Legislative Reform to Foster a Sustainable Orbital Launch Industry in Canada

A Thesis Submitted to the College of Graduate and Postdoctoral Studies in Partial Fulfillment of the Requirements for the Degree of Master of Laws in the College of Law
University of Saskatchewan
Saskatoon

By:

Mason Palmer Stott

© Copyright Mason Palmer Stott, April, 2022. All Rights Reserved.
Unless otherwise noted, copyright of the material in this thesis belongs to the author.

Permission to Use

In presenting this thesis/dissertation in partial fulfillment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis/dissertation in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis/dissertation work or, in their absence, by the Head of the Department or the Dean of the College of Law. It is understood that any copying or publication or use of this thesis/dissertation or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis/dissertation.

Disclaimer

Maritime Launch Services, SpaceX, NASA, and all other named organizations and individuals were exclusively included to meet the thesis and/or exhibition requirements for the degree of Master of Laws at the University of Saskatchewan. Reference in this thesis/dissertation to any specific company, organization, entity, person, commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its/their endorsement, recommendation, or favouring by the University of Saskatchewan. The views and opinions of the author expressed herein do not state or reflect those of the University of Saskatchewan, and shall not be used for advertising or product endorsement purposes.

Requests for permission to copy or to make other uses of material in this thesis/dissertation in whole or part should be addressed to:

Dean
College of Law
University of Saskatchewan
15 Campus Drive
Saskatoon, Saskatchewan, S7N 5A6
Canada

Dean
College of Graduate and Postdoctoral Studies
University of Saskatchewan
116 Thorvaldson Building, 110 Science Place
Saskatoon, Saskatchewan, S7N 5C9
Canada

Abstract

Canada's orbital rocketry industry is underdeveloped and governed by outdated and unclear laws that fail to attract both investors and launch providers to the market. This thesis contends that improving existing laws will provide greater certainty and clarity to investors, business leaders, and other stakeholders, in turn drawing investment to this nascent Canadian industry. An increase in investment will accordingly offer economic and social benefits to local communities and Canadians. As a product of this study, the author's draft bill, titled the *Space Transportation Authorization and Registration Act* (*STAR Act*), illustrates the legislative improvements recommended to the Canadian federal government.

The *STAR Act* is provided in full in chapter 5 and was drafted as a tool to bring about change in the nearly non-existent orbital rocketry industry in Canada. It honours obligations imposed on Canada at international law and learns from other domestic and foreign space-related legislative and regulatory frameworks. The *STAR Act* has been tailored specifically to the Canadian context, namely by leveraging Canada's existing infrastructure as well as vast amounts of uninhabited land and lengthy coastlines, and by acknowledging the considerable barriers to entry in this capital-intensive industry. The draft bill will guide stakeholders on the operational procedures and regulatory oversight of this industry in Canada, is written in plain language to ensure understandability, and offers flexibility and adaptability to changes within the operating environment. Overall, the *STAR Act* was drafted to balance legal specificity with simplicity, and will facilitate the industry's safe, secure, and sustainable growth and development while minimizing bureaucratic "red-tape".

Acknowledgements

Thank-you to my academic supervisor, Professor Robin Hansen, for guiding the progression of my thesis with thoughtful planning and timely feedback, and for taking an interest in a topic I am so enthusiastic about. Also thank-you for always being accommodating and supportive as I balance competing commitments and plan for my future career.

Thank-you to committee members Dean Martin Phillipson and Distinguished Professor Ron CC Cuming, QC, for sharing your enthusiasm and unique and extensive expertise and knowledge so that I may further improve this thesis. Also thank-you for being readily available for one-on-one instruction sessions, and all your other fresh and insightful feedback on the paper.

Thank-you to the College of Law at the University of Saskatchewan for the financial funding of my thesis. It allowed me to focus a great deal more on my research and writing. Additionally, thank-you to the College of Law and Associate Dean Heather Heavin for providing me the opportunity to research an area of the law I am incredibly passionate about.

Thank-you to my family for their keen interest in my "space law paper" and for the many different ways you have all supported me throughout this LL.M. Thank-you to my Mom for "rooting" for me every step of the way, to my Dad for sharing his valuable thoughts and comments on the paper, to my sister, Cearra, and brother, Tarquin, for each of their support on not only the paper, but also on planning for my future career and personal life, and to my brother-in-law, Kent, for providing topical comments on the thesis and for sharing my love of "economic efficiency" and, especially, appreciation for "negative externalities". All my grandparents deserve posthumous recognition for supporting me so much for many of my years of post-secondary education – I'm thankful all of you were able to at least witness the beginning of my love for the world of academia.

Special recognition to Tarquin for brainstorming the creative and aptly descriptive acronym, *STAR,* used to name the paper's *Space Transportation Authorization and Registration Act*.

