to just 4 in the same coalition during the 1960s. This expansion signals a broadening of the subsystem's participant base that continued into the most recent era.

The contemporary network (2017-2025) bifurcates into distinct security and commercial blocs. The emergence of the "Innovation-Friendly Regulatory Environment" coalition (n = 52) alongside the massive "Counter Adversaries in Space" coalition (n = 108) captures the modern dual-track focus of U.S. space policy. This era is defined simultaneously by the establishment of the U.S. Space Force in 2019, which consolidated military space operations into a dedicated service branch to address growing threats from peer competitors, and by the rapid expansion of a commercially driven space economy requiring modernized regulatory frameworks. The "Counter Adversaries in Space" coalition is the largest single coalition observed in any era that contains 35 Civil Society actors and 16 Firm actors alongside 57 State actors. The scale and diversity of this coalition suggest that space security

has become a broadly shared concern across the subsystem rather than a niche preoccupation of defense-sector state actors, as it was in the 1960s.

Table 2 presents the structural properties of coalition networks across the four policy eras. The modularity scores (Q) are consistently low, ranging from 0.1042 in the most recent era to 0.1143 in the 2011-2015 period. In network science, Q values between 0.10 and 0.30 indicate weak but detectable community structure. These results suggest that while distinct coalitions can be identified through the Louvain algorithm, the networks themselves are characterized by considerable cross-coalition connectivity. Actors sharing multiple policy core beliefs span coalition boundaries, indicating that the U.S. space policy subsystem is more integrated than segmented. This finding speaks to a broader debate in the ACF literature about whether technically complex subsystems produce more rigid or more porous coalition boundaries. The consistently low modularity observed here suggests that the technical complexity of space policy may actually encourage cross-coalition engagement, as actors require specialized knowledge that is distributed across organizational and ideological lines. In subsystems where expertise is a critical resource, even actors who disagree on policy priorities may maintain ties through shared technical language and overlapping programmatic concerns.

Table 2: Coalition Network Summary Statistics by Era

Era	Actors	Edges	Coalitions	Q	Assortativity (r)
1960–1964	271	11,376	4	0.1125	-0.0122
1982–1986	315	15,790	4	0.1056	-0.0109
2011–2015	243	12,173	3	0.1143	-0.0027
2017–2025	314	15,685	4	0.1042	-0.0022

Note: Q = Louvain modularity score. Assortativity (r) measures whether actors of the same type preferentially connect with one another; values near 0 indicate no preference.

The assortativity coefficients are uniformly negative across all four eras, ranging from -0.0122 in 1960-1964 to -0.0022 in 2017-2025 and approaching zero in the later periods. Negative assortativity means that actors are not systematically connecting with others of the same organizational type; state actors, firms, and civil society organizations form ties across rather than within categories. This cross-type connectivity is consistent with the ACF's foundational expectation that coalitions form around shared beliefs rather than organizational identity (Sabatier & Jenkins-Smith, 1993; Sabatier & Weible, 2007). The near-zero values in later eras suggest that as the policy subsystem expanded to include more nonstate participants, the tendency toward any type-based coalition building diminished further. The movement toward zero, rather than toward positive values, indicates that the entry of new commercial and civil society actors did not produce organizationally homogeneous coalitions but instead reinforced the belief-based logic of coalition formation that the ACF posits.

It is also worth noting the relationship between edge density and era. The 1982-1986 network contains the most edges (15,790) despite not having the most actors (315), producing the densest network observed across the four periods. This heightened connectivity corresponds to a period of exceptional policy contestation. The Space Shuttle's cost overruns, the Challenger disaster, intellectual property disputes over government-developed technologies, and the legislative push for commercial launch all generated overlapping debates that drew actors into contact with one another across multiple belief dimensions. The 2011-2015 era, by contrast, has the fewest actors (243) and fewest edges (12,173), yet the highest modularity ($Q = 0.1143$), suggesting that the Shuttle retirement concentrated subsystem debate around a smaller number of issues and produced somewhat more distinct coalition boundaries.

5. Discussion

The results of this study speak directly to several core propositions of the ACF and, in certain respects, extend the framework's explanatory reach into territory it has not previously occupied. Three sets of findings warrant sustained discussion: the relationship between actor type and belief content, the structural properties of coalition networks in a collaborative subsystem, and the evidence for policy-oriented learning across the subsystem's history.

The ACF's belief homophily hypothesis predicts that actors who share policy core beliefs will coordinate their behavior and form coalitions (Sabatier & Jenkins-Smith, 1993; Sabatier & Weible, 2007). This hypothesis has been broadly confirmed across dozens of empirical applications (Pierce et al., 2017; Weible et al., 2009). What the hypothesis does not specify, however, is the degree to which actors' organizational affiliations systematically shape which policy core beliefs they hold in the first place. The findings from the case of U.S. space policy provide evidence that organizational type is a meaningful predictor of belief content. Firm actors demonstrate a coherent and evolving set of policy core beliefs that reflect the commercial sector's institutional interests from foundational infrastructure concerns in the 1960s, to affordability and reusability in the 1980s, to scheduling milestones and regulatory modernization in the contemporary period. This trajectory parallels the broader transformation of U.S. space power that Moltz (2019) documents, in which commercially led innovation has reshaped traditional definitions of space capability and introduced new forms of networked, bottom-up policy influence that state-controlled models cannot easily replicate. State actors distribute their expressed beliefs broadly across the issues that dominate each era, consistent with the brokerage role the ACF assigns to governmental authorities (Sabatier & Weible, 2007; Ingold & Varone, 2012). Bosso and Kay (2004)

identified this brokerage function in the post-Apollo subsystem, describing NASA's position as one of mediating among competing coalitions rather than dominating a single unified program. The findings of the present study suggest that this brokerage role has persisted even as the subsystem has diversified far beyond the conditions Bosso and Kay observed, with state actors continuing to distribute their attention across whatever issues the subsystem places at the center of debate. Civil society actors, once confined to education and workforce mobilization, have expanded their thematic range dramatically and now participate in coalitions organized around security, commercial regulation, and international competition.

These patterns suggest that the belief homophily hypothesis, while confirmed in its core prediction that shared beliefs produce coalition coordination, requires supplementation with attention to the sources of the beliefs that actors bring to a subsystem. Actors do not arrive at their policy core beliefs independently of their organizational context. A firm actor whose revenues depend on government launch contracts will prioritize affordability and scheduling milestones not because these beliefs reflect abstract normative commitments but because they map directly onto the operational realities of commercial spaceflight. A state actor responsible for overseeing multiple programs across the subsystem will distribute attention broadly not out of ideological indifference but because the institutional mandate of government is to mediate among competing priorities. The ACF has long acknowledged that beliefs are shaped by experience and information processing (Sabatier, 1988; Jenkins-Smith et al., 2014), but it has given less systematic attention to the organizational structures through which that processing occurs. This study provides empirical grounds for incorporating organizational affiliation as a variable that conditions the belief profiles actors bring to coalition formation. In doing so, it complements recent calls in the ACF literature to deepen

actor typologies beyond the standard categories of coalition membership and institutional role (Nohrstedt et al., 2023; Weible et al., 2020).

The structural properties of the coalition networks identified here also carry implications for the ACF's subsystem typology. The consistently low modularity scores across all four eras (ranging from Q = 0.1042 to Q = 0.1143) indicate that the U.S. space policy subsystem is characterized by weak but detectable community structure with extensive cross-coalition connectivity. This pattern is characteristic of what the ACF literature describes as a collaborative subsystem: one in which multiple coalitions exist and continue to disagree on certain policy core beliefs but are able to find enough common ground to negotiate and coordinate across coalition lines (Weible et al., 2010; Koebele, 2019). The space policy subsystem does not resemble the adversarial model in which tightly bounded coalitions compete in zero-sum fashion over entrenched policy differences (Weible & Sabatier, 2009). Nor is it a unitary subsystem dominated by a single coalition. Instead, it occupies the collaborative middle ground, and the findings of this study help to clarify what that collaborative structure looks like in empirical practice.

Kammerer et al. (2021), in a comparative study of climate change subsystems across four countries, found that the link between beliefs and collaboration tightens under conditions of high conflict and loosens under conditions of low conflict, with actors in collaborative subsystems coordinating for reasons that include professionalism and information exchange rather than belief alignment alone. The space policy case is consistent with this pattern. The low modularity and negative assortativity observed here indicate that coalition boundaries are porous: actors from different organizational types and, to some extent, different belief

clusters maintain ties across coalition lines. In a technically complex domain like space policy, this porosity may reflect the practical reality that expertise is distributed across organizational categories. Jakhu, Chen, and Goswami (2020) document a similar dynamic in the international space security arena, where the increasing entanglement of military, commercial, and scientific activities compels actors with competing policy preferences to maintain working relationships across organizational boundaries. A firm actor developing reusable launch vehicles and a state actor overseeing launch safety regulation may disagree on the appropriate regulatory burden, but they share a technical vocabulary and overlapping programmatic concerns that sustain cross-coalition engagement. The ACF's theory of the collaborative subsystem has been less thoroughly developed than its theory of adversarial dynamics (Koebele, 2019; Wesche et al., 2025), and the space policy case offers a sustained empirical illustration of how collaboration and contestation coexist within a single subsystem over extended periods.

Finally, the results provide evidence for what the ACF terms policy-oriented learning (Sabatier, 1988). The ACF predicts that learning, defined as the revision of belief-system components in response to new technical or analytical information, is most likely to occur at the level of secondary beliefs and least likely at the level of deep core beliefs, with policy core beliefs occupying an intermediate position. The evolutionary trajectory of firm actors' beliefs documented here is consistent with policy-oriented learning at the policy core level, but it unfolds over a much longer time horizon than single-episode learning events. The Shuttle program's escalating costs and the Challenger disaster created conditions in which commercial actors reassessed fundamental assumptions about the relationship between government procurement and operational efficiency. The subsequent shift toward

affordability, reusability, and eventually commercial scheduling milestones represents a cumulative revision of policy core beliefs that unfolded across decades rather than within a single policy cycle. Weible, Olofsson, and Heikkila (2023) recently examined the dynamics of belief stability, change, and reinforcement within coalitions and found that beliefs can be reinforced as well as revised through repeated engagement with policy issues. The firm actor trajectory observed here is consistent with a reinforcement dynamic: once commercial actors shifted their policy core beliefs toward market-oriented priorities in the 1980s, subsequent developments (the Shuttle's retirement, the growth of commercial crew, the Artemis program's partnership model) reinforced rather than reversed that shift. The result is a belief trajectory that appears evolutionary and path-dependent rather than episodic.

These findings complement and extend several strands of existing scholarship. The study builds most directly on the ACF's research agenda for coalition measurement and subsystem typology. Pierce, Peterson, Jones, Garrard, and Vu's (2017) comprehensive review of 161 ACF applications found that while 89 percent of studies identified at least one coalition, only 42 percent analyzed policy change, and fewer still traced coalition evolution across multiple time periods. This study responds to that gap by tracking coalition structure and belief content across four eras spanning more than six decades. Similarly, Pierce, Giordono, Peterson, and Hicks (2020), in their focused review of the ACF's theory of policy change, identified the infrequent use of many core ACF concepts and called for greater clarity and transparency in how applications operationalize the framework's variables. The regex-based coding dictionary and community detection approach used here offer one response to that call: a replicable, semi-automated method for identifying policy core beliefs

and mapping coalition structure that can be applied to other domains where longitudinal hearing or text data are available.

The findings also engage the growing literature on discourse network analysis as a method for studying policy subsystems and the coalitions within them. Discourse network analysis has been applied to study coalition dynamics in a broad array of topics, for example, in German pension politics (Leifeld, 2013), Swiss climate policy (Ingold, 2011), European software patent debates (Leifeld & Haunss, 2012), energy policy transitions (Kukkonen & Ylä-Anttila, 2020), and Mexican electricity reform (Chacón-Aragón et al., 2024). This study extends that methodological lineage in two ways. First, it applies discourse network analysis across a far longer time horizon than previous congressional hearing studies, demonstrating that the method can capture evolutionary dynamics that single-period analyses cannot. Second, it pairs coalition identification with an analysis of how belief content varies by actor type, adding a dimension to discourse network analysis that standard applications, which focus on actor-concept networks without disaggregating by organizational affiliation, have not systematically explored.

The study further contributes to the nascent literature on subsystem and coalition evolution. Stritch (2015) examined advocacy coalitions in a nascent Canadian policy subsystem and found that the subsystem's early developmental stage limited the scope of policy-oriented learning. Heinmiller, Osei, and Danso (2021) investigated ACF policy change theory in a unitary subsystem in Ghana and found that the absence of competing coalitions constrained the applicability of several standard ACF hypotheses. Kefeli et al. (2023) examined advocacy coalitions in a newly established natural-resource sector and documented

how contrasting conceptions of sustainability shaped coalition formation. Each of these studies examines a subsystem at a particular developmental stage. This study, by contrast, traces a single subsystem across multiple stages: from a nascent, state-dominated arrangement in the 1960s, through periods of perturbation and restructuring, to the contemporary collaborative configuration. The longitudinal design makes it possible to observe not only what coalitions look like at a given moment but how the thematic content of those coalitions changes as the subsystem's participant base evolves.

The study's engagement with multi-stakeholder governance (Raymond and Denardis, 2015) also represents a contribution to the ACF literature. While the ACF has always recognized that actors come from diverse institutional positions, it has not systematically incorporated the multi-stakeholder governance approach to categorizing actor types. By coding actors as state, firm, civil society, or intergovernmental and then examining how belief profiles vary across these categories, analysts studying subsystems undergoing structural diversification, whether in space policy or in analogous domains like artificial intelligence governance, cybersecurity, or commercial biotechnology, can use multi-stakeholder coding alongside ACF belief analysis to capture dimensions of subsystem and coalition change.

5.1 Implications for Space Policy Governance

The substantive findings carry implications for the governance of U.S. space policy. The emergence of the dual-track structure in the contemporary era, in which a massive security-focused coalition coexists with a smaller but distinct commercial-regulatory coalition, reflects a subsystem that is simultaneously consolidating around shared security

concerns and differentiating around the governance of a rapidly expanding commercial economy. The "Counter Adversaries in Space" coalition, with 108 actors drawn from all three organizational categories, suggests that space security has become a consensus priority: a belief shared so broadly across the subsystem that it no longer functions as a basis for inter-coalition competition but rather as a unifying theme that crosscuts organizational and ideological boundaries. This has practical significance for policymakers. When a policy core belief achieves this degree of cross-coalition saturation, it becomes a foundation on which coalition-spanning legislation and executive action can be built with relatively low political cost.

The "Innovation-Friendly Regulatory Environment" coalition, by contrast, represents a more specialized set of concerns associated disproportionately with firm actors and the state actors who regulate them. The emergence of this coalition in the most recent era reflects the regulatory challenges created by the rapid growth of commercial space activities, including spectrum management, space debris mitigation, launch licensing, and the governance of in-orbit servicing. These issues are technically demanding, often involve proprietary information, and require regulatory frameworks that balance innovation incentives against safety and sustainability. The concentration of this coalition among actors with direct stakes in commercial operations suggests that the regulatory dimension of space policy is developing a distinct coalitional identity within the broader subsystem. Further, this finding resonates with concerns raised in the space governance literature about the adequacy of existing regulatory frameworks for the pace and scale of commercial expansion (Jakhu, Chen, & Goswami, 2020). Policymakers designing regulatory frameworks for commercial space activities should recognize that the actors most engaged in these debates bring specific belief

profiles shaped by commercial incentives, and that effective regulation will require sustained engagement with the broader subsystem.

The dramatic expansion of civil society participation documented across the four eras also merits attention from practitioners. In the 1960s, civil society actors were marginal participants focused narrowly on education and workforce issues. By the contemporary period, they constitute a substantial portion of the largest coalition in the subsystem and participate across a wider range of policy core beliefs. This expansion is consequential because civil society actors, including academic institutions, nonprofits, and advocacy organizations, bring different resources and different modes of engagement than state or firm actors. They provide independent analysis, mobilize public attention, and articulate normative claims about equity, sustainability, and the public interest that commercial and governmental actors may underemphasize.

5.2 Limitations

Several limitations should be noted. First, congressional hearings are curated venues. Witnesses are invited by committee chairs and ranking members, their testimony is audience-aware, and the full range of actors influencing space policy extends beyond those who testify. Hearings therefore provide a representative rather than exhaustive account of subsystem and coalition participation. The patterns identified here reflect observable discourse network structure rather than the complete architecture of policymaking activity. Lobbying, executive branch deliberation, international negotiation, and informal consultation all shape space policy in ways that hearing testimony cannot fully capture.

Second, the regex-based coding dictionary, while designed to capture the major dimensions of policy core beliefs in space policy, inevitably involves choices about which patterns to include and how to resolve ambiguity. The dictionary was developed iteratively and validated against manually coded samples, but any automated coding procedure introduces the possibility of measurement error, including both false positives (paragraphs coded as containing a belief that was not substantively present) and false negatives (paragraphs containing beliefs expressed in language the dictionary did not capture). Future applications should consider supplementing dictionary approaches with human validation on larger samples and potentially with more advanced natural language processing techniques.

Third, the community detection approach used to identify coalitions, the Louvain algorithm, is sensitive to resolution parameters and can produce different coalition structures depending on algorithmic settings. The consistently low modularity scores observed within this study demonstrate that the community structure in these networks is genuinely weak, which means that the specific coalition labels should be interpreted with some caution. The named coalitions (e.g., “Counter Adversaries in Space,” “Innovation-Friendly Regulatory Environment”) are analytically useful for describing the thematic policy core belief center of gravity around which groups of actors cluster, but they should not be treated as rigidly bounded entities.

Fourth, this study examines a single policy domain. While the longitudinal depth of the analysis compensates for the absence of cross-domain comparison, the findings about belief-type correspondence, collaborative network structure, and policy-oriented learning trajectories may not generalize to subsystems with different characteristics. Space policy is

technically complex, relatively bipartisan compared to many domestic policy areas, and shaped by an unusually strong tradition of public-private partnership. Subsystems characterized by deeper partisan polarization, fewer barriers to entry, or less dependence on specialized technical knowledge may exhibit different patterns of belief organization and coalition structure.

6. Conclusion

This chapter set out to investigate how the introduction of different actor types and their corresponding policy beliefs have shaped the focus and direction of the U.S. space policy subsystem over time. Using a combination of multi-stakeholder actor coding, regex-based policy core belief identification, and community detection applied to congressional hearing testimony spanning from 1958 to 2025, the study addressed three research questions concerning the evolution of policy agenda items, the thematic differentiation of policy preferences by actor type, and the reorganization of coalitions as the subsystem's participant base diversified.

The findings can be summarized along three dimensions. First, with respect to the evolution of the policy agenda (RQ1), the results demonstrate that while certain policy core beliefs, most notably the imperative of countering adversaries in space, persist as stable features of the subsystem's coalitions across all four eras, the entry of commercial and civil society actors has introduced new thematic emphases and shifted the center of gravity of subsystem discourse. The early subsystem was organized around infrastructural and geopolitical coalitions driven almost exclusively by state actors. The contemporary subsystem is organized around a dual-track structure in which security concerns and

commercial-regulatory concerns coexist as distinct but interconnected coalitions. This evolution was not the product of a single external shock; it was the cumulative result of policy design choices that recruited new actor types into the subsystem over several decades.

Second, with respect to thematic differentiation by actor type (RQ2), they convey that organizational affiliation is a meaningful predictor of which policy core beliefs actors prioritize. Firm actors demonstrate the most coherent and evolutionarily distinct belief trajectory, shifting from infrastructure to affordability to scheduling and regulatory modernization as the commercial sector matured. State actors maintain the broadest distribution of beliefs in each era, reflecting their institutional role as mediators and brokers. Civil society actors have expanded from a narrow thematic focus on education and workforce development to active participation in the subsystem's largest coalitions, engaging with security, competition, and governance themes that were once the exclusive province of state actors. These findings support the proposition that actors do not arrive at their policy core beliefs independently of their organizational context, and that incorporating organizational affiliation as a conditioning variable enriches the ACF's account of belief formation and coalition dynamics.

Third, with respect to coalition evolution (RQ3), the network analysis reveals a subsystem that has become more integrated rather than more segmented as it has diversified. Modularity remains low across all eras; assortativity is consistently negative and trends toward zero; and the largest contemporary coalitions draw members from all three organizational categories. Coalitions in the space policy subsystem form around shared beliefs, not around shared organizational identity, and the entry of new actor types has

reinforced rather than disrupted this belief-based logic of coalition formation. The subsystem has moved from a unitary configuration dominated by a single government coalition to a collaborative configuration in which multiple coalitions coexist, their policy priorities are diverse, but they maintain extensive cross-coalition connectivity through shared technical language and overlapping programmatic concerns.

Taken together, these findings offer three contributions to the study of policy processes. First, they extend the ACF by demonstrating that organizational affiliation systematically conditions the policy core beliefs that actors bring to coalition formation, a dimension that the framework's traditional emphasis on belief homophily has tended to underspecify. Second, they provide a sustained empirical illustration of what a collaborative subsystem looks like in longitudinal practice, a contribution that responds to the need for more detailed accounts of non-adversarial subsystem dynamics (Koebele, 2019; Wesche et al., 2025). Third, they connect the structural findings of Chapter 1 to the substantive content of policy discourse, demonstrating that the typological transition from a unitary to a collaborative subsystem was accompanied by a parallel transformation in what the subsystem talks about and who talks about it.

These findings also point toward directions for future research. The most immediate extension would be to examine whether the patterns of belief-type correspondence observed here hold in other technically complex, relatively bipartisan subsystems, such as cybersecurity policy, critical minerals governance, or commercial biotechnology. If organizational affiliation conditions belief profiles in space policy, does the same mechanism operate in other domains undergoing similar structural diversification? A second direction

concerns the causal relationship between actor entry and belief change. This study has documented that the entry of commercial actors was followed by a shift in the thematic content of the subsystem's discourse, but it has not isolated the causal mechanisms through which that shift occurred. Did established state actors adopt market-oriented beliefs in response to commercial entry, or did the belief landscape change simply because new actors brought new beliefs into the network without affecting incumbents? Answering this question would require actor-level longitudinal data that traces individual belief trajectories across eras, potentially supplemented by interview evidence.

The U.S. space policy subsystem is no longer a conversation among a handful of government agencies about launch contracts and planetary priorities. It is a multi-sector policy arena in which hundreds of actors, drawn from government, industry, and civil society, organize around diverse beliefs about what space is for, who should govern it, and how the benefits and risks of space activities should be distributed. This study has sought to map the thematic content of that conversation, trace how it has changed over six decades of subsystem evolution, and identify the structural and organizational factors that have shaped its trajectory. The results suggest that understanding who participates in a policy subsystem is inseparable from understanding what that subsystem is about. As the participant base diversifies, so does the agenda, and the coalitions that form around that agenda reorganize in ways that reflect both the beliefs actors share and the organizational contexts from which those beliefs emerge.

Chapter 3

Agenda Dynamics Across Institutional Venues: Space Policy Attention in Presidential Documents, Congressional Hearings, and COPUOS Proceedings

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Abstract

Space policy has evolved across domestic and international venues, yet the extent to which U.S. commercialization priorities have registered on the multilateral governance agenda remains unclear. Drawing on the Comparative Agendas Project's (CAP) framework of attention allocation, this study applies structural topic modeling to three corpora spanning 1957 to 2025: 890 presidential documents, 2,111 records from the UN Committee on the Peaceful Uses of Outer Space (COPUOS), and 587 congressional hearings. Each topic is assigned a CAP major code, providing both an aggregate classification within the broader taxonomy of government activity and a granular, domain-specific measure of attention. The presidential record reveals an issue-attention cycle in which Space topics dominated during the Apollo era before yielding to a fragmented agenda where International Affairs and Defense claimed growing shares and governance-oriented Space topics became the primary executive focus. The COPUOS record shows Space-coded topics consistently subordinate to International Affairs and Government Operations, with the venue oscillating between procedural governance and cooperative diplomacy in a sequential pattern consistent with institutional bottleneck theory. No commercialization topic emerged at the multilateral level. The congressional record shows Space topics dominating overall, but with composition shifting from mission operations toward space science, Earth observation, and contemporary exploration, while Commercial Use of Space maintained a persistent but modest presence from the 1980s onward. Cross-venue comparison reveals that the three settings process space issues through fundamentally different CAP-level compositions, that cooperative security themes have achieved cross-venue prominence, and that commercialization remains concentrated in domestic settings. These findings extend the CAP's comparative logic to a domain that has received almost no attention from the comparative agendas community and demonstrate that domestic and international space policy agendas follow distinct institutional logics rather than simple diffusion.

1. Introduction

The previous chapters established that the U.S. space policy subsystem has undergone a structural transformation, driven not solely by exogenous shocks but by endogenous policy design and the deliberate incorporation of commercial and nonprofit actors into governance.

Chapter 1 traced this transformation through the lens of the Advocacy Coalition Framework, documenting how the subsystem evolved from a government-dominated unitary subsystem into a collaborative network of diverse stakeholders. Chapter 2 mapped the organization of policy preferences and coalition structures within that evolving subsystem. This chapter turns to a different but related question: how has the substantive content of space policy, its thematic agenda, evolved over time and across the executive and international institutional venues? Where the first two chapters examined who participates in space policy and how those participants organize, this chapter examines what they talk about and how those conversations have changed.

To answer that question, this chapter draws on the theoretical and methodological tradition of the Comparative Agendas Project (CAP). Where the Advocacy Coalition Framework employed in Chapters 1 and 2 foregrounds the belief systems and strategic coordination of policy actors, the CAP tradition foregrounds the allocation of political attention itself as the key outcome of interest (Baumgartner et al., 2019; Dowding, Hindmoor, and Martin, 2016; Jones & Baumgartner, 2005). The shift from coalition structure to agenda content is not merely a change of topic; it reflects a complementary level of analysis. The ACF asks how coalitions form and how their interactions produce or resist policy change. The CAP asks what those coalitions, and the institutions they inhabit, actually attend to, and how that attention shifts across time and institutional venues (Jennings et al., 2011; Mortensen et al., 2011). By pairing these two frameworks across the three chapters of this dissertation, the analysis captures both the organizational structure of the space policy subsystem and the substantive priorities that emerge from its operation.

The question matters because domestic policy priorities do not exist in isolation. U.S. executive orders, space policy directives, and congressional hearings produce a record of national attention to space issues, but these national priorities intersect with an international governance architecture built on treaties, multilateral agreements, and the proceedings of the United Nations Committee on the Peaceful Uses of Outer Space, or COPUOS (Moltz, 2014; Johnson-Freese, 2017). While Chapters 1 and 2 demonstrated that commercialization initiatives have reshaped the domestic subsystem since the 1980s, limited research has investigated how these domestic shifts have influenced the international policy landscape (Pomeroy, 2019; Del Canto Viterale, 2023). This chapter addresses that gap by constructing a multi-venue corpus of space policy texts and applying structural topic modeling (STM) to measure thematic change across institutional boundaries and over a temporal arc spanning from the late 1950s to 2025.

Methodologically, the chapter represents a deliberate complement to the approaches used in Chapters 1 and 2. Those chapters employed discourse network analysis (DNA), which operates at the speaker level and requires hand-coded or semi-automated identification of policy beliefs attributable to individual actors. DNA is well suited to questions about who aligns with whom and on what grounds. Structural topic modeling, by contrast, operates at the document level and uses unsupervised machine learning to identify latent thematic dimensions in large text corpora (Roberts et al., 2014; Roberts, Stewart, & Airoldi, 2016). It is well suited to questions about what institutional venues discuss and how those discussions change over time. The combination of DNA and STM across the three chapters thus provides a multi-method account of the space policy subsystem that links actor-level coalition dynamics to aggregate patterns of attention allocation. This pairing of relational and

distributional text methods reflects a broader trend in computational social science, in which scholars increasingly combine network and topic approaches to capture dimensions of policy discourse that neither method alone can reveal (Baumgartner, Bevan, & Sebők, 2026; Isoaho et al., 2021; Wilkerson & Casas, 2017; Grimmer & Stewart, 2013).

The analysis answers two primary questions. First, how does the prevalence of space policy topics differ among domestic executive actions, multilateral diplomatic proceedings, and congressional hearings? Second, how has the thematic focus of space policy shifted over time, particularly during the transition from the Cold War space race to the contemporary commercial space era? Answering these questions requires both a theoretical framework for understanding agenda dynamics and a methodological approach capable of measuring thematic content at scale (Grimmer, Roberts, & Stewart, 2022). The sections that follow develop each in turn before presenting the research design.

In addressing these questions, the chapter makes three contributions. First, it extends the CAP's comparative logic to a policy domain that has received almost no attention from the comparative agendas community, despite space policy's long history of multi-venue governance (Moltz, 2008; Shackelford, 2020; Tepper, 2022) and its increasingly prominent role in national and international affairs (Pomeroy, 2019). Second, it demonstrates that structural topic modeling can serve as a scalable, replicable instrument for measuring policy attention across institutional venues, complementing the hand-coded content analyses that have anchored most CAP research to date (Baumgartner, Bevan, & Sebők, 2026; Sebők et al., 2025; Baumgartner et al., 2019). Third, it situates the domestic findings from Chapters 1 and 2 within a broader institutional context, showing how the subsystem transformation

documented in those chapters corresponds, or fails to correspond, to agenda shifts in the executive branch and in international governance forums.

2. Background

2.1 Attention, Agendas, and Institutional Venues

The Comparative Agendas Project, or CAP, (Baumgartner, Breunig, and Grossman 2019), brings together data on government activities in over twenty countries and provides a consistent categorizing system for understanding when and how a given institution of government addresses any issue of public policy. The project's theoretical core rests on a premise with direct implications for this chapter: the capacity of political institutions to process information is limited, and the selection of which issues receive attention is itself a consequential political outcome.

The CAP's analytical infrastructure rests on a master codebook that classifies government outputs into major topic categories, enabling systematic cross-national and cross-institutional comparison of policy attention (Comparative Agendas Project, 2026; Baumgartner, Breunig, and Grossman, 2019; Bevan, 2019). This coding framework has been applied to legislative speeches, executive orders, court decisions, media coverage, and party platforms across more than twenty countries, producing one of the largest comparative datasets on government activity in existence (Baumgartner et al., 2019; Bevan & Jennings, 2014; Boydstun, 2013; Vliegenthart & Walgrave, 2011). The codebook's space policy content falls primarily within the CAP's Science and Technology major topic (topic code 17), though space-related activity also appears in the Defense (topic code 16) and International Affairs (topic code 19) categories, reflecting the cross-cutting nature of the domain. This

chapter does not apply the CAP codebook directly to its corpora; instead, it uses the CAP's theoretical logic of attention allocation and venue comparison as the organizing framework for a structural topic model that identifies latent thematic dimensions within the space policy domain. The approach is consistent with a growing body of work that adapts CAP concepts to domain-specific corpora where the standard codebook's granularity is insufficient to capture within-domain variation (Nowlin, 2016; Cross & Greene, 2020).

Jones and Baumgartner (2005) developed this further into a general theory of government information processing. Because decision-makers cannot attend to all issues simultaneously, most policy areas are managed within relatively insulated subsystems where change is incremental. When information signals about a problem intensify, whether through focusing events, media coverage, or strategic action by policy entrepreneurs, issues can move from subsystem management onto the macropolitical agenda, creating the conditions for significant policy shifts (Walgrave & Varone, 2008; True, Jones, & Baumgartner, 2007). The mechanism is not primarily budgetary; it operates through the allocation of attention itself, which is observable in the thematic content of the documents institutions produce (Jones, Sulkin, & Larsen, 2003; Baumgartner et al., 2009).

This framework supplies the logic for the present analysis. The space policy domain has experienced precisely the kinds of attention-shifting events the theory describes. The launch of Sputnik in 1957 moved space from an obscure technical concern to a first-order national security priority virtually overnight (McDougall, 1985; Logsdon, 2010). The Apollo landings sustained that attention before it receded through the 1970s in a pattern consistent with Downs's (1972) issue-attention cycle. The commercialization of launch services beginning in the 1980s reframed space as an economic issue, and the recent proliferation of

commercial actors, mega-constellations, and anti-satellite weapons tests has generated a new wave of attention that crosscuts security, commercial, and environmental concerns (Moltz, 2019; Weeden & Samson, 2023). Each of these moments plausibly shifted the distribution of topics in the policy documents this chapter analyzes.

Comparative agendas research is also attentive to variation across institutional venues, a feature central to this study's design. For example, the approach has identified that core functions of government consistently command executive attention while other issues compete for remaining agenda space (Mortensen et al., 2011; Jennings et al., 2011). Further, Dowding, Hindmoor, and Martin (2016) argued that the CAP's common measurement infrastructure has enabled genuinely comparative analysis of when and why governments attend to particular issues. This chapter extends that comparative logic beyond a single national government to a cross-level comparison of domestic executive actions, congressional hearings, and multilateral deliberations. The question of whether attention to a given issue, say commercial resource extraction or orbital debris mitigation, appears first in U.S. executive orders and later in international agreements, or vice versa, is a question about inter-venue agenda dynamics of precisely the kind the comparative agendas framework is designed to address.

An extension of the CAP framework to international venues is not without precedent. When applied to the European Parliament, it demonstrated that topic modeling could recover meaningful agenda dynamics, identifying shifts in attention that corresponded to exogenous shocks such as treaty referenda and the Euro Crisis (Cross and Greene, 2020; Alexandrova, Carammia, and Timmermans, 2012). This work showed that computational text analysis could operationalize the CAP's attention-allocation logic even outside the hand-coded

datasets that originally defined the project. Grimmer and King (2011) and Quinn et al. (2010) similarly showed that automated methods could recover political attention structures from large text corpora with minimal a priori assumptions. The present chapter builds on these precedents by applying the CAP's venue-comparison logic to a domain, space policy, where institutional outputs span domestic and international settings and where the documentary record stretches across nearly seven decades.

2.2 Space Governance: Domestic and International Architectures

The institutional landscape across which space policy attention is distributed is complex and layered. Internationally, the foundational architecture was erected in the decade following Sputnik. COPUOS, established in 1959, provided the multilateral platform through which five core treaties were negotiated: the Outer Space Treaty (1967), the Rescue Agreement (1968), the Liability Convention (1972), the Registration Convention (1976), and the Moon Agreement (1979) (Jakhu & Pelton, 2017; Lyall & Larsen, 2009). The Outer Space Treaty remains the cornerstone, prohibiting weapons of mass destruction in space, mandating free exploration for the benefit of all countries, and precluding national appropriation by claim of sovereignty. Yet the treaty regime has conspicuous limitations. These texts were drafted when only a handful of states possessed launch capability and governments were the sole actors in space. Treaty-making has been effectively stalled since 1979 (Tepper, 2022; Freeland, 2010), and COPUOS decision-making requires consensus, which has proven increasingly difficult as membership has expanded from 24 to over 100 states.

Given the difficulties of creating new treaty law, most recent governance efforts have turned toward non-binding instruments. The 2019 COPUOS Guidelines for the Long-Term

Sustainability of Outer Space Activities established 21 voluntary best practices (COPUOS, 2019), and the Artemis Accords, launched in 2020 with eight initial signatories and expanded to 61 countries by January 2026 (NASA, 2026; Artemis Accords, 2020), created a non-binding framework for civil space exploration grounded in the Outer Space Treaty. The Accords address transparency, interoperability, space resource utilization, safety zones, and debris mitigation. Their significance for this chapter is that they illustrate how domestic preferences, particularly the U.S. emphasis on commercial development and property rights in extracted resources, can possibly shape international governance arrangements. The 2015 Commercial Space Launch Competitiveness Act asserted resource rights nationally; a 2020 executive order rejected the global commons characterization of space; and the Artemis Accords subsequently multilateralized these positions (Tronchetti 2021). Tracing such sequences through the thematic content of the relevant documents is precisely what structural topic modeling is designed to facilitate.

Domestically, U.S. space policy is produced across a constellation of institutional actors: the president through executive orders and space policy directives, Congress through authorizing legislation and oversight hearings, and agencies including NASA, the Department of Defense, the Department of Commerce, and the Federal Aviation Administration (Stares, 1985; Handberg & Li, 2007). The historical trajectory can be divided into rough phases: Cold War national security competition through the early 1970s, early commercial experimentation through the 1980s, post-Cold War reorientation in the 1990s, and the contemporary era of accelerating commercialization. Recent executive orders issued in 2025 direct federal agencies to streamline commercial launch licensing, attract $50 billion in additional private investment by 2028, deploy nuclear reactors on the Moon, and establish a permanent lunar

outpost by 2030. These directives underscore the extent to which the domestic agenda has shifted from a security-first paradigm to one in which commercial development and national security are increasingly intertwined.

This transition has been traced by contrasting Cold War space power determinants, in which state-controlled programs defined capability, with twenty-first-century dynamics in which commercially led, bottom-up innovation is reshaping definitions of space power (Moltz, 2019; Moltz, 2014). Further, they document recurring patterns of competitive thrust and cooperative regrouping across the space age, arguing that environmental learning about the consequences of debris-generating weapons tests has historically pushed spacefaring states toward restraint (Moltz, 2008). The increasing involvement of commercial actors has expanded the set of stakeholders with interests in a stable space environment, reinforcing restraint but also complicating governance by multiplying the actors whose behavior must be coordinated (Shackelford, 2020; Johnson-Freese & Weeden, 2012). Tepper (2022) has characterized the resulting governance landscape as polycentric, fragmented across multiple levels and arenas in ways that resist explanation through any single institutional lens.

The space governance literature has traditionally been organized around legal, institutional, and strategic analyses rather than around the systematic measurement of policy attention. Pomeroy (2019) surveyed the quantitative space policy literature and identified significant scope for methodological development, noting that the field had not yet incorporated the computational text and network analysis methods that had become standard in adjacent policy domains (Wilkerson & Casas, 2017; Grimmer & Stewart, 2013). The present chapter responds to that call by applying an agenda dynamics framework and computational methods to a domain that has relied predominantly on case-study and doctrinal

approaches. By treating the documents produced by the executive branch, Congress, and COPUOS as records of institutional attention, this chapter provides a measurement-based complement to the interpretive governance literature, revealing how the priorities described by Moltz (2019) and Tepper (2022) manifest in the aggregate thematic content of institutional outputs.

2.3 Measuring Policy Agendas with Computational Text Analysis

Studying agenda dynamics across a corpus spanning nearly seven decades, three institutional venues, and hundreds of documents requires methods that scale beyond close reading. The growth of computational text analysis in political science over the past two decades has produced a set of tools well suited to this task as text-as-data methods expand research opportunities by leveraging computing power for ambitious data collection and by offering a growing toolkit for quantitative analysis of text (Grimmer, Roberts, & Stewart, 2022; Wilkerson and Casas, 2017). Within this toolkit, topic models are the most prominent unsupervised method. Latent Dirichlet Allocation (LDA), introduced by Blei, Ng, and Jordan (2003), and revisited by Blei (2012), represents each document as a mixture of topics, with each topic defined as a probability distribution over words. This mixed-membership structure, which allows a single document to address multiple topics, makes topic models well suited to policy documents that typically span several issues.

The structural topic model, or STM, (Roberts et al., 2016; Roberts, Stewart, and Tingley, 2014), extends standard topic models by incorporating document-level metadata directly into the estimation process. Metadata covariates can influence both topical prevalence, the proportion of a document devoted to a given topic, and topical content, the

specific vocabulary used to discuss a topic. This dual capacity is the STM's central contribution for this study: it allows estimation of how topic proportions change as a function of covariates such as year and institutional venue, and it enables examination of whether the same underlying topic is discussed in different terms across contexts (Lucas et al., 2015). For a corpus where documents vary simultaneously by time period, venue, and originating actor, the STM provides the most appropriate analytical framework.

The application of topic modeling to policy texts has developed rapidly over the past decade. Approaches have demonstrated that LDA could operationalize the concept of issue definitions when measuring policy discourse (Hopkins & King, 2010; Laver, Benoit, & Garry, 2003), for example, using topic proportions to measure how the framing of nuclear waste management shifted across policy actors and time periods (Nowlin, 2016). Other efforts have been made to review how topic modeling interacts with qualitative policy research methods, distinguishing between content-oriented designs that use topics as classification instruments and discourse-oriented designs that use topics as entry points for interpretive analysis (Isoaho, Gritsenko, and Mäkelä, 2021; Farrell, 2016). The present chapter falls primarily in the former category: it uses STM-estimated topic proportions as measures of attention allocation across venues and time periods, though the interpretation of specific topics draws on the qualitative knowledge of the space policy domain developed in the earlier chapters.

The utility of any topic model depends on the care taken in assessing its output. Automated text methods are useful but incorrect models of language, requiring extensive, problem-specific validation rather than reliance on fit statistics alone (Denny & Spirling, 2018; Grimmer and Stewart, 2013). Bernhard-Harrer et al. (2025) and Ying, Montgomery, &

Stewart (2022) provided a comprehensive review of validation methods for topic models in the computational social sciences, identifying best practices for assessing coherence, exclusivity, and substantive interpretability and the model selection and validation procedures described in the Methods section below follow these recommendations, employing a combination of statistical diagnostics and qualitative assessment to ensure that the estimated topics correspond to recognizable features of the space policy domain.