LIST OF ABBREVIATIONS

AA = Aeronautics Act

CAR = Canadian Aviation Regulations

ATR = Air Transportation Regulations

RSSSA = Remote Sensing Space Systems Act

RSSSR = Remote Sensing Space Systems Regulations

RA = Radiocommunication Act

RR = Radiocommunication Regulations

BA = Broadcasting Act

TA = Telecommunications Act

CSLA = Commercial Space Launch Act (USA)

OST = Outer Space Treaty

ARRA = Astronaut Rescue and Return Agreement

MA = Moon Agreement

PM = Permit Measures (China)

RM = Registration Measures (China)

CCRM = Commercial Carrier Rocket Measures (China)

SLSO = Statute on Licensing Space Operations (Russia)

FSOA = French Space Operations Act

USC = United States Code

CFR = Code of Federal Regulations (USA)

GAC = Global Affairs Canada

ISED = Innovation, Science and Economic Development (Canada)

FAA = Federal Aviation Administration (USA)

AST = Office of Commercial Space Transportation (USA)

ILV = Integrated Launch Vehicle

ELV = Expendable Launch Vehicle

RLV = Re-useable Launch Vehicle

LEO = low-Earth orbit

ISS = International Space Station

STAR Act = Space Transportation Authorization and Registration Act (proposed by author)

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

DETAILED CONTENTS

CHAPTER 1: BACKGROUND OF THE LAUNCH INDUSTRY AND LAW REFORM, AND THESIS OBJECTIVES

While numerous factors may contribute to the absence of orbital rocketry in Canada, it is contended here that one such reason is the existence of suboptimal laws governing this industry. The central question this thesis asks is this: How may the current legislative and regulatory framework governing orbital rocketry be improved in Canada? The current scheme lacks comprehensiveness, applicability, clarity, and detail while also failing to address the practicalities of this industry's ability to develop in Canada. The result is that potential investors, business leaders, and stakeholders remain uncertain about the potential profitability of conducting sustained launch activities in Canada.

This thesis' first four chapters examine the topic of Canadian law reform from several angles. The thesis then culminates in chapter 5 with a proposed draft bill titled the *Space Transportation Authorization and Registration Act* (*STAR Act*). The individual chapters are laid out as follows: chapter 1 achieves two objectives; it first provides a background discussion of the world's orbital launch industry; second, it discusses key considerations relevant to Canadian law reform in this area and introduces scholarship on legal and pragmatic instrumentalism and the economics of lawmaking which is ultimately used to inform the thesis' proposal for updated legislation. Chapter 2 reviews the United Nations' (UN) treaties Canada has ratified and identifies outstanding obligations imposed on the country and the benefits of honouring these duties. The chapter also uses content from the UN treaties as a base structure to build upon in proposed legislation. Chapter 3 investigates space-related federal Canadian laws to learn the various domestic approaches taken in structuring space-governing law and how some of these drafting techniques may be incorporated into new launch-specific law. Chapter 4 conducts a comparative legal analysis of four of the world's leading launching nations to learn what has worked well for those countries and how favourable aspects of these laws may be tailored to improve launch oversight in Canada.

Finally, chapter 5 presents a draft bill containing 55 sections that improve the potential for success of the orbital launch industry in Canada. The *STAR Act* addresses Canada's intentions,

objectives, and international responsibilities relevant to engaging in space transportation; requires Transport Canada to create contingency plans with regard to ensuring astronaut health and safety and protecting the environment; ensures that prospective launch providers acquire adequate liability insurance and proper licensing and authorizations to launch; and that all stakeholders directly involved in launch activities uphold human health and safety, protection of property, and national security and defence efforts. The *STAR Act* will address the unique concerns of three major stakeholder groups including the market-related concerns of investors and business leaders, financial and diplomatic concerns of the federal government, and environmental and health and safety concerns of the Canadian public.

1: Background: The Global Orbital-Launch Industry

This section introduces important launch industry concepts and discusses technical information on launch types, costs, frequency, risks, and environmental impacts. Following this, a summary of major historical milestones of this relatively new type of transportation activity illustrates the past, present, and possible future of the industry, known as the space "economy". The Organisation for Economic Co-operation and Development (OECD) defines the space economy as "the full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding, managing and utilizing space."[1] To offer a perspective on the current size and potential growth of the industry worldwide, 92 percent of which consists of small (less than 500kg) satellite operations,[2] the Bank of America estimates the space economy was valued at about US$424 billion in 2019 and will grow to about US$1.4 trillion in 2030 – roughly the same size as the 2020 global tourism market.[3] The orbital rocketry industry offers not only the newest commercial *transportation* opportunity for investors

[1] "Chapter 2: Definitions and Industrial Classifications" (2012), OECD Handbook on Measuring the Space Economy, online: <https://read.oecd-ilibrary.org/economics/oecd-handbook-on-measuring-the-space-economy_9789264169166-en#page21> (16 January 2022) at 19.
[2] Fraser Tennant, "The space economy: ready for lift-off" (January 2022), Financier Worldwide, online: <https://www.financierworldwide.com/the-space-economy-ready-for-lift-off#.YeSJ8_7MKUk> (16 January 2022).
[3] Michael Sheetz, "Bank of America expects the space industry to triple to a $1.4 trillion market within a decade" (4 October 2020), CNBC, online: <https://www.cnbc.com/2020/10/02/why-the-space-industry-may-triple-to-1point4-trillion-by-2030.html> (16 January 2022).