Cross and Greene (2020) demonstrated the empirical power of combining agenda dynamics with computational text analysis in their study of the European Parliament plenary from 1999 to 2014. Using a dynamic topic modeling method, they found that the EP agenda evolved significantly over time and responded to exogenous events such as EU Treaty referenda and the Euro Crisis. Several features of their design are directly relevant here. They showed that topic prevalence responds to identifiable external shocks, a pattern this chapter expects to find in the space policy domain. Further, they demonstrated that institutional structure shapes topic prevalence, with MEPs' contributions influenced by committee assignments and voting behavior, suggesting that similar venue-based variation should appear across executive orders, treaties, and COPUOS proceedings, consistent with other venue-based variation findings (Jennings et al., 2011; Alexandrova et al., 2012). And their method allowed vocabularies associated with a given topic to shift over time, capturing the kind of rhetorical evolution likely to characterize a domain transitioning from Cold War security competition to commercial space development.

STM's advantages over alternatives include LDA, factor analysis, and single-membership models, showing that the ability to condition on covariates produces more interpretable and theoretically informative results (Roberts, Stewart, & Tingley, 2019;

Roberts et al. 2014). There are both opportunities and challenges in applying text-as-data methods to international relations, corpus selection skews toward English-language and Western sources (Windsor, 2022; Baturo, Dasandi, & Mikhaylov, 2017), a concern partially mitigated in this study given that the dominant governance instruments in the space domain are produced in or translated into English.

A growing literature also demonstrates the value of computational analysis for studying international legal instruments specifically. Text similarity measures can reveal asymmetries in investment treaty-making, track the diffusion of legal provisions across states, and identify which countries serve as rule-makers in the international system (Alschner and Skougarevskiy 2023). In this manner, computational approaches can complement doctrinal analysis by identifying patterns invisible to close reading. The application of structural topic modeling to the space policy domain, however, remains undeveloped, representing both a gap in the literature and an opportunity this chapter is designed to address.

Taken together, the theoretical framework of the CAP, the substantive literature on space governance, and the methodological literature on computational text analysis converge on a research design that treats the documents produced by political institutions as observable indicators of policy attention. The approach taken here applies Grimmer and Stewart's (2013) foundational insight that automated text methods amplify human reading abilities rather than replace them. The structural topic model provides the scalability needed to analyze thousands of documents across seven decades, while the qualitative understanding of the space policy domain developed in Chapters 1 and 2 provides the interpretive foundation needed to assess whether the topics the model recovers correspond to meaningful features of the policy landscape.

3. Data and Methods

The theoretical and methodological considerations developed in this chapter motivate a research design organized around three components: corpus construction, structural topic modeling, and a two-pronged analytical strategy that examines both temporal evolution and institutional comparison. The sections that follow detail each component. The research design is organized by the logic of the Comparative Agendas Project, which treats institutional outputs as observable measures of policy attention (Baumgartner et al., 2019). In a standard CAP analysis, human coders assign each document to one or more major topic categories from the project's master codebook, enabling cross-venue and cross-national comparison. The present analysis adapts this logic by replacing manual coding with structural topic modeling, which estimates latent thematic categories from the text itself. This substitution offers two advantages for the space policy domain. First, the CAP codebook's major topic categories are too coarse to distinguish among the competing priorities within space policy; the STM's data-driven topics provide finer-grained differentiation. Second, the STM accommodates the mixed-membership property of policy documents, recognizing that a single executive order or hearing transcript may address multiple themes simultaneously, a common feature of the space policy record that a single-code assignment would obscure.

3.1 Corpus and Data Sources

The selection of documents follows the logic of the Comparative Agendas Project, which conceptualizes policy attention as a finite resource distributed across competing issue areas. Within the CAP tradition, agenda-setting is measured by tracking how the allocation of attention to policy domains shifts over time and across institutional venues. The present analysis applies this logic to a domain-specific corpus – rather than coding documents into

broad CAP categories, the STM identifies latent thematic dimensions within the space policy agenda itself. This approach allows for a more granular account of how attention is allocated among competing priorities within the space domain, such as exploration, commercial regulation, arms control, and international cooperation, while also revealing how the space agenda intersects with broader policy concerns including defense, education, and budgetary politics.

3.1.1 Presidential Corpus

The presidential corpus comprises 890 documents related to space policy, spanning from 1957 to 2025. Documents were collected from two primary sources: the Compilation of Presidential Documents hosted on GovInfo and the APP. The corpus encompasses materials from every administration since Eisenhower, including executive orders, proclamations, policy memoranda, public addresses, press conference transcripts, joint statements with foreign leaders, budget messages, and party platform excerpts that address space policy. This breadth of document types permits the model to capture how space policy discourse operates not only through formal directives but also through the rhetorical and political channels that presidents use to communicate priorities to different audiences.

The selection of documents follows the logic of the Comparative Agendas Project framework, which conceptualizes policy attention as a finite resource distributed across competing issue areas (Baumgartner, Breunig, and Grossman 2019). Rather than coding documents into broad CAP categories, the structural topic model identifies latent thematic dimensions within the space policy agenda itself. This approach allows for a more granular account of how attention is allocated among competing priorities within the space domain while also revealing how the space agenda intersects with broader policy concerns including defense, education, and budgetary politics.

The presidential corpus occupies a distinct position in the CAP's institutional architecture. In the comparative agendas literature, executive outputs are treated as indicators of macropolitical attention, reflecting the priorities that have risen above subsystem management to command the attention of the head of state (Jones & Baumgartner, 2005). The inclusion of both formal directives and informal rhetorical outputs in the presidential corpus captures both the binding policy choices of the executive and the agenda-signaling function that presidential speeches, press conferences, and proclamations serve. This dual coverage aligns with the CAP's recognition that political attention operates through multiple channels, some authoritative and some communicative, and that the full picture of executive attention requires measurement across both.

3.1.2 COPUOS Multilateral Corpus

The COPUOS corpus comprises 2,111 documents drawn from the proceedings of the United Nations Committee on the Peaceful Uses of Outer Space, spanning from 1961 to 2025. The corpus captures discourse from 113 state delegations, 24 nongovernmental organizations, and several intergovernmental organizations and UN bodies, including the United Nations Office for Outer Space Affairs (UNOOSA). The corpus draws on three source types that correspond to distinct periods and reflect the changing documentary record of COPUOS deliberations. The first source is from Pomeroy (2018), which provides transcripts of COPUOS plenary and subcommittee sessions from 1961 through 1993. These transcripts were processed to extract individual speaker-level statements, yielding 886 documents from 76 countries. Each document corresponds to the remarks of a single delegation or speaker within a session, preserving the deliberative structure of the proceedings. The first archive constitutes the only available source of speech-level COPUOS data for this period; the

original UN verbatim records for many early sessions are not available in machine-readable form.

The second source consists of the annual reports of COPUOS to the UN General Assembly, covering 1994 through 2020. These 27 documents are compiled at the institutional level rather than the speaker level. Each report summarizes the activities, recommendations, and deliberations of the committee and its subcommittees for a given year. The shift from speech-level transcripts to document-level annual reports is a consequence of the archival record: no comparable speech-level source exists for COPUOS proceedings during this period. The annual reports are publicly accessible through the UN Official Document System. The third source consists of written statements submitted by member states, observer organizations, and NGOs to COPUOS sessions from 2021 through 2025. These 1,198 documents were collected from the COPUOS documentation portal maintained by UNOOSA. Written statements are submitted in advance of sessions and represent each actor's formal position on agenda items. Unlike the Pomeroy transcripts, which capture real-time deliberation, written statements are prepared texts that reflect considered policy positions. The shift to written statements beginning in 2021 coincided with procedural changes during and following the COVID-19 pandemic, which expanded the practice of submitting formal written contributions alongside or in place of oral interventions. This period also introduced nongovernmental organizations into the corpus for the first time: all 72 NGO documents and all 34 intergovernmental organization documents in the corpus date from the 2021 to 2025 period.

The three source types produce a corpus with an uneven temporal distribution. The 1960s through 1993 period contains 886 speech-level documents. The 1994 through 2020 period contains only 27 document-level annual reports. The 2021 through 2025 period contains 1,198 written statements. Three years are absent from the corpus entirely: 1971,

1986, and 1987. These gaps reflect the availability of the underlying archival materials rather than an absence of COPUOS activity. This compositional variation poses a methodological challenge that the research design addresses in two ways. First, the structural topic model includes a prevalence covariate for source format, which allows the model to estimate topic prevalence while accounting for systematic differences in vocabulary and document structure across the three source types. Second, the results are interpreted with explicit attention to the source-format effect, particularly during the annual-report period, where the procedural vocabulary of institutional summaries may register as topic prevalence shifts that reflect document genre rather than substantive changes in the multilateral agenda. The interpretation of the Working Groups topic, which dominates the 1994 to 2020 period, is discussed with this caveat in the results section.

3.1.3 Congressional Hearings Corpus

The congressional hearings corpus consists of 587 space-related hearings spanning from the 85th Congress (1957) through the 119th Congress (2025). This corpus is broader than the 293-hearing sample used in Chapters 1 and 2, which was restricted to four discrete policy eras for the purposes of discourse network analysis. The Chapter 3 corpus includes all available space-related hearings identified through the data collection procedures described in Chapter 1, Section 3.2, without restriction to specific eras, in order to provide the continuous temporal coverage required for structural topic modeling. Each hearing was treated as a single document. Unlike the speaker-level tokenization used for discourse network analysis in Chapters 1 and 2, where individual witness statements served as the unit of analysis, the STM treats the full hearing transcript as the unit. This difference in granularity reflects the distinct analytical purposes of the two methods. Discourse network analysis requires speaker-level attribution to construct actor-belief networks. Structural topic modeling requires document-level text to estimate the distribution of latent topics across institutional outputs. The hearing-

level unit of analysis is consistent with the treatment of policy documents in CAP approaches, where the document rather than the paragraph serves as the unit of attention measurement (Baumgartner, Breunig, and Grossman 2019).

3.2 Preprocessing

Prior to estimation, each corpus was preprocessed using standard procedures for computational text analysis (Grimmer and Stewart 2013). Texts were tokenized into individual terms, converted to lowercase, and stripped of punctuation and numeric characters. English-language stopwords were removed using a standard stopword list. All terms were then stemmed using the Porter algorithm to reduce inflected forms to common roots. In addition to standard stopwords, a set of domain-specific terms was removed after an initial estimation revealed that high-frequency modal verbs and conversational fillers appeared across the majority of topics without contributing to substantive discrimination. Terms removed included “will,” “can,” “must,” “shall,” “just,” “know,” and “one.” Removing these terms sharpened the distinctiveness of the resulting topics, particularly among the core space policy themes, without altering the overall topic structure. Terms appearing in fewer than 10 documents were excluded from the vocabulary to eliminate rare terms unlikely to contribute to topic estimation. The resulting document-term matrices served as the input to the structural topic models described below.

3.3 Model Specification and Selection

The analysis employs a Structural Topic Model (STM) following the framework developed by Roberts, Stewart, and Tingley (2014). The STM extends conventional Latent Dirichlet Allocation by allowing document-level metadata to influence both topic prevalence and topic content, making it well suited for political text corpora where the distribution of themes varies systematically by institutional context and historical period.

The choice of the STM over alternative topic modeling approaches reflects both methodological and theoretical considerations. Unlike standard LDA, which treats all documents as exchangeable draws from a common distribution, the STM's prevalence covariates allow the analyst to model how topic proportions vary as a function of observable document characteristics. This capacity is essential for a comparative agendas analysis in which the central questions concern how attention allocation differs across time periods, institutional venues, and document types (Roberts et al., 2014). By including temporal and source-type covariates, the STM directly parameterizes the relationships that the CAP tradition treats as its core explanatory targets: systematic variation in what institutions attend to, and when. Additionally, the STM's content covariate function allows the same underlying topic to be expressed through different vocabularies in different contexts, an important feature for a corpus in which Cold War-era documents and contemporary documents may address the same substantive concern, such as launch capability, using substantially different terminology.

3.3.1 Presidential Corpus (K = 20)

Model selection for the presidential corpus followed a diagnostic approach evaluating four criteria across candidate models ranging from K = 10 to K = 30 topics: held-out likelihood, residual dispersion, semantic coherence, and the variational lower bound. The diagnostics supported a 20-topic solution as a reasonable balance between granularity and interpretability. The held-out likelihood reached a local maximum near K = 20, while semantic coherence remained stable across the range. Higher values of K yielded diminishing returns in model fit while introducing topics that resisted clear substantive interpretation. *Appendix Figure 1* demonstrates these model selection diagnostics.

The final model includes prevalence covariates for document source (GovInfo versus APP) and year of issuance. The year covariate was estimated with a spline to capture

nonlinear temporal trends. These covariates allow the model to account for the fact that topic prevalence shifts over time and that the two archival sources differ in their coverage of document types, with the APP providing greater coverage of press conferences and campaign materials and GovInfo focusing on formal directives and statements.

3.3.2 COPUOS Corpus (K = 10)

Model selection for the COPUOS corpus evaluated candidate models from K = 5 to K = 20, using the same four diagnostic criteria applied to the presidential corpus. The diagnostics supported a 10-topic solution. The lower K relative to the other corpora reflects both the smaller effective vocabulary of the COPUOS proceedings, which are more thematically concentrated than the presidential or congressional records, and the compositional constraints imposed by the three-source structure. Models with higher K tended to split the dominant Legal Frameworks and Working Groups topics into subcomponents that lacked clear substantive interpretation, suggesting that additional topics were capturing noise rather than meaningful thematic variation. *Appendix Figure 2* demonstrates these model selection diagnostics. The final model includes prevalence covariates for source format (transcript-extracted, annual report, or written statement), year, and ISO3 country code. The source-format covariate is the most consequential for interpretation. Because the three source types differ in their documentary structure and vocabulary, the model must distinguish between topic prevalence shifts driven by genuine changes in the multilateral agenda and shifts driven by the transition from one source type to another. The source-format covariate allows the model to estimate these effects separately, though it does not eliminate the interpretive challenge entirely. The year covariate was estimated with a spline to capture nonlinear temporal trends. The country covariate allows for the estimation of delegation-specific topic profiles, which are reported in the results as mean topic proportions by member state.

3.3.3 Congressional Hearings Corpus (K = 20)

Model selection for the congressional hearings corpus evaluated candidate models from K = 10 to K = 30. The diagnostics supported a 20-topic solution, which captured both the core space policy topics and the peripheral but substantively important topics that appear in hearings spanning adjacent policy domains, such as patent law, telecommunications regulation, and aeronautics research. Models with K below 15 merged substantively distinct topics, particularly collapsing the Commercial Space and Launch Industry topic into the broader Space Policy category. Models above K = 25 produced highly granular topics that captured individual policy episodes, such as specific shuttle missions, rather than thematically coherent policy areas. *Appendix Figure 3* demonstrates these model selection diagnostics.

3.3 Topic Interpretation and Labeling

Each topic was interpreted by examining both the highest-probability terms and the FREX terms. The highest-probability terms are those most likely to appear in documents assigned to the topic. The FREX terms are those that are both frequent within a topic and exclusive to it, downweighting terms that appear across many topics and foregrounding the words most diagnostic of each theme (Roberts, Stewart, and Tingley 2014). Descriptive labels were assigned based on a joint reading of these term lists and the documents with the highest topic proportions for each theme.

The interpretation of the resulting topics proceeds on two levels that correspond to different scales of the Comparative Agendas Project's measurement infrastructure. At the aggregate level, each topic is assigned a CAP major code from the project's master codebook (Comparative Agendas Project, 2026; Bevan, 2019). This assignment situates the space-specific topic structure within the standardized taxonomy that the CAP applies across

countries and institutional venues, enabling comparison with the broader patterns of government attention that the project has documented. A topic organized around satellite communications regulation, for example, maps onto the CAP's Telecommunications code (1706), while a topic dominated by arms limitation vocabulary maps onto Defense (1605). At the more granular level, the descriptive topic label captures the specific substantive character of each theme as it appears within the space policy domain. The topic label distinguishes, for instance, between Human Spaceflight and Exploration and Space Policy and Institutional Governance, two themes that would both fall under the CAP's Space code (1701) but that represent qualitatively different claims on executive attention. The CAP category thus provides a bridge to the broader comparative agendas literature, while the topic label provides the within-domain differentiation that a standard CAP coding of these documents into major topic categories would obscure. By taking this approach, the STM's data-driven topics provide finer-grained differentiation than the CAP codebook's major categories allow, while the CAP codes anchor the analysis in the project's cumulative empirical record.

Table 1 reports the twenty topics estimated from the presidential corpus, along with their CAP classifications, defining terms, and mean corpus proportions. The two-level classification structure described above is immediately visible in the results. Three topics fall under the CAP's Space code (1701), but they represent qualitatively different modes of presidential engagement with the domain. Human Spaceflight and Exploration (Topic 2) captures the vocabulary of specific missions and personnel; Space Policy and Institutional Governance (Topic 5) captures the administrative and programmatic language of satellite development, launch policy, and advisory council deliberation; and Space Visionary Rhetoric (Topic 8) captures the aspirational discourse of frontiers, discovery, and national purpose that presidents deploy when positioning space as a symbol rather than a policy area. A standard CAP coding exercise would assign all three to the same major topic category, obscuring the

distinction between binding directives, institutional management, and rhetorical signalling that the STM recovers. Beyond the space-specific topics, the model identifies a substantial cluster of defense and international affairs topics that reflect the extent to which presidential space discourse has been embedded in broader strategic and diplomatic agendas. Arms Control and Missile Treaties (Topic 4), Arms Compliance and Verification (Topic 10), and Strategic Defense and Deterrence (Topic 11) together account for nearly ten percent of the corpus, consistent with the CAP literature's finding that executive attention is organized around core state functions, particularly security, with other issues competing for remaining agenda space (Mortensen et al., 2011; Jennings et al., 2011). The three Non-Policy Discourse topics (Topics 15, 16, and 19) capture register variation rather than substantive content, distinguishing informal press conference language from campaign rhetoric and casual speech. These topics serve an important diagnostic function. Their presence confirms that the model is distinguishing genuine thematic variation from differences in communicative context, a distinction that will matter when interpreting temporal shifts in topic prevalence in the results section.

Table 1. Structural Topic Model, Presidential Corpus (K = 20): Topic Labels, CAP Classifications, Defining Terms, and Average Corpus Proportions

No.	Topic Label	CAP Category (Code)	Highest Probability Terms	FREX Terms	Avg. %
2	Human Spaceflight & Exploration	Space (1701)	space, astronaut, men, flight, moon, program, day	Apollo, astronaut, colonel, Webb, crew, moon, flight, captain	13.2
5	Space Policy & Institutional Governance	Space (1701)	space, technology, program, develop, system, science, policy, satellite, launch	satellite, aeronautics, commercial, communications, space, council, scientific	12.6
8	Space Visionary Rhetoric	Space (1701)	space, new, world, future, time, challenge, technology, work	dream, planet, discovery, frontier, imagine, spirit, vision, hero	9.9

20	Science, Technology & Energy	Energy (800)	energy, technology, research, oil, solar, new, product, industry	solar, fuel, oil, energy, coal, heat, gas, electric, drill	2.7
4	Arms Control & Missile Treaties	Defense (1605)	missile, party, inspection, treaty, launcher, article, vehicle, ICBM	launcher, article, inspection, reentry, ICBM, protocol, entry, vehicle	0.8
10	Arms Compliance & Verification	Defense (1605)	Soviet, defense, missile, treaty, nuclear, force, test, arms, weapon	ABM, Iraq, radar, ban, ballistic, violation, noncompliance, chemical	4.4
11	Strategic Defense & Deterrence	Defense (1600)	defense, Soviet, missile, nuclear, weapon, arms, world	SDI, Iran, Gorbachev, weapon, allied, terrorist, deterrence, INF	4.5
3	Cold War Ideology	International Affairs (1921)	world, power, peace, freedom, free, communist, war, country	communist, communism, Khrushchev, strength, prestige, Cuba	4.3
14	International Security & Diplomacy	International Affairs (1900)	cooperation, minister, security, country, international, prime, agreement	minister, Russia, Ukraine, prime, Korea, India, bilateral	4.8
17	Alliance & Friendship Rhetoric	International Affairs (1902)	peace, world, nation, country, freedom, hope, war, together	Canada, democracy, German, Canadian, Berlin, friendship, peace	4.7
7	Vietnam-Era Foreign Policy	International Affairs (1921)	force, develop, nation, policy, international, world, economy, peace	Vietnam, Vietnamese, South, Asia, settlement, Japan, Laos	2.0
1	Domestic Policy & Reform	Government Operations (2000)	program, administration, increase, new, develop, continue, proposal	reform, legislative, regulatory, rural, health, enact, comprehensive	2.3
9	Congressional Appropriations	Government Operations (2000)	fund, administration, program, million, bill, house, request, budget	HUD, fund, request, EPA, committee, discretionary, fee	4.8
18	Partisan Economic Policy	Government Operations (2099)	Republican, tax, support, economy, family, policy, work, job	Republican, drug, family, spending, crime, incentive, tax, deficit	2.6
13	Party Platforms & Labor	Government Operations (2099)	Democrat, program, labor, administration, develop, party, support	railroad, dispute, labor, pledge, investigation, board, Democrat	1.4

6	STEM Education & Public Address	Education (600)	education, school, student, science, work, teacher, young	math, teacher, student, graduate, school, kid, parent, teach	4.6
12	Federal Budget & Expenditure	Macroeconomics (105)	program, budget, increase, billion, million, expenditure, estimate	expenditure, estimate, total, budget, receipt, billion, payment	3.5
16	Informal Presidential Speech	Non-Policy Discourse	people, want, get, that, like, got, lot, said	lot, they're, got, guy, okay, really, advisor, senior	6.9
19	Press Conference Register	Non-Policy Discourse	make, time, hope, country, matter, said, believe	comment, suggest, matter, indicate, judgment, attempt, Senate, feel	6.5
15	Campaign Rhetoric	Non-Policy Discourse	tax, people, audience, right, great, said, day, country	audience, opponent, vote, USA, tax, Senate	3.6

Note: Highest Probability = highest-probability terms after stemming reversal for readability. FREX = terms with high frequency and exclusivity to the topic. Avg. % = mean expected topic proportion across all 890 documents. CAP codes follow the Comparative Agendas Project Master Codebook (v1.1). Non-Policy Discourse topics capture register and rhetorical variation rather than substantive policy content and are not assigned CAP codes.

Table 2 reports the ten topics estimated from the COPUOS corpus. The lower number of topics relative to the presidential and congressional corpora reflects both the narrower thematic range of multilateral space deliberation and the compositional constraints imposed by the three-source structure described in Section 3.1.2. The most prominent feature of the COPUOS topic structure is the dominance of Legal Frameworks (Topic 4), which accounts for 22.5 percent of the corpus and captures the vocabulary of subcommittee deliberation over treaty principles, liability provisions, and broadcasting regulations. This topic's outsized proportion is consistent with the historical trajectory of COPUOS as an institution: the committee's primary output during its first three decades was the negotiation of binding treaty law, and the Pomeroy transcripts that constitute the earliest source layer capture this activity at the speech level. The second-largest topic, Space Security and Cooperation (Topic 2), captures the contemporary vocabulary of long-term sustainability guidelines, space traffic management, and transparency measures, vocabulary that is largely absent from the pre-1994

transcripts and concentrated in the post-2020 written statements. The separation of these two topics illustrates a finding that the results and discussion sections will develop. The model also recovers a clear Cold War Cooperation topic (Topic 8) defined by references to Soviet programs, Intercosmos, and socialist internationalism, providing a baseline against which the post-Cold War reorientation of COPUOS deliberation can be measured. The International Delegation topic (Topic 7) and the two Government Operations topics (Topics 1 and 9) capture institutional and procedural vocabulary that reflects the documentary genre of COPUOS proceedings rather than substantive policy content, paralleling the function of the Non-Policy Discourse topics in the presidential corpus.

Table 2. Structural Topic Model, COPUOS Corpus (K = 10): Topic Labels, CAP Classifications, Defining Terms, and Average Corpus Proportions

No.	Topic Label	CAP Category (Code)	Highest Probability Terms	FREX Terms	Avg. %
5	Space Programs	Space (1701)	satellite, programme, launch, sensing, remote, use, data, develop, system, work	shuttle, spacelab, experiment, television, Ariane, rocket, station, Landsat, launcher, receiver	9.3
10	Lunar Exploration	Space (1701)	exploration, Japan, mission, technology, develop, program, lunar, agency, launch, Italy	Artemis, Japan, program, Italian, Israel, ISS, Mars, Italy, Brazilian, Japanese	6.8
3	Earth Observation	Space (1708)	climate, data, change, satellite, observation, earth, develop, use, monitor, global	climate, Philippines, change, CEO, resilience, Netherlands, carbon, emission, ocean, SDG	8.8
6	Resource Management	International Affairs (1905)	develop, technology, application, use, resource, region, manage, water, nation, Indonesia	Pakistan, Indonesia, African, Iran, geospatial, Nigeria, Indonesian, Africa, ISNET, Islam	6.6
2	Space Security & Cooperation	International Affairs (1926)	work, use, peace, group, sustain, develop, cooperate, COPUOS, important, support	EU, LTS, traffic, Ukraine, transparency, subcommittee, safe, COPUOS, UN, guidelines	16.8

8	Cold War Cooperation	International Affairs (1900)	use, peace, develop, cooperate, Soviet, exploration, important, work, technology, scientific	Soviet, socialist, Intercosmos, cosmonaut, mankind, Czechoslovak, democrat, military, race, cooperate	14.0
7	International Delegation	International Affairs (1926)	delegation, distinguished, support, sustain, COPUOS, work, member, thank, global, future	quiet, dark, sky, SGAC, honour, Eutelsat, organisation, event, astronomy, SKAO	9.9
1	Institutional Procedures	Government Operations (2000)	work, use, technical, legal, recommend, develop, group, scientific, express, application	UNISPACE, recommend, agree, paragraph, subsidiary, endorse, paragraph, satisfaction, review, America	3.3
9	Working Groups	Government Operations (2000)	develop, use, work, express, sustain, group, technology, organ, application, inform	paragraph, intergovernment, statement, workplan, entitled, near-earth, guidelines, took, fiftieth	1.9
4	Legal Frameworks	Government Operations (2000)	sub-committee, work, legal, use, technical, question, agreement, group, like, principle	sub-committee, seem, liability, suggest, broadcast, perhaps, certain, connexion, say, might	22.5

Note: Highest Probability = highest-probability terms after stemming reversal for readability. FREX = terms with high frequency and exclusivity to the topic. Avg. % = mean expected topic proportion across all 1,605 documents. CAP codes follow the Comparative Agendas Project Master Codebook (v1.1).

Table 3 reports the twenty topics estimated from the congressional hearings corpus. The prominent feature of the congressional topic structure is the concentration of corpus proportion in Space Science and Earth Observation (Topic 9), which accounts for 36 percent of the corpus. This dominance reflects the institutional character of congressional space oversight with hearings on NASA authorization and appropriation, which recur annually, consistently addressing the agency's science portfolio, Earth observation programs, and mission planning. The topic's high average proportion does not mean that every hearing is primarily about space science; rather, space science vocabulary is distributed broadly across the corpus, appearing as a secondary theme even in hearings organized around other subjects. The second-largest topic, Contemporary Space Exploration (Topic 6), captures the

vocabulary of the post-2010 period, with FREX terms including Bridenstine, Artemis, and JWST that anchor it to the institutional actors and programs of the current era. The separation of this topic from the broader Space Science topic conveys that the STM detects a shift in the character of congressional space discourse that corresponds to the commercialization and programmatic reorientation documented in Chapters 1 and 2. The congressional corpus also produces the clearest Commercial Space and Launch Industry topic (Topic 2) of any of the three corpora, with FREX terms including insurance, underwriter, venture, and ELV that reflect the legislative attention to launch licensing, liability frameworks, and private-sector participation that has defined the commercial space agenda since the 1984 Commercial Space Launch Act. This topic's presence, and its distinctiveness from the broader space topics, provides a direct measurement of the subsystem diversification that the discourse network analysis in the earlier chapters traced at the actor level. Finally, Topic 18 (OCR Artifacts) captures residual noise from the optical character recognition of scanned hearing transcripts and is excluded from substantive analysis, though its identification by the model provides a useful reminder that preprocessing decisions shape the vocabulary available to the estimation procedure.

Table 3. Structural Topic Model, U.S. Congressional Hearings Corpus (K = 20): Topic Labels, CAP Classifications, Defining Terms, and Average Corpus Proportions

No.	Topic Label	CAP Category (Code)	Highest Probability Terms	FREX Terms	Avg. %
9	Space Science & Earth Observation	Space (1701)	space, science, universe, mission, NASA, earth, technology	planet, astronomy, stratosphere, universe, ozone, discovery, planetary	36.0
6	Contemporary Space Exploration	Space (1701)	space, NASA, mission, science, exploration, technology, moon	Bridenstine, JWST, exoplanet, WFIRST, Artemis, Mars, Orion	16.5

1	Human Spaceflight Operations	Space (1701)	help, think, flight, time, orbit, see, look	Glenn, colonel, captain, tile, Friendship, rendezvous, Mercury	5.2
15	Early Space Program & NASA Origins	Space (1701)	space, NASA, research, develop, vehicle, use, satellite	Stennis, Army, Hechler, Glennan, Braun, von, capsule, Gemini	3.0
4	Space Station & Life Sciences	Space (1701)	space, station, NASA, research, cost, science, develop	microgravity, Goldin, Freedom, restructure, Russian, station, Alpha	3.0
3	Shuttle Accident Investigations	Space (1701)	think, NASA, flight, time, launch, problem, space	O-ring, Thiokol, seal, SRM, 51-L, Mulloy, Fletcher, leak	2.7
14	Shuttle Fleet & Access to Space	Space (1701)	space, NASA, launch, shuttle, develop, system, station	Gorton, Nelson, fleet, ELV, shuttle, Titan, CCDS, Odom	2.7
11	Space Telescopes & Robotic Missions	Space (1701)	program, NASA, project, system, space, test, launch, flight	Ranger, mirror, Surveyor, telescope, Perkin-Elmer, Hubble, Gemini, JPL	2.2
17	Space Nuclear Power & Propulsion	Space (1701)	system, power, space, reactor, nuclear, program, develop	reactor, DOE, SP-100, RTG, nuclear, radioisotope, NERVA, SNAP	1.2
12	NASA Facilities & Infrastructure	Space (1701)	facility, test, system, require, space, equip, area, provide	construction-of-facilities, mezzanine, launcher-umbilical, cableway	1.2
5	NASA Budget & Workforce	Space (1701)	space, system, program, operate, support, develop, estimate	Boland, workyear, ADP, aeroassist, LWS, SFCDC	1.2
20	NASA Authorization & Program Review	Space (1701)	space, program, NASA, system, operate, develop, technology	Flippo, IUS, STS-2, STS-3, Landsat-D, ISPM, wide-body	1.1
7	Apollo Accident Investigation	Space (1701)	control, system, test, data, board, spacecraft, fire	RCS, MSC, connector, valve, hatch, wire, ignition, NAA, voltage	0.9
16	Arms Control & Strategic Defense	Defense (1605)	defense, Soviet, system, missile, space, weapon, treaty	ABM, ASAT, SDI, interceptor, laser, warhead, ballistic, deterrence	6.5

2	Commercial Space & Launch Industry	Commercial Use of Space (1704)	commercial, space, launch, industry, private, NASA, insurance	insurance, underwriter, commercial, venture, market, private, ELV	5.2
19	Aeronautics Research & Development	Commercial Use of Space (1704)	technology, NASA, aircraft, research, system, aeronautics, develop	rotor, rotorcraft, STOL, helicopter, aircraft, subsonic, tunnel	2.3
13	Science Policy & Patent Law	Copyrights and Patents (1522)	patent, space, invention, develop, use, NASA, right, research	patent, invention, Daddario, court, infringement, jurisdiction, license	3.7
8	Satellite Communications & Regulation	Telecommunications (1706)	satellite, communication, system, service, INTELSAT, international, rate	INTELSAT, FCC, carrier, telephone, telecommunication, corporation, ownership	2.4
10	International Space Cooperation	International Affairs (1926)	data, space, satellite, develop, system, international, sensing	EOSAT, UNISPACE, Landsat, COPUOS, U.N., remote, delegation	2.4
18	OCR Artifacts	N/A	homa, air, program, can, use, cost, system	homa, ona, requ, yea, atio, ort, wha, ryden	0.7

Note: Highest Probability = highest-probability terms after stemming reversal for readability. FREX = terms with high frequency and exclusivity to the topic. Avg. % = mean expected topic proportion across all 587 documents. CAP codes follow the Comparative Agendas Project Master Codebook (v1.1). Topic 18 (OCR Artifacts) captures residual noise from optical character recognition of scanned hearing transcripts and is excluded from substantive analysis.

3.5 Analytical Strategy

The analysis proceeds in two stages. The first examines the temporal evolution of topic prevalence within each corpus, tracing how the allocation of attention to space policy themes has shifted over the period covered by each institutional venue. Topic prevalence is estimated as the expected proportion of each document devoted to a given topic, averaged across documents within each year or administration. These time-series estimates reveal when specific themes entered or exited the institutional agenda, how long they persisted, and whether their trajectories correspond to identifiable policy events or institutional changes.

The second stage compares topic prevalence across the three corpora to assess whether attention shifts in one venue correspond to, lead, or diverge from shifts in others. This cross-venue comparison follows the comparative logic of the CAP, which treats variation in attention allocation across institutional settings as evidence of how different venues process the same underlying policy domain (Jennings et al. 2011; Dowding, Hindmoor, and Martin 2016). Because the three corpora differ in their temporal coverage, document types, and units of analysis, cross-venue comparisons are interpreted in terms of relative attention allocation within each venue rather than absolute comparisons of topic prevalence across venues. A five percent topic proportion in a presidential executive order carries different substantive weight than a five percent proportion in a 200-page congressional hearing transcript. The analysis accordingly focuses on the direction and timing of within-venue trends and whether those trends align or diverge across institutional settings.

This two-stage analytical strategy directly links the findings of this chapter to those of Chapters 1 and 2. The first stage provides a longitudinal account of what institutional venues have attended to in the space policy domain, complementing Chapter 1's account of who has participated in that domain and Chapter 2's account of how participants have organized into coalitions. The second stage tests whether the subsystem diversification documented in those chapters, particularly the entry of commercial actors and the proliferation of new policy concerns, is visible in the aggregate agenda content of different institutional venues. If the coalitions identified in Chapters 1 and 2 have successfully reshaped the space policy agenda, that reshaping should be detectable as shifts in topic prevalence in the venues where those coalitions operate. Conversely, if the international venue has remained insulated from domestic subsystem changes, the COPUOS agenda should show a distinct trajectory. The comparative agendas framework provides the theoretical warrant for treating these patterns of

convergence and divergence as evidence about the structure of policy attention in a multi-level governance system.

4. Results

The structural topic models estimated across the three corpora provide a systematic account of how the allocation of policy attention within the space domain has shifted over time and across institutional venues. Because political institutions cannot attend to all issues simultaneously, the selection of which issues receive agenda space is itself a consequential political outcome (Jones and Baumgartner 2005). The results below apply this logic within a single policy domain, treating variation in topic prevalence as evidence of how institutional actors distribute their limited attention across competing space policy priorities. The section is organized in three parts corresponding to the three corpora, followed by a cross-venue comparison that examines whether attention shifts in one institutional setting correspond to, lead, or diverge from shifts in others.

4.1 Presidential Space Policy Documents

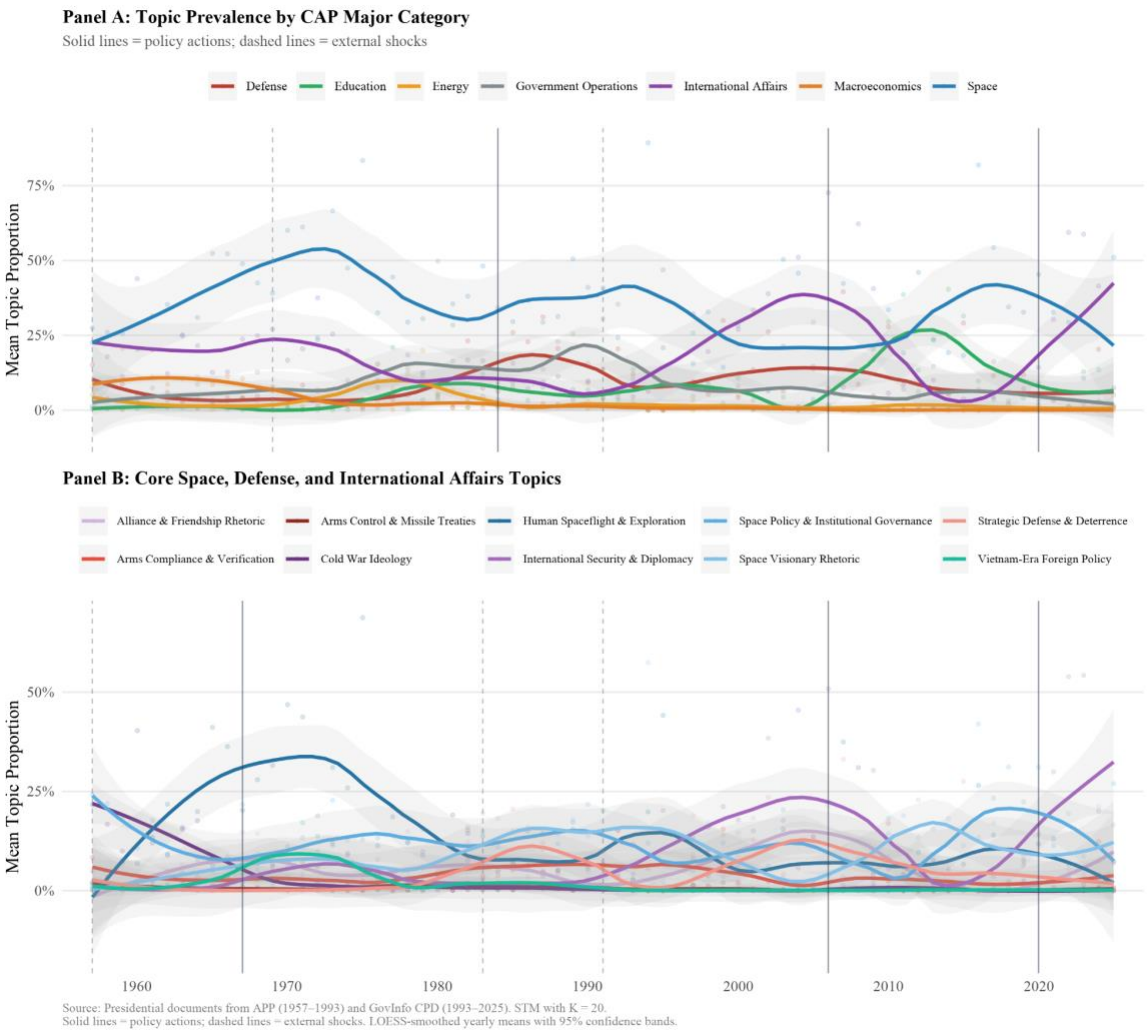
Figure 1 displays the temporal trajectory of topic prevalence in the presidential corpus, organized by CAP major category (Panel A) and by the core space, defense, and international affairs topics estimated by the structural topic model (Panel B). Read through the lens of agenda dynamics, the presidential record reveals a pattern of concentrated attention followed by diversification, consistent with the broader finding in the CAP literature that executive agendas are constrained by limited processing capacity and respond to issue salience in punctuated rather than incremental fashion (Jones and Baumgartner 2005; Jennings et al. 2011).

Panel A captures the broader CAP major categories that frame presidential space discourse. The Space category itself dominates the corpus, as expected, but its share fluctuates considerably across administrations. International Affairs was largely absent from presidential space documents until the Clinton administration, when it rose sharply under Obama. This trajectory tracks the post-Cold War expansion of multilateral security architecture and the growing salience of space as a domain of international strategic competition. Defense maintained a persistent but variable presence across the full time series, while Government Operations showed its highest proportions in the early space age before declining. These temporal signatures are consistent with findings that attention to security-related topics responds to identifiable geopolitical punctuations rather than shifting gradually (Baumgartner and Jones 1993). Returning to Panel B, Cold War Ideology dominated the Eisenhower and Kennedy administrations (16.0 and 21.8 percent, respectively) before declining precipitously after the Soviet Union's dissolution. Strategic Defense and Deterrence concentrated in the Reagan era (10.3 percent) and Bush Jr. administration (9.5 percent), corresponding to the Strategic Defense Initiative and its institutional successors.

The most prominent pattern in Panel B is the sharp rise and decline of Human Spaceflight and Exploration. Presidential attention to human spaceflight peaked during the Johnson and Ford administrations, when it commanded 31.3 percent of expected topic proportion in each, reflecting the political commitment that sustained Apollo and the programmatic continuity of the early shuttle era. That proportion fell from 29.4 percent under Nixon to 9.9 percent under Carter and stabilized at lower levels from the 1980s onward, fluctuating between roughly 5 and 10 percent in subsequent administrations. This trajectory closely resembles the issue-attention cycle described by Downs (1972): a rapid surge of

public and elite attention driven by a galvanizing event, followed by a gradual recognition of the costs of sustained engagement, and eventual displacement by competing priorities. Human spaceflight, once the organizing center of presidential space discourse, has become one topic among several rather than the dominant claim on executive attention.

Figure 1. Evolution of Presidential Space Policy Topics (1957–2025)



Space Policy and Institutional Governance followed a different trajectory. It reached its highest proportion under Eisenhower (24.6 percent), reflecting the institutional founding of NASA and the initial governance architecture of the space age, then declined through the Kennedy and Johnson administrations as Apollo-era exploration claimed the dominant share

of presidential attention. The topic maintained moderate proportions through Ford (15.2 percent) and the Reagan through Bush Sr. period (12.3 and 18.7 percent, respectively) before declining under Clinton. The Trump I and Trump II administrations show the highest proportions for this topic in the contemporary period (26.8 and 25.9 percent), reflecting the issuance of Space Policy Directives, executive orders on commercial launch licensing, and formal policy statements on lunar resource extraction and permanent lunar presence. This demonstrates a qualitative shift in the character of presidential space attention from exploration as narrative to governance as institutional design. The resurgence of governance language in presidential documents is consistent with what Jennings et al. (2011) identified as core executive functions claiming persistent agenda space, as the regulatory architecture of commercial space has become a recurring institutional obligation for the executive branch.

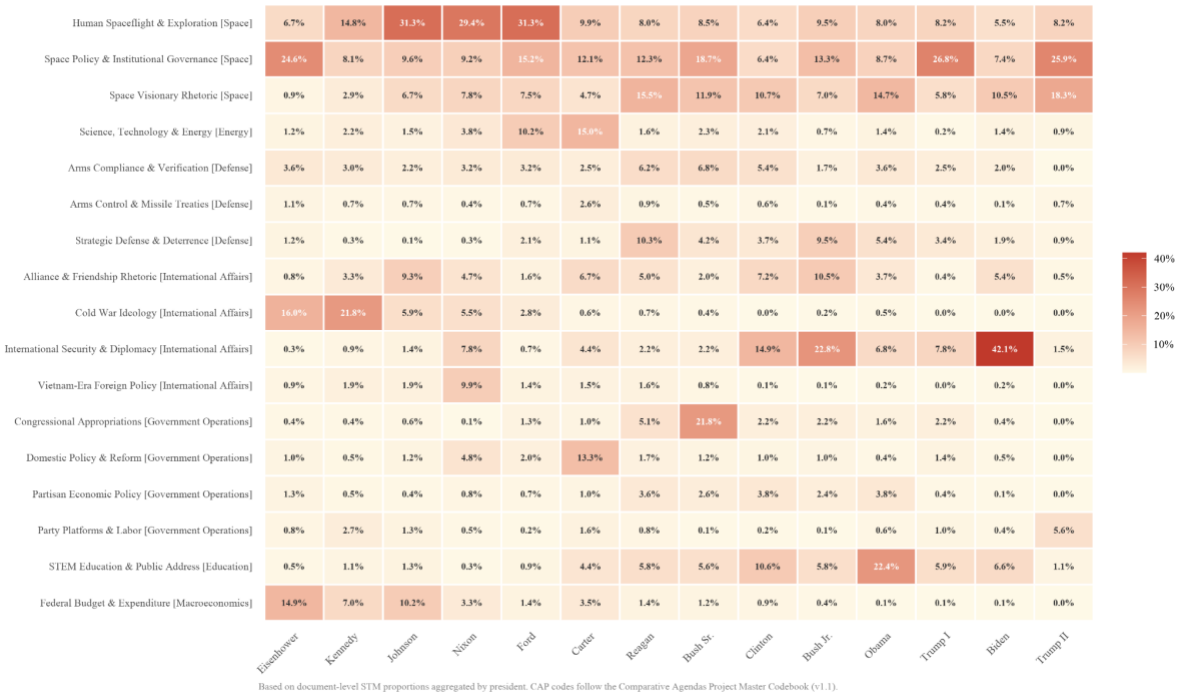
Arms Control and Missile Treaties, though never dominant, show a notable concentration during the Carter administration (2.6 percent), consistent with the negotiation and ratification of arms limitation agreements that included space-related provisions. Science, Technology, and Energy maintained a generally modest presence but spiked under Carter (15.0 percent) and Ford (10.2 percent), likely reflecting the energy crisis and its intersection with satellite-based Earth observation.

Figure 2 presents a heatmap of mean topic prevalence by presidential administration, restricted to substantive space policy topics. Several patterns that the time-series plot obscures become visible. The Johnson and Ford administrations were the high-water marks for Human Spaceflight and Exploration (31.3 percent each), while the most recent administrations allocate substantially less. Space Visionary Rhetoric, the aspirational and inspirational language presidents use when discussing space, heightened under Reagan (15.5

percent) and has remained elevated in subsequent Republican administrations, reaching 14.7 percent under Bush Jr. and 18.3 percent under Trump II. Space Policy and Institutional Governance reached 26.8 percent under Trump I and 25.9 percent under Trump II, proportions similar only by Eisenhower's 24.6 percent. The Eisenhower administration reflects the institutional founding of NASA and the initial governance architecture of the space age; the recent figures reflect a new phase of institutional design centered on commercial regulation, resource rights, and multi-sector coordination. International Security and Diplomacy shows a striking late surge, reaching 42.1 percent under Biden and 22.8 percent under Bush Jr., reflecting the growing salience of space as a domain of strategic competition in the post-Cold War era.

Figure 2. Topic Prevalence by Presidential Administration

Mean topic proportion for substantive space policy topics. Labels show Topic [CAP Category].



Based on document-level STM proportions aggregated by president. CAP codes follow the Comparative Agendas Project Master Codebook (v1.1).

The heatmap also documents the disappearance of certain topics. Congressional Appropriations peaked under Bush Sr. at 21.8 percent and fell to near zero subsequently. Federal Budget and Expenditure followed a similar pattern, declining from 14.9 percent under Eisenhower and 10.2 percent under Johnson to negligible proportions by the Clinton administration. Cold War Ideology, which reached 21.8 percent under Kennedy and 16.0 percent under Eisenhower, vanished entirely after the Soviet Union's dissolution. These declines may reflect changes in how presidents communicate about space, as detailed budgetary language and Cold War framing have migrated to other institutional venues or lost their political salience, while presidential documents increasingly emphasize strategic direction, governance, and policy vision. This finding is consistent with executive attention that tends to concentrate on a smaller set of high-priority issues while delegating technical and budgetary detail to legislative and administrative venues (Jennings et al. 2011).

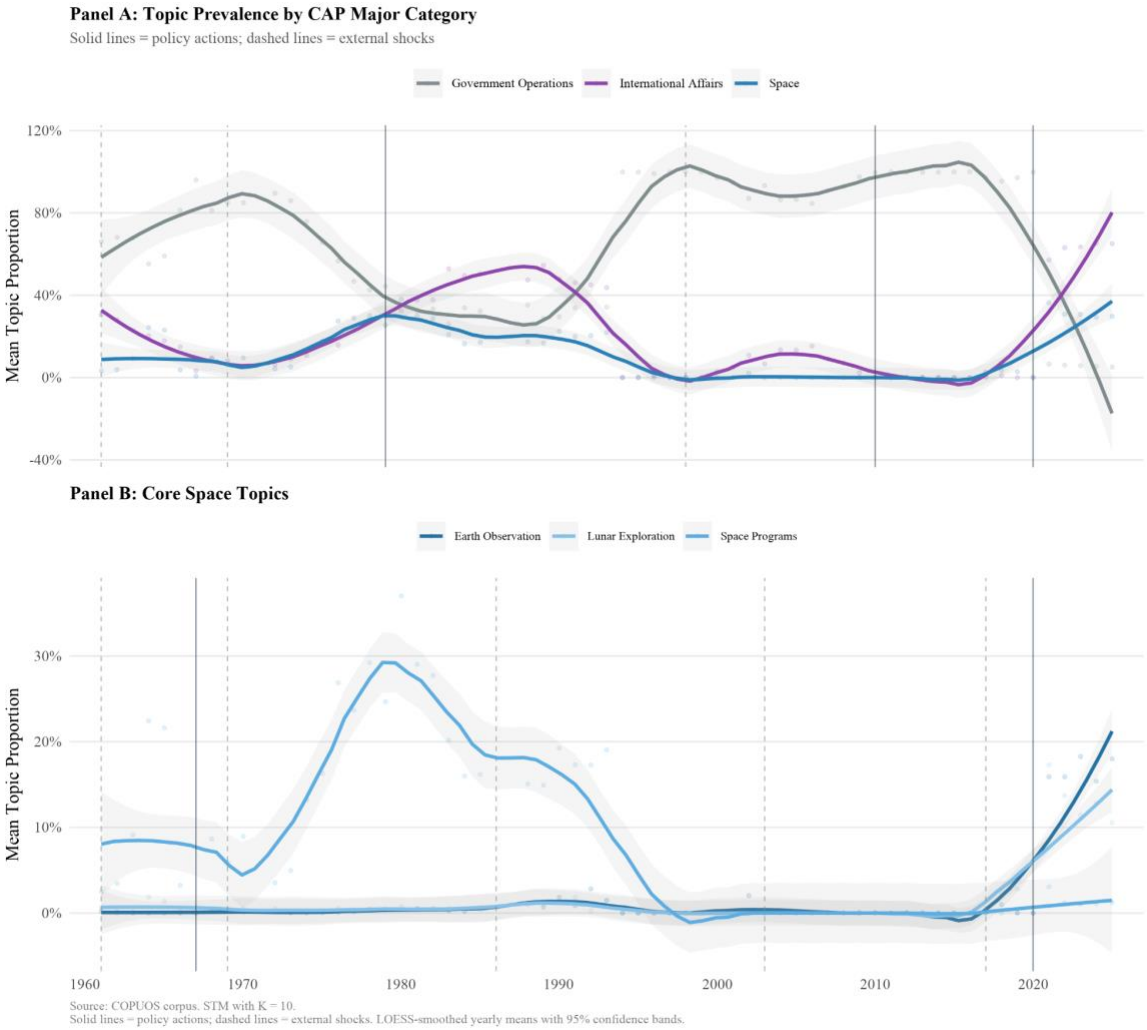
4.2 COPUOS Multilateral Proceedings

Figure 3 presents the temporal evolution of topic prevalence in the COPUOS corpus, divided into all structural topics organized by CAP major category (Panel A) and core Space topics (Panel B). Read at the CAP level, the COPUOS record differs from both the presidential corpora in a fundamental respect. Space-coded topics occupy the smallest aggregate share of the multilateral corpus, not the largest. Of the ten estimated topics, four fall under International Affairs codes (Space Security and Cooperation, coded 1926; Cold War Cooperation, coded 1900; Resource Management, coded 1905; and International Delegation, coded 1926), and together the International Affairs category accounts for approximately 47 percent of the corpus. Three topics fall under Government Operations (2000): Legal Frameworks (22.5 percent), Institutional Procedures (3.3 percent), and

Working Groups (1.9 percent), for a combined share of roughly 28 percent. Only two topics are coded as Space (1701), Space Programs (9.3 percent) and Lunar Exploration (6.8 percent), for a combined share of approximately 16 percent. Earth Observation, a mix of environment, satellites, and remote-sensing, (8.8 percent) falls under Space (1708). The COPUOS venue, in other words, processes space issues primarily through the categories of International Affairs and Government Operations rather than through substantive space policy content, reflecting its institutional character as a diplomatic and procedural forum (Moltz 2014; Del Canto Viterale 2023).

Government Operations commanded the largest share of COPUOS discourse from the committee's founding through the mid-1970s, driven almost entirely by Government Operations. This topic peaked at roughly 80 to 90 percent of expected topic proportion through the 60s and 70s before declining steadily over the next two decades. With Government Operations, the topic's dominance corresponds to the treaty-drafting period during which the five foundational space treaties were negotiated: the Outer Space Treaty (1967), the Rescue Agreement (1968), the Liability Convention (1972), the Registration Convention (1976), and the Moon Agreement (1979) (Jakhu and Pelton 2017; Lyall and Larsen 2009). That COPUOS devoted its first two decades primarily to the procedural work of constructing a governing architecture illustrates what Baumgartner and Jones (1993) describe as agenda monopoly in which a single institutional definition of the policy problem dominated available attention and left little room for competing priorities.

Figure 3. Evolution of COPUOS Space Policy Topics (1961–2025)



As Government Operations declined through the 1970s, International Affairs rose to claim the dominant position, and the two categories crossed in the late 1970s to early 1980s. International Affairs peaked in the mid-1980s and early 1990s at the highest levels of any single topic in the COPUOS record. This topic was characterized by Cold War cooperation language of East-West scientific exchange, with FREX terms including Soviet, socialist, Intercosmos, and cosmonaut. Its temporal signature tracks the period of détente-era scientific collaboration and the use of COPUOS as a venue for signaling peaceful intent between the superpowers.

The International Affairs topics absorbed the agenda space that Cold War Cooperation vacated. Space Security and Cooperation (1926) and International Delegation (1926) maintained the category's elevated levels through the 2000s and 2010s, and Space Security and Cooperation rose further in the most recent period (2021–2025). This topic captures the contemporary multilateral agenda around long-term sustainability, space traffic management, transparency, and debris mitigation, with FREX terms including EU, LTS, traffic, Ukraine, transparency, and guidelines. Its growth aligns with the adoption of the Long-Term Sustainability Guidelines (COPUOS 2019), the expansion of COPUOS membership to over 100 states, and heightened geopolitical tensions following Russia's 2021 anti-satellite weapons test and growing U.S.-China strategic competition in cislunar space (Weeden and Samson 2023; Moltz 2019). The persistence of International Affairs dominance across more than three decades, surviving the collapse of the Cold War and the emergence of entirely new governance challenges, is itself a significant finding. It suggests that COPUOS gravitates toward framing space issues in cooperative and security terms regardless of the specific political context, consistent with theoretical expectations about how consensus-based multilateral institutions respond when the costs of uncoordinated behavior become visible to a wide range of actors (Moltz 2008; Johnson-Freese and Weeden 2012).

Space (blue line in Panel A) remained at the lowest level of the three CAP categories throughout the corpus, never exceeding roughly 10 percent until a modest uptick in the most recent period. This late rise is visible in Panel B, which isolates the core Space topics. Space Programs (1701) peaked in the late 1970s and early 1980s, coinciding with the period when multiple states were establishing national space agencies and reporting their capabilities to COPUOS. Its decline after the mid-1980s portrays a shift away from national capability

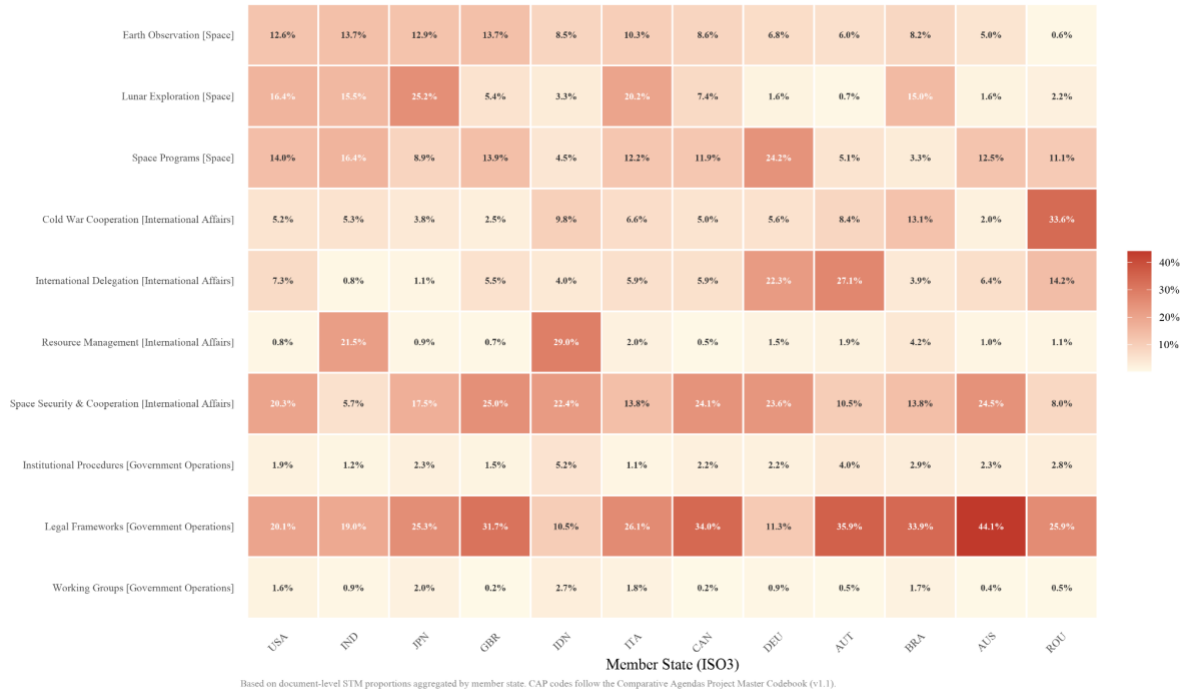
reporting, a trajectory that Paikowsky (2017) characterizes as the movement from space as a club of national prestige to space as a domain of collective governance. Lunar Exploration (1701) and Earth Observation (1708) both remained at low levels throughout most of the corpus but show increases in the most recent period. The late rise in Lunar Exploration tracks renewed international interest in lunar missions associated with the Artemis Accords (Artemis Accords 2020; Tronchetti 2021). Earth Observation reflects growing attention to climate monitoring and the Sustainable Development Goals. Together, these late increases produce the modest uptick in the Space line visible in Panel A, but even at their highest recent levels, Space-coded topics remain well below International Affairs. Notably absent from the entire COPUOS topic structure, at any CAP level, is any theme organized around commercialization or commercial launch activity.

Figure 4 presents mean topic prevalence by top member states, revealing how national delegations distribute their attention across competing themes. The heatmap confirms several patterns visible in the time-series data. Legal Frameworks (Government Operations 2000) shows high values broadly across nearly all delegations, with the highest concentrations in Australia (44.1 percent), Austria (35.9 percent), Canada (34.0 percent), and Brazil (33.9 percent), reflecting the centrality of treaty negotiation to COPUOS proceedings across a wide range of member states rather than any single bloc. Space Security and Cooperation (International Affairs 1926) shows relatively uniform engagement across major spacefaring states: the United States at 20.3 percent, the United Kingdom at 25.0 percent, Canada at 24.1 percent, Germany at 23.6 percent, and Indonesia at 22.4 percent. The broad distribution demonstrates that cooperative security governance has become a shared priority across the membership rather than a concern confined to any single group of states, a pattern

consistent with the comparative agendas finding that attention diversifies across actors as issue salience increases (Dowding, Hindmoor, and Martin 2016; Shackelford 2020).

Figure 4. Topic Prevalence by Top COPUOS Member States

Mean topic proportion for all topics. Labels show Topic [CAP Category].



Based on document-level STM proportions aggregated by member state. CAP codes follow the Comparative Agendas Project Master Codebook (v1.1).

The heatmap also demonstrates delegation-specific concentrations that reflect national priorities and historical positioning. Indonesia's concentration on Resource Management (International Affairs 1905, at 29.0 percent) reflects the prominence of equitable access and developing-country resource concerns in its statements. Romania's high proportion of Cold War Cooperation (International Affairs 1900, at 33.6 percent) reflects its active participation during the period of East-West diplomatic signalling. India allocates substantial attention to Resource Management (21.5 percent), consistent with its emphasis on space applications for development. Japan shows the highest concentration on Lunar Exploration (Space 1701, at 25.2 percent), reflecting its active lunar program and its participation in the Artemis partnership. These delegation-level patterns confirm that the aggregate temporal trends in

Panel A are not artifacts of any single country's dominance but reflect broadly distributed attention patterns shaped by both institutional position and national interest.

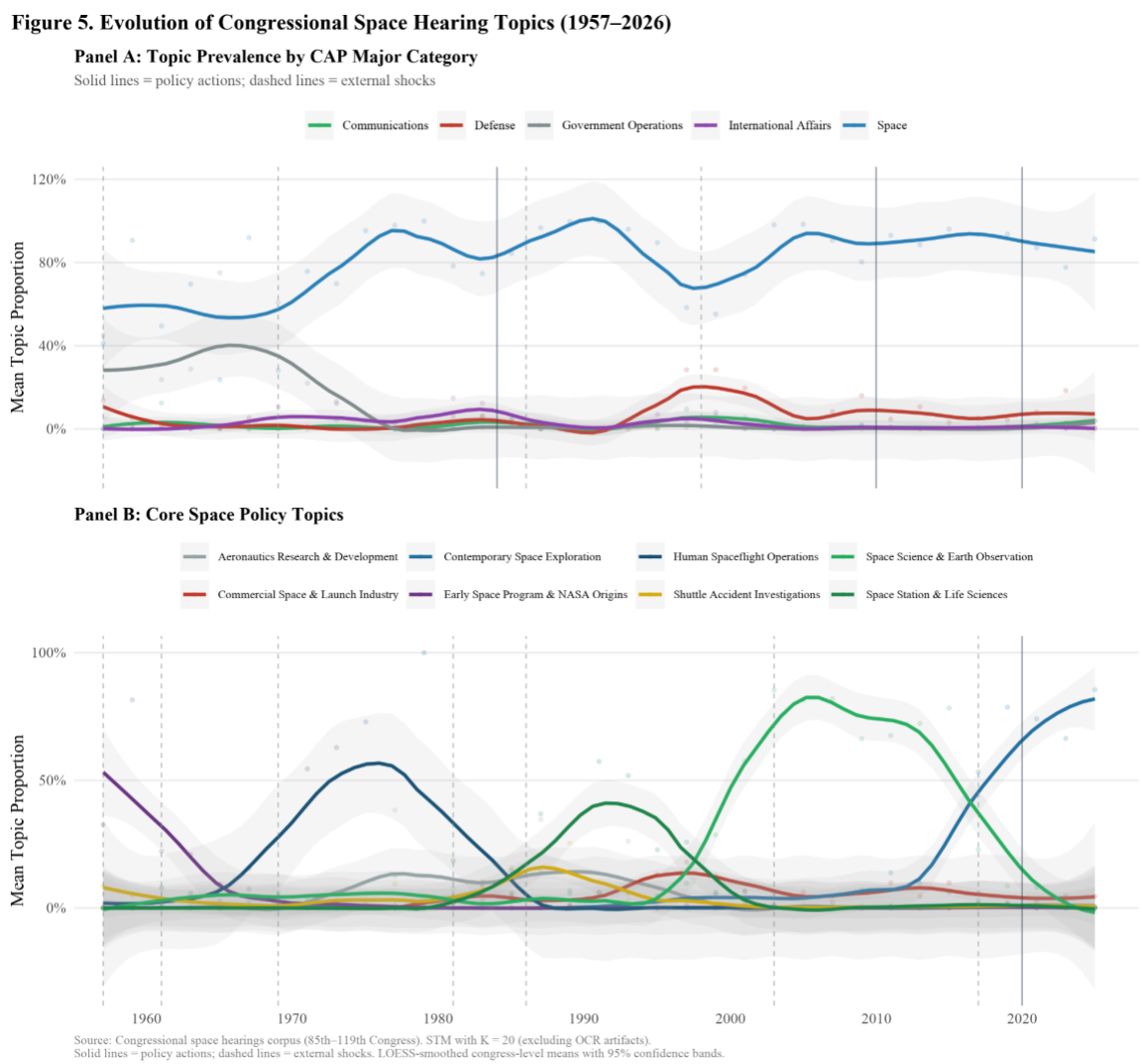
4.3 Congressional Hearings

Figure 5 displays the temporal trajectory of topic prevalence in the congressional hearings corpus, the largest and most granular of the three corpora. Panel A presents all 19 substantive topics (excluding OCR Artifacts), and Panel B isolates the core space policy topics. Read at the CAP level, the congressional corpus contrasts sharply with the COPUOS record. Where COPUOS is dominated by International Affairs and Government Operations with Space-coded topics in a subordinate position, the congressional corpus is dominated by Space (1701) to a degree unmatched in either of the other two venues. Thirteen of the twenty estimated topics fall under Space (1701), and these topics collectively account for the vast majority of the corpus. This concentration reflects the institutional character of congressional space oversight: hearings on NASA authorization and appropriation recur annually, and the committees with jurisdiction over space policy engage primarily with the substantive content of space programs. The remaining topics are distributed across Defense (1605, at 6.5 percent), Commercial Use of Space (1704, with two topics totaling 7.5 percent), Copyrights and Patents (1522, at 3.7 percent), Telecommunications (1706, at 2.4 percent), and International Affairs (1926, at 2.4 percent).

The non-Space CAP categories each carry distinct temporal signatures. Defense (1605), represented by Arms Control and Strategic Defense, concentrated in the 1980s and early 1990s, corresponding to the Strategic Defense Initiative and post-Cold War arms reduction debates. Commercial Use of Space (1704) includes both the Commercial Space and

Launch Industry topic (5.2 percent) and Aeronautics Research and Development (2.3 percent). The former has maintained a persistent presence since the 1980s, consistent with the incremental growth of commercial space as a legislative concern documented in Chapter 1. International Affairs (1926) appears through International Space Cooperation (2.4 percent), reflecting congressional attention to COPUOS and bilateral space arrangements, though at a far lower proportion than International Affairs topics occupy in the COPUOS corpus. The modest size of the International Affairs category in the congressional record, compared to its dominance in the COPUOS corpus, underscores the venue-specific character of attention allocation that the comparative agendas literature predicts (Jennings et al. 2011).

Figure 5. Evolution of Congressional Space Hearing Topics (1957–2026)



The most prominent pattern within Space (1701) in Panel B is the rise of Space Science and Earth Observation, which grew from a minor presence in the early decades to the single largest topic in the contemporary period, commanding over 75 percent of expected topic proportion in some recent congresses. This ascent accelerated around 2000. The scale of this concentration is striking within a domain that, as Chapters 1 and 2 documented, has become more diverse in its participant base and more heterogeneous in its belief structure. Space Science and Earth Observation has come to dominate the congressional space agenda in the way that Baumgartner and Jones (1993) describe monopolistic attention, in which a single topic absorbs a disproportionate share of available agenda space. That monopolistic attention within Space (1701) can coexist with participant diversification suggests that institutional structures through which attention is allocated, in this case committee jurisdiction and authorization cycles, can channel diverse voices toward a common set of issues (Jones, Sulkin, and Larsen 2003).

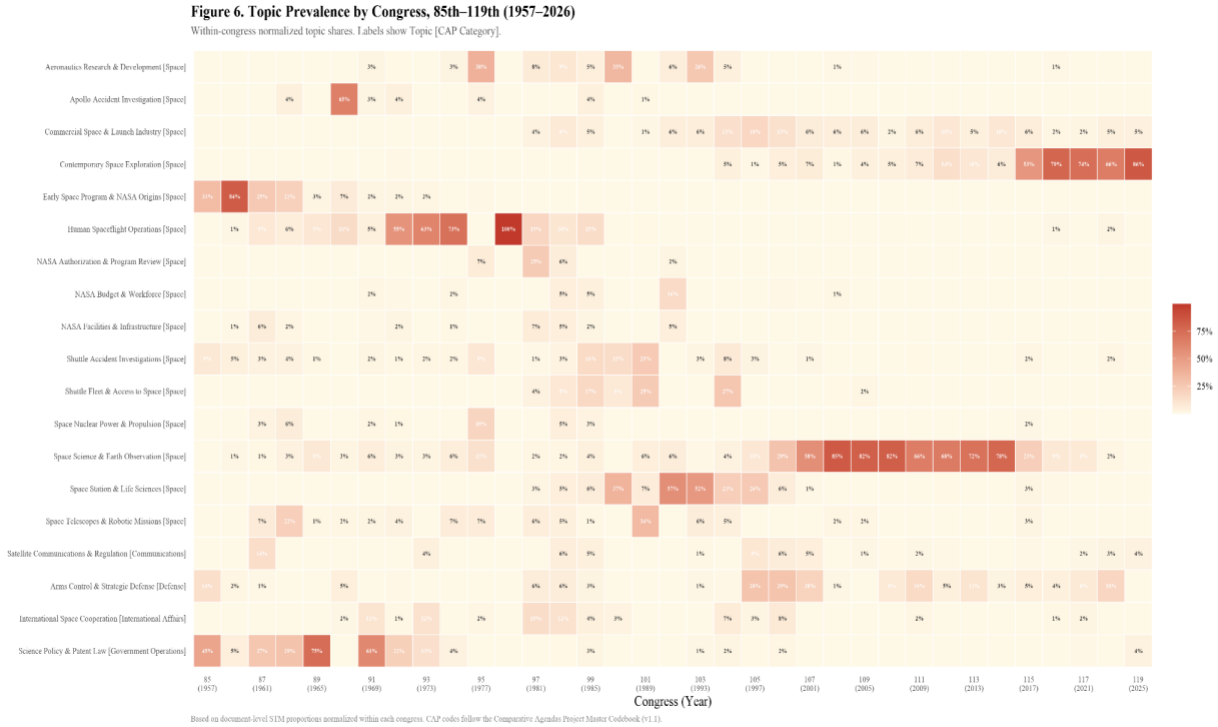
Space Science and Earth Observation captures not only traditional astronomical and planetary science but also climate monitoring and satellite-derived Earth observation. Its dominance likely reflects two reinforcing dynamics of the growing political salience of climate and environmental monitoring, which routes through space committees because the relevant instruments are satellite-based, and the diversification of NASA's portfolio beyond human spaceflight. The topic's expansion suggests that the institutional category of "space science" has broadened to absorb concerns previously distributed across narrower Space (1701) topics, a pattern consistent with issue redefinition (Baumgartner and Jones 1993, 25–27; Nowlin 2016).

Contemporary Space Exploration, the second-largest Space (1701) topic, is characterized by FREX terms such as Bridenstine, JWST, Artemis, and Mars and shows a sharp rise in the most recent congresses. This topic is distinct from the earlier Human Spaceflight Operations topic that dominated the 1960s and 1970s within the same CAP code. The earlier topic was organized around operational details, with FREX terms like Mercury, rendezvous, and colonel reflecting astronaut and mission controller testimony. The contemporary topic is organized around programmatic strategy and institutional partnerships. Both fall under Space (1701), but the vocabulary shift from operational to strategic language reveals a qualitative transformation within the category that a CAP-level analysis would not detect. This differentiation provides evidence that the subsystem diversification documented in Chapters 1 and 2 has left a measurable imprint on congressional discourse. The vocabulary shift parallels the shift in network brokerage from state actors to firm actors (Chapter 1) and the shift in expressed beliefs from infrastructure to regulatory modernization (Chapter 2).

Several smaller Space (1701) topics show concentrated temporal signatures corresponding to specific policy episodes, consistent with the punctuated-attention dynamic (Baumgartner and Jones 1993; Baumgartner et al. 2009). Shuttle Accident Investigations spiked following Challenger (1986) and Columbia (2003). Space Station and Life Sciences concentrated in the 100th through 103rd Congresses (1987–1994). Episode-specific topics illustrate the granularity the STM recovers within Space (1701) and demonstrate that within-category variation can be as informative as between-category variation.

Figure 6 presents a heatmap organized by Congress number. Early Space Program and NASA Origins concentrated in the 85th through 89th Congresses (1957–1966) and then disappeared. Copyrights and Patents (1522), represented by Science Policy and Patent Law,

peaked in the 89th through 92nd Congresses (1965–1972). Contemporary Space Exploration shows no appreciable presence before the 114th Congress (2015) and then rises rapidly through the 116th through 119th Congresses (2019–2026), aligning with the Artemis program and commercial lunar lander contracts.



This finding reinforces Chapter 2's evidence that firm actors concentrate their expressed beliefs around programmatic milestones and regulatory modernization. That Commercial Use of Space (1704) has not achieved the kind of agenda dominance that Space Science (1701) now commands, despite the subsystem-level transformation documented in the earlier chapters, indicates that institutional structures channel commercial concerns through existing authorization processes rather than generating a distinct high-profile agenda item.

4.4 Cross-Venue Topic Comparison

Examining the three corpora together allows for a comparative analysis of how attention to space policy themes is distributed across institutional venues. The comparative agendas literature predicts that different venues will attend to different aspects of the same policy domain (Jennings et al. 2011; Dowding, Hindmoor, and Martin 2016; Mortensen et al. 2011). The cross-venue patterns confirm that prediction while revealing dynamics specific to the space domain.

At the CAP level, the three venues display strikingly different compositions. The congressional corpus is dominated by Space (1701), with 13 of 20 topics under that code. The presidential corpus distributes attention more evenly across Space, Defense, International Affairs, and Government Operations. The COPUOS corpus is dominated by International Affairs (approximately 47 percent) and Government Operations (approximately 28 percent), with Space-coded topics (1701 and 1708 combined) occupying the smallest aggregate share at roughly 25 percent. These compositional differences illustrate a central comparative agenda finding where institutional mandates shape which dimensions of a shared policy problem receive attention (Jennings et al. 2011). Congress engages with the substantive content of space programs. The president engages with space as it intersects with strategic and diplomatic priorities. COPUOS engages with space primarily as a domain requiring procedural governance and cooperative diplomacy rather than as a substantive policy area.

First, the transition from Cold War-era topics to contemporary governance topics is visible across all three venues but proceeds at different rates and through different CAP categories. In the presidential corpus, Defense topics gave way to International Affairs topics during the 1990s, with Space (1701) regaining dominance only through governance-oriented

topics in the most recent administrations. In the COPUOS corpus, Government Operations (Legal Frameworks) yielded to International Affairs (Cold War Cooperation) in the late 1970s to early 1980s, and International Affairs has remained the dominant category since, sustained first by Cold War Cooperation and then by Space Security and Cooperation and International Delegation. Space-coded topics never held the dominant position in any COPUOS era. In the congressional corpus, Defense (1605) declined after the early 1990s without a successor from outside Space (1701); attention consolidated within the Space category itself. These differences illustrate the broader finding that executive venues concentrate on high-priority issues, legislative venues concentrate within their jurisdictional domains, and international venues are shaped by procedural rhythms and diplomatic framing (Jennings et al. 2011; Jones and Baumgartner 2005).

Second, commercialization appears as an identifiable theme in the presidential and congressional corpora but is absent from the COPUOS record at any CAP level. The congressional corpus contains a distinct Commercial Use of Space (1704) category with a persistent presence since the 1980s. The presidential corpus registers commercialization through governance-oriented Space (1701) topics. The COPUOS corpus contains no topic organized around commercial space activity under any CAP code. This asymmetry reflects the institutional character of COPUOS, where consensus-based diplomacy and the interests of non-spacefaring states have oriented discourse toward cooperation, capacity-building, and equitable access (Del Canto Viterale 2023; Tepper 2022).

Third, the exploration agenda shows divergent patterns. In the presidential corpus, Human Spaceflight and Exploration (1701) peaked during Apollo and has not returned to comparable levels. In the congressional corpus, the earlier Human Spaceflight Operations

(1701) gave way to a thematically distinct Contemporary Space Exploration (1701). In the COPUOS corpus, Lunar Exploration (1701) remained minor throughout with only modest recent growth. This divergence indicates that the renewed domestic exploration agenda has not yet translated into proportionate multilateral attention.

Fourth, Earth observation emerged as significant in both the congressional and COPUOS corpora but through different pathways and classifications. In Congress, it was absorbed into Space Science and Earth Observation under Space (1701). In COPUOS, it emerged as a distinct topic under Space (1708) with growing prevalence among developing-state delegations. The distinction illustrates a core comparative agendas insight: the same issue can occupy different positions on different institutional agendas depending on how it is framed and which actors claim jurisdiction (Baumgartner, Breunig, and Grossman 2019; Baumgartner and Jones 1993).

5. Discussion

5.1 Agenda Dynamics in a Transforming Policy Domain

The Comparative Agendas approach treats the allocation of attention as a political outcome shaped by institutional capacity, issue salience, and the strategic behavior of policy actors (Jones and Baumgartner 2005; Baumgartner, Breunig, and Grossman 2019). The space policy domain provides an instructive case because it has experienced the full range of attention-shifting dynamics the theory describes through galvanizing events that elevated space to a first-order national priority (McDougall 1985; Logsdon 2010); the gradual recession of attention (Downs 1972); issue redefinition as new dimensions expanded (Baumgartner and Jones 1993); and the redistribution of attention across venues as the governance architecture grew more complex (Tepper 2022; Moltz 2014).

The presidential corpus illustrates the issue-attention cycle most clearly. The Apollo-era concentration of Space (1701) topics followed by their sustained decline and displacement by Defense and International Affairs categories demonstrates Downs (1972) pattern in a specific policy domain. What the results add is evidence of what replaced the exploration agenda. There was not a single successor but a fragmentation across CAP categories, with Space (1701) regaining dominance through governance topics rather than exploration topics only in the most recent administrations. This delayed resurgence indicates that the institutional and regulatory demands of a commercialized space economy, documented in Chapter 1's analysis of subsystem diversification and Chapter 2's analysis of firm actors' evolving belief profiles, took decades to cross the salience threshold that commands sustained presidential attention.

The COPUOS corpus portrays a fundamentally different dynamic. Rather than the fragmentation visible in the presidential record, the multilateral record shows a single major transition. Government Operations (2000), driven by Legal Frameworks and the procedural vocabulary of treaty negotiation, dominated the founding decades before yielding to International Affairs. The transition was not abrupt. Government Operations declined gradually through the 1970s as the treaty-drafting agenda was progressively exhausted, while International Affairs rose through Cold War Cooperation (1900) with the two categories crossed in the late 1970s to early 1980s. Cold War Cooperation gave way to Space Security and Cooperation and International Delegation, but the category pattern held. This persistence demonstrates that COPUOS gravitates toward framing space issues in cooperative and security terms regardless of the specific political context, consistent with expectations about how consensus-based multilateral institutions tend toward norm-building and restraint rather

than operational policy coordination (Moltz 2008; Johnson-Freese and Weeden 2012). Space-coded topics, meanwhile, never commanded the dominant position in any era. The implication is that COPUOS functions less as a venue for debating the content of space policy and more as a venue for constructing and maintaining the institutional and diplomatic architecture within which space activities are governed. This characterization aligns with Tepper's (2022) description of the contemporary space governance landscape as polycentric.

The congressional corpus provides the most granular evidence of how agenda composition changes within a single dominant CAP category. Because Space (1701) dominates the congressional record, the most informative variation is not between CAP categories but within them. The emergence of Contemporary Space Exploration as a topic distinct from Human Spaceflight Operations, both coded Space (1701), reveals a qualitative transformation that a CAP-level analysis would not detect. The shift from operational to strategic vocabulary reflects the transformation documented in Chapters 1 and 2 through the entry of commercial actors, the reorganization of NASA's procurement model (Zancan and Paravano 2024), and the shift from government-operated to government-sponsored exploration. The coalitions that formed around new policy beliefs (Chapter 2) and that occupy new brokerage positions (Chapter 1) have reshaped not only who speaks but what they say, and that transformation is legible in the topic structure of the congressional record.

5.2 Connecting Domestic Subsystem Change to Agenda Evolution

The connection between subsystem diversification and agenda evolution operates through the mechanism the CAP identifies as issue redefinition (Baumgartner and Jones 1993). When new actors enter a policy subsystem, they bring new concerns, new vocabularies, and new claims on institutional attention (Sabatier and Weible 2007; Weible et

al. 2020). Chapter 1 showed that commercial actors entered through deliberate policy design. Chapter 2 showed that they brought distinct policy core beliefs. This chapter shows those concerns in the aggregate agenda: the emergence of Commercial Use of Space (1704) as a persistent congressional topic, the appearance of Contemporary Space Exploration as a distinct Space (1701) topic, and the late resurgence of governance-oriented Space topics in the presidential record.

The timing of agenda shifts corresponds to identifiable policy design choices. The Commercial Space Launch Act of 1984 coincides with the appearance of Commercial Use of Space (1704) in the congressional corpus. Space Policy Directive-1 and the Artemis program coincide with the rise of Contemporary Space Exploration. Executive orders in the Trump I and Trump II administrations coincide with the resurgence of Space Policy and Institutional Governance in the presidential record. These correspondences indicate that the endogenous policy design choices documented in Chapter 1 function as drivers of agenda change as well as structural change. The pattern is consistent with policy entrepreneurs that can reshape the thematic content of institutional agendas by altering the composition of subsystem participants (Baumgartner and Jones 1993; Walgrave and Varone 2008). What the space case adds is evidence that the mechanism operates through mobilization around existing issues and through the creation of entirely new actor categories whose concerns generate new topics in institutional discourse. The COTS program amplified existing commercial voices and created a class of actors whose testimony introduced vocabulary and priorities that the STM registers as a distinct topic. This finding bridges the ACF's emphasis on belief-driven coalition formation (Sabatier and Weible 2007) with the CAP's emphasis on attention allocation by showing that policy design choices alter both who participates and what the institutional agenda contains.

5.3 The Domestic-International Agenda Gap

The most consequential cross-venue finding is the absence of any commercialization topic in the COPUOS record at any level of analysis. The congressional corpus produces a distinct Commercial Use of Space (1704) category. The presidential corpus registers commercialization through governance-oriented Space (1701) topics. The COPUOS corpus contains neither. Chapters 1 and 2 established that commercialization has been a transformative force in the domestic space policy subsystem, with firm actors achieving the highest mean betweenness centrality (Chapter 1) and concentrating their expressed beliefs around regulatory modernization (Chapter 2). That this transformation has not generated a corresponding thematic footprint in the primary multilateral forum warrants attention.

The gap is not just one of timing or emphasis. The CAP-level structure of the COPUOS corpus, dominated by International Affairs and Government Operations, is organized around categories that have no direct counterpart in the domestic commercial transformation. Domestic commercialization registers in the congressional record as Commercial Use of Space (1704) and in the presidential record through governance-oriented Space (1701) topics. Neither of these framings has a structural home in a multilateral venue whose discourse is organized around cooperative diplomacy and procedural governance. The gap may therefore reflect something more persistent than temporal lag. The institutional architecture of COPUOS may be structurally oriented away from engaging with commercialization, not just slow to incorporate it. The consensus requirement allows non-spacefaring states to resist agenda items that primarily serve commercial interests, and the dominance of International Affairs framing means that issues must be cast in cooperative or security terms to gain traction.

Practically, the gap has implications for the coherence of global space governance. Twenty-first-century space power is increasingly defined by commercially led innovation (Moltz 2019; Weinzierl 2018; Melamed et al. 2024). The foundational treaties were drafted when only governments operated in space; the Artemis Accords represent an effort to multilateralize domestic preferences around resource rights and commercial activity without renegotiating the treaty framework (Tronchetti 2021; Tepper 2022). The STM results suggest that this effort has not yet registered as a major theme in COPUOS proceedings. This extends the concern raised by Moltz (2008, 2014) and provides empirical evidence for a specific dimension of the disconnect between the CAP-level composition of domestic and multilateral space policy agendas.

The sequential pattern observed in the COPUOS corpus is itself theoretically informative. The transition from Government Operations dominance to International Affairs dominance, and the subsequent cycling between procedural governance and cooperative diplomacy within International Affairs, is consistent with what Jones and Baumgartner (2005) describe as institutional bottleneck dynamics. When a consensus-based institution can attend to only a limited set of issues at a time, the result is not a gradual diversification of the agenda but a serial pattern in which one dominant framing absorbs the available institutional capacity before yielding to a successor. The COPUOS record displays this serial pattern across nearly seven decades. Legal Frameworks gave way to Cold War Cooperation, which gave way to Space Security and Cooperation, each commanding a disproportionate share of the multilateral agenda during its period of dominance. Commercialization may face a structural disadvantage in competing for the limited attention that the consensus requirement allows. The Artemis Accords can be understood in this light as an institutional workaround.

Rather than competing for COPUOS agenda space, the United States constructed a parallel multilateral framework organized around bilateral agreements that could accommodate commercial priorities without navigating the bottleneck (Tronchetti 2021; Shackelford 2020). Whether this workaround produces durable governance or merely fragments the international architecture further is a question the data cannot answer, but the agenda dynamics documented here clarify why the workaround was pursued.

5.4 Methodological Contributions and Considerations

The two-level classification structure, in which each STM topic receives both a CAP major code and a descriptive topic label, provides a bridge between the unsupervised topic structure and the standardized CAP measurement infrastructure. The CAP codes enable cross-venue comparison at the level of government activity categories. The topic labels capture within-domain differentiation that the CAP codebook is too coarse to detect, as illustrated by the distinction between Human Spaceflight Operations and Contemporary Space Exploration, both coded Space (1701) but representing qualitatively different forms of attention. This approach extends the CAP's comparative logic into a domain-specific design, answering the call by Pomeroy (2019) for computational text methods in space policy scholarship.

The design also demonstrates the value of combining unsupervised text methods with established policy classification systems. The CAP codebook provides a principled external structure against which the data-driven topics can be evaluated, and the topic labels provide the granularity that the codebook's major categories cannot supply. This pairing addresses a recurring tension in computational text analysis between the flexibility of unsupervised methods and the interpretive discipline that standardized coding schemes impose (Grimmer and Stewart 2013; Grimmer, Roberts, and Stewart 2022). By anchoring each topic in both an

empirical word distribution and a theoretically motivated classification, the analysis avoids the common criticism that topic models produce themes whose substantive meaning is uncertain (Bernhard-Harrer et al. 2025). The approach is portable to other policy domains where the CAP codebook's major categories are too broad to capture within-domain variation but where the discipline of a standardized taxonomy is nonetheless desirable for cross-venue or cross-national comparison.

The multi-corpus design itself represents a methodological contribution. Most applications of structural topic modeling in political science analyze a single corpus from a single institutional venue (Roberts, Stewart, and Tingley 2019; Cross and Greene 2020). The present study applies the same analytical logic across three corpora drawn from different institutional settings, using the CAP classification as the common measurement layer that enables cross-venue comparison. This design operationalizes the comparative agendas framework's core premise that the same policy domain is processed differently by different institutions (Baumgartner, Breunig, and Grossman 2019). The inclusion of the COPUOS corpus extends this comparison to an international venue, a step that comparative agendas research has taken only rarely and never in the space policy domain. Future work could extend this approach by incorporating additional venues, such as agency rulemaking documents, media coverage, or the records of bilateral space agreements, to construct a more complete picture of how space policy attention is distributed across the full institutional landscape.

5.5 Limitations

Several limitations should be noted. First, the three corpora differ in their unit of analysis. The presidential corpus consists of individual documents (executive orders, speeches, press statements). The COPUOS corpus combines speech-level data (1961–1993

and 2021–2025) with document-level annual reports (1994–2020). The congressional hearings corpus treats each hearing as a single document. These differences in granularity affect the comparability of topic proportions across corpora. A 5 percent topic proportion in a presidential executive order carries different substantive weight than a 5 percent proportion in a 200-page congressional hearing transcript. Cross-venue comparisons should accordingly be interpreted in terms of relative attention allocation within each venue rather than absolute comparisons of topic prevalence across venues.

Second, the corpora are not exhaustive. The presidential corpus draws on two archival sources (GovInfo and APP) that, while comprehensive, may not capture every relevant document. The COPUOS corpus relies on Pomeroy's archive for its earliest period, which includes only a subset of COPUOS proceedings. The congressional hearings corpus is broader than the 293-hearing sample used in Chapters 1 and 2 but is still limited by the availability of digitized and machine-readable texts, particularly for pre-GovInfo hearings that required manual sourcing. Publication delays of up to two years for recent hearings mean that the most recent congresses may be underrepresented.

Third, topic models are sensitive to preprocessing decisions. The removal of domain-specific stop words, the choice of stemming algorithm, the minimum document-frequency threshold, and the selection of K all influence the resulting topic structure. The models reported here used standard preprocessing procedures and evaluated multiple values of K using diagnostic criteria (held-out likelihood, semantic coherence, residual dispersion), but alternative specifications could yield different topic configurations. The results should be interpreted as one defensible account of the thematic structure of space policy discourse rather than the only possible account.

Finally, STMs identify patterns of word co-occurrence, not meaning. The labels assigned to topics (e.g., “Space Security and Cooperation,” “Legal Frameworks”) reflect the analyst’s interpretation of the highest-probability and FREX terms and the documents with the highest topic proportions. Different analysts might label the same topic differently. The CAP codes assigned to each topic similarly involve interpretive judgment about how unsupervised topic clusters map onto the standardized coding scheme. These labels and codes should be understood as analytical instruments rather than as objective descriptions of the topics’ content.

6. Conclusion

This chapter asked how the thematic content of space policy has evolved across domestic and international institutional venues, and to what extent the commercialization priorities that transformed the U.S. space policy subsystem have registered on the multilateral governance agenda. The structural topic models applied to three corpora spanning 1957 to 2025 provide answers to both questions, and those answers carry implications for comparative agendas research, space governance scholarship, and the broader study of cross-level policy dynamics.

The first question yields a clear result. The three institutional venues process space issues through fundamentally different CAP-level compositions. Congress concentrates on the substantive content of space programs, with thirteen of twenty topics falling under Space (1701). The president engages with space where it intersects with strategic, diplomatic, and governance priorities, distributing attention more evenly across CAP categories. COPUOS processes space primarily through International Affairs and Government Operations, with

Space-coded topics occupying the smallest aggregate share. These differences are not incidental, and they reflect the institutional mandates, decision rules, and participant compositions that the comparative agendas framework identifies as the primary determinants of what any given venue attends to (Jennings et al. 2011; Mortensen et al. 2011; Jones and Baumgartner 2005). The finding that a policy domain as seemingly unified as space policy is processed through such different thematic structures across venues demonstrates the explanatory power of the CAP's venue-comparison logic, even in a domain that has received virtually no prior attention from the comparative agendas community.

Within each venue, the temporal dynamics of attention tell a story that connects directly to the subsystem transformation documented in Chapters 1 and 2. The presidential record displays a classic issue-attention cycle (Downs 1972) in which Space (1701) topics commanded extraordinary executive attention during the Apollo era, declined through the 1970s and 1980s, and regained dominance only in the most recent administrations through governance-oriented topics rather than exploration narratives. That the resurgence took the form of institutional governance rather than visionary rhetoric alone reflects the regulatory demands of the commercialized subsystem that Chapters 1 and 2 described. The congressional record shows the emergence of Contemporary Space Exploration as a topic distinct from the earlier Human Spaceflight Operations, a within-category transformation that captures in aggregate text data the same shift from government-operated to government-sponsored space activity that the discourse network analysis traced at the actor level. The COPUOS record reveals a sequential pattern of agenda monopolization, with Government Operations yielding to International Affairs in the late 1970s and International Affairs maintaining dominance through successive substantive reformulations, from Cold War

Cooperation to Space Security and Cooperation. This persistence is consistent with institutional bottleneck theory (Jones and Baumgartner 2005) and with the characterization of COPUOS as a venue oriented toward norm-building and procedural governance rather than operational policy coordination (Moltz 2008; Tepper 2022).

The second question, concerning the international registration of domestic commercialization priorities, yields a finding that is perhaps the most consequential of the chapter. Commercialization has been a highly transformative force in the U.S. space policy subsystem over the past four decades. Chapter 1 documented how commercial actors moved from peripheral participants to central brokers. Chapter 2 showed that they brought distinct policy core beliefs organized around regulatory modernization and market access. The congressional corpus registers this transformation through a distinct Commercial Use of Space (1704) category with a persistent presence since the 1980s, and the presidential corpus registers it through governance-oriented Space (1701) topics that have come to dominate executive attention. Yet the COPUOS corpus contains no topic organized around commercialization at any level of the CAP taxonomy. The institutional architecture of the multilateral venue, with its consensus requirement, its orientation toward cooperative diplomacy, and its membership dominated by states with limited commercial space capacity, appears to be structurally resistant to the commercial framing that has reshaped domestic U.S. space governance. This gap is not simply an artifact of temporal lag. The domestic commercial transformation began in the 1980s, and four decades of structural change have not produced a corresponding thematic footprint in the primary international forum for space governance.

The implications extend in three directions. For comparative agendas research, the chapter demonstrates that the CAP's venue-comparison logic is productive when applied across the domestic-international boundary. The finding that institutional mandates shape the CAP-level composition of space policy attention in predictable ways, with legislative venues concentrating within their jurisdictional domains and multilateral venues concentrating on procedural governance and diplomatic framing (Jennings et al. 2011; Dowding, Hindmoor, and Martin 2016), adds a new policy domain to the empirical base of the comparative agendas literature and extends that literature's geographic scope to the international level. The two-level classification structure developed here, pairing CAP major codes with domain-specific topic labels, offers a replicable template for future work that seeks to apply the CAP's standardized taxonomy to within-domain variation that the codebook's major categories cannot capture.

For space governance scholarship, the chapter provides the first corpus-based comparison of space policy agendas across domestic executive, legislative, and international venues. The space policy literature has long recognized that governance challenges span multiple institutional settings (Moltz 2014; Jakhu and Pelton 2017; Del Canto Viterale 2023), but empirical analysis has generally proceeded venue by venue, examining congressional hearings, executive documents, or COPUOS proceedings in isolation. By analyzing all three within a common framework, this chapter enables the kind of cross-venue comparison that the fragmented character of space governance makes necessary. The finding that cooperative security themes have achieved cross-venue prominence, appearing as International Security and Diplomacy in the presidential corpus, Space Security and Cooperation in the COPUOS corpus, and International Space Cooperation in the congressional corpus, suggests that

security framing may represent the most durable bridge between domestic and international space policy agendas. That Earth observation has similarly achieved cross-venue significance, though through different CAP pathways, reinforces the comparative agendas insight that the same substantive concern can occupy different positions on different institutional agendas depending on how it is framed, and which actors claim jurisdiction (Baumgartner and Jones 1993; Baumgartner, Breunig, and Grossman 2019).

For the broader study of policy subsystems, the chapter completes the empirical arc of the dissertation by showing that the structural diversification documented in Chapter 1 and the belief-content diversification documented in Chapter 2 are visible in the aggregate thematic structure of institutional discourse. The entry of commercial and civil society actors into the space policy subsystem did not merely change who participates. It changed what the institutions that govern space policy talk about. The emergence of Commercial Use of Space (1704) as a persistent congressional topic, the appearance of Contemporary Space Exploration as a distinct Space (1701) topic, and the resurgence of governance-oriented Space topics in the presidential record all reflect the cumulative agenda effects of the subsystem transformation that the earlier chapters traced at the actor level. That these effects are confined to domestic venues and have not propagated to the multilateral level raises a question that reaches beyond the space domain: under what conditions does domestic subsystem transformation reshape the agendas of the international institutions that govern the same policy area? The space policy case provides one empirical anchor for addressing that question, and the methodological framework developed here provides the tools for pursuing it systematically.

Conclusion

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The U.S. space policy subsystem has been transformed. What began in the late 1950s as a tightly centralized arrangement, organized around a small core of government actors with aligned beliefs and clear jurisdictional authority, has become a multi-sector policy arena in which hundreds of actors from government, industry, and civil society participate in shaping the direction of space governance. This dissertation has traced that transformation across three analytical dimensions: the structural evolution of the subsystem and its coalitions, the thematic content of policy preferences organized by actor type, and the longitudinal evolution of the space policy agenda across domestic and international institutional venues. The findings, taken together, offer a more complete account of how the space policy subsystem arrived at its present configuration and what that configuration implies for governance, theory, and practice.

The three chapters tell a coherent story, but each contributes a distinct piece of evidence. Chapter 1 documented the structural transformation of the subsystem from a unitary, government-dominated form to a collaborative, multi-stakeholder configuration. Using discourse network analysis applied to congressional hearings across four policy eras, it showed that actor diversity increased steadily, that Shannon entropy nearly tripled from the foundational period to the contemporary era, and that the brokerage function shifted from exclusively state actors to a configuration in which firm and civil society actors also hold high mean betweenness centrality. This transformation was not driven solely by external shocks. It was the cumulative product of deliberate policy design choices, from the Commercial Space Launch Act of 1984 through the COTS and CRS programs to the Artemis

program's commercial partnership model, that recruited new classes of actors into the subsystem and altered the institutional rules governing participation.

Chapter 2 moved from structure to substance. It examined how the introduction of different actor types reshaped the thematic content of policy preferences expressed in congressional hearings. The analysis revealed that while certain policy core beliefs, particularly the imperative of countering adversaries in space, persist as stable features of the subsystem across all four eras, the entry of commercial and civil society actors introduced new thematic emphases. The contemporary subsystem is organized around a dual-track coalition structure in which security concerns and commercial-regulatory concerns coexist as distinct but interconnected clusters. Firm actors concentrate their discourse around contracting methodology, commercial scheduling, and regulatory modernization. Civil society actors emphasize workforce development, international collaboration, and addressing adversarial ambitions. State actors span both tracks but have increasingly incorporated commercial and cooperative language into their testimony. These patterns demonstrate that the structural diversification documented in Chapter 1 carries substantive consequences: as the participant base changes, so does the content of the policy conversation.

Chapter 3 extended the analysis beyond the congressional venue and beyond the domestic arena. By applying structural topic modeling to three corpora of space policy texts, it measured how the allocation of attention to space policy themes has shifted over time across presidential documents, COPUOS multilateral proceedings, and U.S. congressional hearings. The results revealed several important dynamics. The presidential record shows a classic issue-attention cycle in which human spaceflight commanded extraordinary attention during the Apollo era before declining and giving way to a fragmented agenda in which governance and institutional design have emerged as the dominant claim on executive attention only in recent administrations. The congressional record shows the emergence of

thematically new topics, particularly contemporary space exploration, that reflect the vocabulary and institutional referents of the commercialized subsystem rather than the operational language of the earlier space age. And the COPUOS record reveals a sequential pattern of agenda monopolization in which dominant themes absorb the vast majority of available attention before yielding to successors, with no commercialization topic emerging to match the domestic transformation.

The Domestic-International Gap

Perhaps the most consequential finding across the three chapters is what is absent from the international record. Chapters 1 and 2 established that commercialization has been a transformative force in the domestic U.S. space policy subsystem over the past four decades. Commercial actors have moved from peripheral contractors to central brokers. Market-oriented beliefs have entered the policy discourse and reorganized coalition structures. Legislative and executive actions have repeatedly redesigned institutional arrangements to accommodate and encourage private sector participation. Yet the multilateral venue most directly responsible for international space governance shows no corresponding thematic concentration around commercial space activity. The COPUOS corpus contains topics organized around legal frameworks, Cold War cooperation, space security, and Earth observation. It does not contain a topic organized primarily around the commercial space economy.

This gap is not simply a curiosity of the data. It carries practical implications for the coherence of global space governance. The foundational treaties of international space law were drafted when governments were the sole actors in space and the domestic subsystem was in its unitary form. The Artemis Accords represent an effort to multilateralize domestic preferences around resource rights and commercial activity, but the STM results suggest that this effort has not yet registered as a major theme in COPUOS proceedings. If the primary

multilateral forum for space governance is not engaging with the policy transformation that is reshaping the domestic subsystems of spacefaring nations, questions arise about whether COPUOS is keeping pace with the governance challenges generated by commercialization. The consensus requirement in COPUOS, which allows non-spacefaring states to resist agenda items that primarily serve commercial interests, may explain part of this gap. Temporal lag may explain another part. But the gap itself is a finding that warrants attention from both scholars and practitioners.

Contributions to Policy Process Theory

This dissertation makes three contributions to the theoretical literature on policy subsystems and the Advocacy Coalition Framework. The first is the demonstration that subsystem typology is a dynamic outcome rather than a stable condition. By treating typological change as the dependent variable and tracing the mechanisms that produced it, this study offers a framework for understanding how subsystems evolve outside of the dramatic external punctuations traditionally emphasized in the ACF and punctuated equilibrium literatures. The policy design choices documented here functioned as endogenous drivers of structural change, altering who could participate, what resources they could bring, and what beliefs were represented. This finding has implications for how scholars periodize and study subsystem change. If typological transitions can occur gradually through the accumulation of policy design choices, then the practice of classifying subsystems at a single point in time risks mischaracterizing the underlying process.

The second contribution concerns the relationship between actor composition and agenda content. Chapter 2 demonstrated that the coalitions identified through network analysis reflect meaningful differences in what actors advocate for, not just in how they are structurally positioned. Chapter 3 extended this insight to the aggregate agenda level,

showing that the entry of new actor types is visible in the thematic content of institutional discourse. The connection operates through what the Comparative Agendas Project identifies as issue redefinition: new actors bring new vocabularies and new claims on institutional attention, and the aggregate agenda shifts in response. This linkage between subsystem diversification and agenda evolution is one of the study's central empirical findings, and it suggests that the ACF's treatment of actor entry should be connected more explicitly to the broader literature on agenda-setting and attention allocation.

The third contribution is methodological. The semi-automated discourse network analysis pipeline developed in Chapters 1 and 2 provides a replicable framework for measuring subsystem-level structural properties, including actor diversity, belief heterogeneity, and network modularity, across extended time periods. The structural topic modeling applied in Chapter 3 provides a complementary tool for measuring the thematic content of institutional agendas at scale. Together, these methods enable longitudinal, multi-venue analysis. The combination of network-level and topic-level measurement is portable to other policy domains where hearing records, treaty texts, or institutional proceedings provide longitudinal records of policy discourse.

Limitations

Several limitations should be acknowledged. First, the three chapters rely on different units of analysis, different corpora, and different methods. The discourse network analysis in Chapters 1 and 2 operates at the speaker-paragraph level within a curated set of 293 congressional hearings. The structural topic modeling in Chapter 3 operates at the document level across three corpora with different temporal coverages and documentary structures. These differences in granularity and scope mean that the findings from each chapter are not

directly commensurable. The connections drawn across chapters in this conclusion and in the discussion sections are interpretive rather than mechanical.

Second, the COPUOS corpus presents a particular challenge. The shift from speech-level transcripts (1961 to 1993) to document-level annual reports (1994 to 2020) to written statements (2021 to 2025) introduces compositional variation that the structural topic model can only partially accommodate. The prevalence covariate for source format mitigates but does not eliminate the risk that apparent changes in topic prevalence reflect changes in document genre rather than changes in the multilateral agenda. The dominance of the Working Groups topic during the annual-report period illustrates this risk clearly. Future research that separates the three source types into distinct sub-corpora or supplements the automated analysis with qualitative examination of documents from each period would provide a valuable robustness check.

Third, congressional hearings are curated venues. Witnesses are invited by committee chairs, their testimony is audience-aware, and the full range of actors influencing space policy extends beyond those who testify. Lobbying, executive branch deliberation, international negotiation, and informal consultation all shape space policy in ways that hearing testimony cannot capture. The patterns identified here reflect observable discourse network structure and institutional agenda content rather than the complete architecture of policymaking activity.

Fourth, topic models identify patterns of word co-occurrence, not meaning. The labels assigned to topics reflect the analyst's interpretation of the highest-probability and FREX terms and the documents with the highest topic proportions. Different analysts might label the same topic differently. The CAP codes assigned to each topic similarly involve interpretive judgment. These labels and codes should be understood as analytical instruments rather than as objective descriptions of the topics' content.

Directions for Future Research

Four directions follow from the findings. The first concerns generalizability. This study has documented the mechanism of policy-induced actor entry and its consequences for subsystem structure, agenda content, and cross-venue dynamics in a single policy domain. Whether the same mechanism operates in analogous domains, such as artificial intelligence governance, commercial biotechnology, or quantum computing, where the government similarly shapes who enters the policy arena through procurement, regulation, and research funding, remains an empirical question. Comparative analysis across domains that have experienced deliberate actor recruitment would allow for the identification of the conditions under which actor entry produces collaborative rather than adversarial dynamics and the conditions under which domestic subsystem transformation does or does not diffuse into international governance forums.

The second direction concerns the COPUOS agenda gap. The absence of a commercialization topic in the multilateral record raises a question that this study identifies but cannot resolve: is the gap a matter of temporal lag, institutional resistance, or something else? Tracing the mechanisms through which domestic policy priorities do or do not enter the COPUOS agenda would require a research design that combines the computational analysis developed here with process-tracing of specific agenda items, such as the Artemis Accords or the Long-Term Sustainability Guidelines, as they move from domestic policy outputs to multilateral deliberation. Such an analysis would contribute both to the space governance literature and to the broader comparative agendas literature on cross-level agenda dynamics.

The third direction concerns prediction. The quantitative framework developed here, comprising entropy scores, centrality distributions, modularity measures, and topic prevalence trends, provides snapshots of subsystem structure at discrete points in time. The

logic of the framework implies a predictive application: if typological transitions are preceded by identifiable changes in belief heterogeneity and actor diversity, then monitoring those indicators should allow for the anticipation of structural change before it fully materializes. A subsystem in which entropy is rising, betweenness centrality is shifting toward non-state actors, and new topics are emerging in the institutional agenda may be approaching a typological threshold. Developing this predictive capacity would require theoretical work to specify threshold conditions and empirical work to validate those thresholds against historical cases.

The fourth direction concerns the role of power in subsystem evolution. This study has documented a case in which the dominant coalition, rather than resisting actor entry, actively facilitated it through policy design. That pattern may not generalize. In subsystems where incumbent actors have strong incentives to suppress participation, such as in fossil fuel extraction or financial regulation, the mechanisms of endogenous change documented here may be blocked or redirected by structural power. Understanding when and how dominant coalitions use institutional rules to gate actor entry, and when they choose instead to recruit new participants, is a question that the ACF has not yet fully addressed. The space policy case, where recruitment was the dominant pattern, provides one data point. Cases where suppression is the dominant pattern would provide the necessary contrast.

Closing

The opening decades of the space age were governed by a handful of people in government agencies and the contractors that served them. The contemporary space policy subsystem bears little resemblance to that arrangement. It encompasses hundreds of actors across the public, commercial, and civil society sectors, organized around diverse beliefs about what space is for, who should govern it, and what obligations the actors operating in it

carry. That transformation was not inevitable. It was the product of political choices, and understanding it requires the kind of systematic, longitudinal, and theory-grounded analysis that this dissertation has attempted to provide.

The ACF offers powerful tools for understanding why policy subsystems look the way they do at any given moment. This dissertation has sought to extend those tools toward an equally important question. How do subsystems come to look the way they do, and what does the trajectory of their development tell us about where they are headed? The space policy case suggests that the answer lies not only in the external environment but in the design of institutions, the strategic choices of actors operating within them, and the cumulative effects of those choices on who enters the arena of governance and what beliefs they bring with them. The international dimension adds a further layer of complexity where domestic subsystem transformation does not automatically propagate to the multilateral venues and where global rules are negotiated. Whether and how that propagation occurs is among the most consequential questions for space governance in the decades ahead.

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Appendix

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Appendix Table 1: ACF Belief Coding System

Variable	Coding Scheme	Description
Actor	Categorical	The narrating actor is the individual speaking or providing a statement. Use the full name (first and last), if known. Use the individual's full name (if known) in the first statement attributable to the narrating actor using "first, last" format. In subsequent statements, utilize DNA's drop-down list function for the same actor to ensure consistency. If a person is paraphrasing for another person, the person being paraphrased is the narrating actor. Look for words such as "said, cited, expressed" to find paraphrased phrases.
Actor Affiliation Institution	Categorical	Affiliation is the organization or group connected to the narrating actor. Include the full name of the organization. If the coded statement is from a journalist, include the name of their outlet as the affiliation. If a narrating actor is not clearly speaking on behalf of the organization they belong to or if their profession rather than their organization identifies them, code their title or profession instead

		(e.g., “emergency physician”).
Actor position	Categorical	The narrating actor’s position (supportive (pro), against (anti), neutral (neutral)) concerning the central focal point of interest, such as a policy, project, process, or situation. The focal point of interest will vary by the research project. Use the compilation of statements for the narrating actor from the document(s) to inform this code. If against the focal point, code as anti. If for the focal point, code as pro. If both against and for or if unclear or undisclosed, code as unidentified.
Deep Core Beliefs	Categorical	Fundamental normative axioms, the priority of values, distributive justice (whose welfare counts), sociocultural identity, race/gender/ethnicity/religion. EX: Anti-Authroitarian, Collaboration, Equity, Public Good, Scientific Fundamentalism
Policy Core Beliefs	Categorical	Look for beliefs in three categories “policy core policy preference,” “overall seriousness of the problem,” and “basic causes of the problem.” Essentially, what is this policy about? EX: Counter Adversaries in Space, Precision from satellites for agriculture, Expand

		Broadband connection, Regulatory inefficiency in satellites, Regulatory environment that fosters commercial innovation
Secondary Belief	Categorical	The belief is about the implementation, the formal and informal policy process. EX: Foreign-based satellite companies (esp. adversarial nations) require heightened scrutiny, Dedicated Space Bureau for FCC responsiveness, Establish a modern and streamlined FCC licensing process, TAIPEI Act, The Secure Space Act
States	1,0	The state is sovereign in its territory (also referred to as jurisdiction) and has the authority to enforce a system of rules over the people living inside it. Normally it consists of legislature, executive, and judiciary. Government is a means by which organizational policies are enforced, as well as a mechanism for determining policy.
IGO	1,0	An intergovernmental organization (IGO) is a group of members (sovereign states, countries) working together on issues of mutual self-interest. Some IGOs are legal entities – i.e. they have been ratified by charter. The United Nations is a good example of a legally constituted IGO. Its charter links the interests of 192 member nations. IGOs that are not chartered do not “exist” in a legal sense. But in other significant ways

		they certainly do exist. For example the non-chartered G7 (Group of Seven) has annual meetings dealing with the substantive political and economic concerns of the world's industrial leaders (the G7 was the G8 until 2014, when seven members suspended Russia for its annexation of Crimea).
Firms	1,0	A "firm organization" refers to a business entity, or company, that is engaged in economic activities like producing or selling goods and services, with the primary goal of generating profit; essentially, it's a structured group that operates to make money in the market by utilizing resources and labor to create products or services for sale.
Civil Society Actors	1,0	Civil society actors are individuals or groups that work to influence government and society. They are not political parties, but instead seek to create social change without holding political office. Examples of civil society actors: Activist groups: Work to bring about social change Charities: Work to help people in need Community organizations: Work to improve the community Environmental rights activists: Work to protect the environment Human rights defenders: Work to protect human rights Non-governmental organizations (NGOs): Work

		to promote social change Trade unions: Work to advocate for workers' rights University institutes: Work to promote education and research Youth organizations: Work to advocate for young people Women's organizations: Work to advocate for women's rights
Multiple Affiliations	1,0	A witness that is representing 2 or more of the category of actors categories. Ex: Firm and civil society actor representative. Coded in short form data set in multiple categories. For example, a witness with multiple affiliations at a firm or university will be coded twice as (1) multiple affiliations (1) firm and again as (1) civil society actor and (1) multiple affiliations.

Note: *This codebook was adapted from the Appendix Table 1 Codebook in: Fullerton, Allegra H. and Christopher M.Weible 2024. "Examining Emotional Belief Expressions of Advocacy Coalitions in Arkansas' Gender Identity Politics." Policy Studies Journal 52 (2): 369–389. https://doi.org/10.1111/psj.12531.*

Appendix Entry 2. Identification of Policy Statements in Hearing Transcripts

To identify policy statements in U.S. congressional hearing transcripts, I used a dictionary and pattern based text coding procedure implemented in R. This procedure combines three main elements: (1) a set of belief dictionaries that capture deep core values and policy core preferences, (2) a set of thematic policy topic codes, and (3) position patterns that identify whether a speaker supports, opposes, or takes no clear stance on a given belief or preference.

1. Text units and preprocessing

Hearing transcripts were converted from PDF to text, cleaned, and divided into paragraphs, which serve as the primary unit of analysis. For each paragraph, the script recorded the hearing, date, speaker, and affiliation, then applied the dictionaries described below to detect and code policy statements.

2. Coding areas

Coding proceeded along four dimensions:

I. **Actor position**

Each paragraph that contained a candidate policy statement was first coded for the speaker's position using a simple four category scheme:

A. Pro: explicit support or endorsement (for example "support," "in favor," "back," "advocate," or "should continue").
B. Anti: explicit opposition or rejection (for example "oppose," "against," "reject," "should not," "must not," "do not support," or "concerned about").
C. Neutral: balanced or explicitly noncommittal language (for example "neutral," "balanced," "on the one hand … on the other hand," "no position").
D. Unidentified: no clear position signal.

II. These categories are implemented through regular expression patterns that search for common support and opposition verbs and phrases. The "anti" pattern is evaluated first so that clear opposition is not overridden by more generic support words in the same paragraph.

III. **Deep core beliefs**

To capture broad value commitments and worldviews, each paragraph was scanned for terms related to deep core beliefs. A deep core dictionary includes concepts such as:

A. Governance and authority: *Accountability, Anti-Authoritarianism, Authority, Democracy, Limited Government, Regulation*
B. Social values and public interest: *Equity, Public Good, Public Welfare, Safety*
C. Collaboration and economic values: *Collaboration, Commercialization, Efficiency*
D. Science and technology: *Scientific fundamentalism, Technological evolution, Innovation*
E. National identity and security: *National Security, Global Competition, Leadership, Defense*

IV. For each belief, I defined a regular expression pattern that captures common variants and phrasings (for example "accountability," "responsibility," and "transparency" for Accountability; "national security" and "security interests" for National Security). If a paragraph matched one or more of these patterns, it received the corresponding deep core belief code(s).

V. **Policy core beliefs**

Policy core preferences capture more specific, durable preferences about the direction of space policy. The policy core dictionary groups related preferences into labeled categories such as:

A. **Access and launch capability**: *Assured Access to Space, Transition off RD-180 / Foreign Engines, Domestic Propulsion & Onshoring, Open Competition in Launch Services, Modernize Launch Architecture, Reusability & Lifecycle Costs, Responsive / Tactically Responsive Launch*
B. **Costs, schedules, and risk**: *Affordability & Cost Control, Schedule & Transition Milestones, Certification & Mission Assurance, Risk Reduction & Technical Risk*
C. **Industrial base, supply chain, and workforce**: *Industrial Base & Surge Capacity, Supply Chain Security, Intellectual Property, STEM & Skilled Workforce, Industrial Policy & Economic Security, Workforce Diversity & Inclusion, Education & Training Initiatives*
D. **Technology and exploration priorities**: *Hydrocarbon Engine Strategy, SLS and Orion Program Continuation, Moon to Mars Exploration Campaign,*

Planetary and Deep Space Exploration, Human vs Robotic Exploration Priority, Science vs Operational Mission Priority

E. **Public–private partnerships and acquisition**: *Public–Private Partnerships & Cost Sharing, Innovation-Friendly Regulatory Environment, OTA & Acquisition Flexibility, NASA–DoD–NRO Coordination*
F. **Regulation, governance, and security**: *Regulatory Modernization for Space, Spectrum Management & Interference, Space Debris & Traffic Management, Export Controls & Compliance, Cybersecurity & Resilience, Interagency Coordination & Oversight, Program Management & Oversight Reform, Acquisition Streamlining & Reform, Congressional Oversight and Statutory Authority*
G. **Communications and services**: *Expand Broadband Connectivity, Earth Observation & Public Value, Rapid and Emergency Satellite Communications, PNT/GPS Resilience & Backup, COMSAT & INTELSAT Policy*
H. **International relations and norms**: *Counter Adversaries in Space, U.S. Leadership & Global Competitiveness, Allied & International Collaboration, International Norms & Treaties, Allied Industrial Cooperation, International Cooperation in Space, Space Race & Geopolitical Competition, Space as Global Commons, Space as National Sovereign Domain, Space Treaty Frameworks, National Space Law & Jurisdiction*
I. **Sustainability, environment, and ethics**: *Space Sustainability & Debris Mitigation, Environmental Impacts & Climate Monitoring, Space Mining and Resource Extraction, Environmental Impacts of Space Resource Use, Ethical Concerns of Space Activities, Space as Symbol of Peace & Unity, Equitable Access to Space Benefits*
J. **Budgetary tradeoffs and priorities**: *Space vs Domestic Spending Tradeoffs, NASA vs DoD Space Budget Priority, Realistic Development Timelines, NASA Budgetary and Scheduling Framework*

VI. As with the deep core beliefs, each policy core category is associated with a set of regular expression patterns that capture common formulations of the preference (for example "assured access to space," "launch assurance," or "reliable access to orbit" for Assured Access to Space). A paragraph can receive more than one policy core code when multiple preferences are clearly articulated.

VII. Policy topics and secondary belief (implementation) details

In addition to beliefs and preferences, I coded more concrete policy topics and implementation details. A topic codebook groups recurring themes such as:

A. Launch access and independence (assured access, foreign engine dependence, engine replacement)
B. Budget and cost
C. Timelines and certification
D. Market structure and competition
E. Technical and engineering details
F. Industrial base and supply chain
G. Innovation and research and development
H. Public–private partnerships
I. National security and defense framing
J. Regulation and governance
K. Domestic industry and workforce
L. International collaboration
M. Acquisition and procurement

VIII. These topics are implemented as labeled codes with associated patterns (for example *assured_access*, *rd180_dependency*, *cost_budget*, *competition_market*). Some topics are allowed to co-occur on a single paragraph when the discussion clearly spans multiple themes.

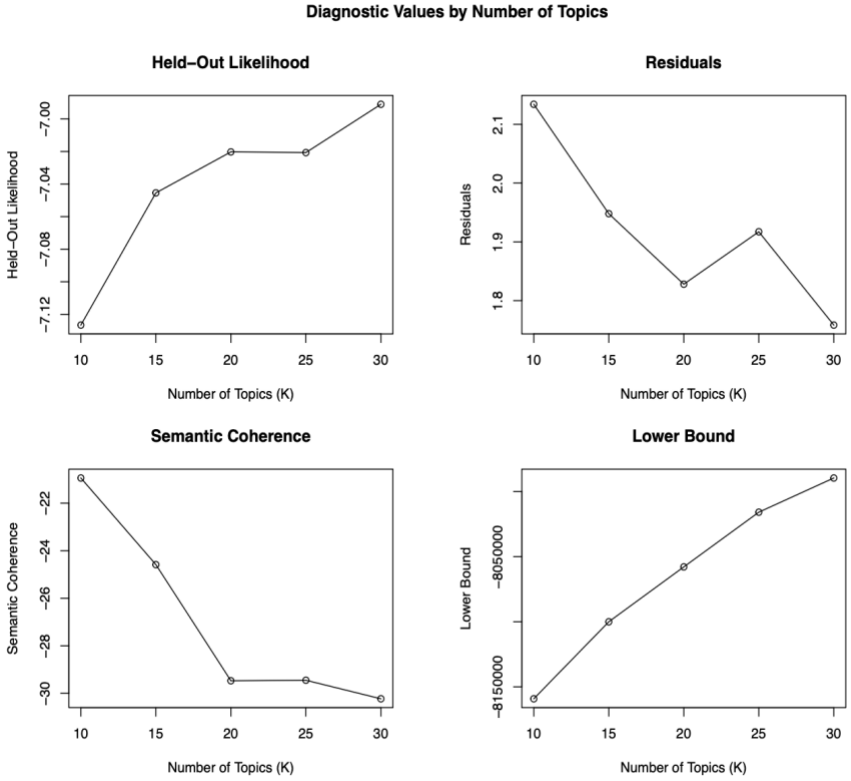
3. From text to policy statements

The identification of policy statements proceeds in three steps for each paragraph:

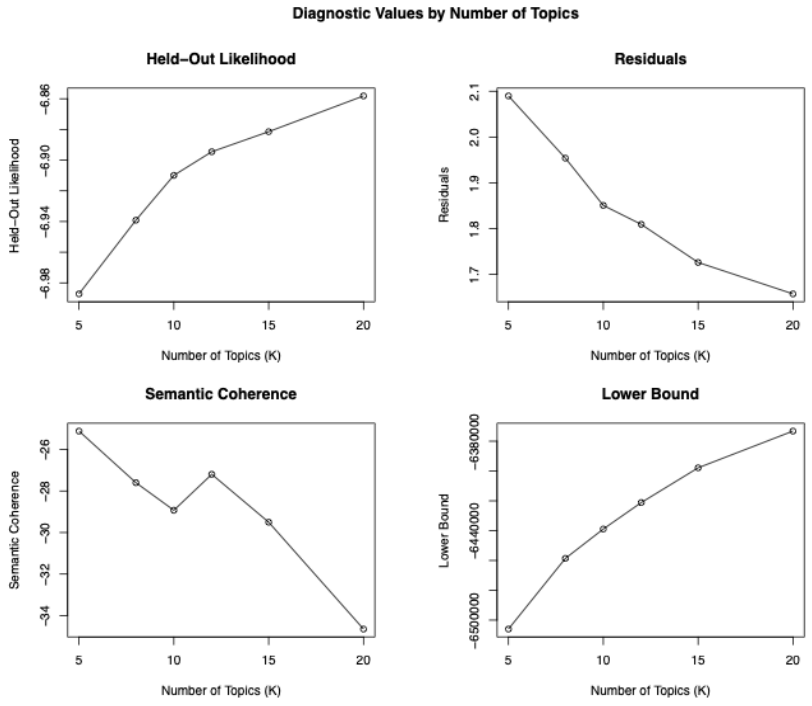
1. *Detect belief and preference content*
   The paragraph is scanned for all policy core patterns. If at least one policy core preference is present, the paragraph is treated as a candidate policy statement and receives the corresponding belief and preference codes. Topic codes from the policy topic codebook are also assigned wherever their patterns match.
2. *Assign actor position*
   The same paragraph is then evaluated against the position patterns. If an "anti" pattern (for example "oppose," "should not," "do not support") is present, the statement is coded as anti. If no anti pattern is found but a "pro" pattern (for example "support," "in favor," "advocate") is present, the statement is coded as pro. If the paragraph matches neutral phrasing, it is coded as neutral. Paragraphs that contain belief or preference content but lack any of these position signals are coded as unidentified.
3. *Allow multiple codes per statement*
   Because speakers often connect several ideas in the same paragraph, policy statements can receive multiple codes. A single paragraph can, for example, be coded as pro for *Assured Access to Space*, *Domestic Propulsion & Onshoring*, and *Industrial Base & Surge Capacity*, while also being associated with deep core beliefs such as *National Security* and *Leadership*. Where the topic codebook specifies that multiple topics are allowed, all matching topics are retained.

This procedure yields a dataset of policy statements where each observation is a paragraph that contains identifiable policy content. Each statement is linked to a speaker and hearing, assigned an actor position, and coded along deep core belief, policy core preference, and policy topic dimensions.

Appendix Figure 1: Presidential Corpus Model Diagnostics



Appendix Figure 2: COPUOS Corpus Model Diagnostics



Appendix Figure 3: U.S. Congress Corpus Model Diagnostics