following the height of the railway industry in the 1870s,[4] automobiles in the 1920s,[5] and aircraft in the 1950s,[6] but also the newest commercial opportunity in *general*, after and concurrent with the growth of the internet in the 1990s and 2000s.[7]

1.1: Defining "Commercial Orbital Rocket Launch" and "Spaceport"

Defining the individual words within "commercial orbital rocket launching" is useful here: "rocket" describes a tall and thin vehicle, and more precisely the engine, that launches itself into space using thrust produced from the combustion of onboard propellants.[8] Unlike aircraft engines, rockets do not require oxygen from the surrounding environment to propel themselves forward.[9] There are two types of trajectories a launched rocket may follow: suborbital and orbital. Suborbital rockets launch to reach outer space, but do not complete one full revolution around the Earth and quickly return to the surface.[10] Suborbital rockets are used for scientific missions and now space tourism, notably onboard Jeff Bezos' New Shepard, for example, but cannot deliver satellites into orbit. Orbital rockets also reach space but remain there while completing at least one full orbit around the Earth.[11] Elon Musk's Falcon 9 rockets launch into orbital trajectories, typically to deliver satellites into low-Earth orbit (LEO), but also to deliver humans and supplies to the International Space Station (ISS), the Moon, or even deeper space. To avoid falling back to Earth's surface, orbital rockets must travel at faster speeds[12] than suborbital rockets and are thus more technically complex and more expensive.[13] Although Canada has never launched an orbital rocket, over 3,500 Black Brant suborbital rockets were

---

[4] "Railroads in the Late 19th Century" Library of Congress, online: <https://www.loc.gov/classroom-materials/united-states-history-primary-source-timeline/rise-of-industrial-america-1876-1900/railroads-in-late-19th-century/> (12 January 2022).
[5] "Ford and the automotive revolution" Britannica, online: <https://www.britannica.com/technology/automobile/Ford-and-the-automotive-revolution> (12 January 2022).
[6] "The Era of Mass Air Travel Begins" Smithsonian National Air and Space Museum, online: <https://airandspace.si.edu/exhibitions/america-by-air/online/heyday/heyday11.cfm> (12 January 2022).
[7] "Internet Growth Statistics" (3 July 2021), Internet World Stats, online: <https://www.internetworldstats.com/emarketing.htm> (12 January 2022).
[8] Edward Price, "Rocket: jet-propulsion device and vehicle" (14 May 2010), Britannica, online: <https://www.britannica.com/technology/rocket-jet-propulsion-device-and-vehicle> (13 July 2021).
[9] *Ibid.*
[10] *Ibid.*
[11] *Ibid.*
[12] *Ibid.*
[13] *Ibid.*

launched from the Churchill Rocket Research Range in Manitoba from 1959 to 1989.[14] Originally developed by the Canadian Armament Research and Development Establishment, a post-WWII initiative to retain military engineers and scientists in Canada,[15] manufacturing of the Black Brant rockets was eventually transferred from the Canadian government to the private company Bristol Aerospace, for commercial manufacturing.[16]

Rockets typically "launch" or "liftoff" vertically from either a land-based spaceport or ocean platform, although some launch after detaching from an airplane in flight ("air-launch-to-orbit" or "air launch"). Air-launches-to-orbit are uncommon, as only Virgin Orbit's Launcher One and Northrop Grumman's Pegasus[17] rockets have successfully launched these types of rockets multiple times.[18] All other functional rockets have been and continue to be vertically launched.

Each of the vertical and air launch approaches have advantages and disadvantages, mostly related to the presence, or lack of, an airplane within the launch process. Vertical rocket launches are less complex than air-launches-to-orbit, since the vertical process involves only a rocket, rather than a rocket and aircraft. Air launches are constrained by the mass of the rocket being transported by the aircraft[19] whereas vertically launched rockets do not face this constraint on size, shape, or weight. Accordingly, vertically launched rockets tend to be much larger than those launched from an aircraft.[20] Since smaller rockets carry smaller amounts of payload, air launch cost-effectiveness may be reduced as costs are spread amongst less potential customers. In terms

---

[14] "Canadian space milestones" (21 June 2018), Canadian Space Agency, online: <https://www.asc-csa.gc.ca/eng/about/milestones.asp> (24 March 2021).
[15] "Canadian Armament Research Development Establishment" (19 July 2007), TERMIUM Plus, online: <https://www.btb.termiumplus.gc.ca/tpv2alpha/alpha-eng.html?lang=eng&i=&index=alt&srchtxt=CANADIAN%20ARMAMENT%20RESEARCH%20DEVELOPMENT%20ESTABLISHMENT> (10 August 2021).
[16] Cynthia Boyko, "Sounding Rockets" (20 August 1996), Friends of CRC online: <https://www.friendsofcrc.ca/Projects/Sounding%20Rockets/rocket.html> (10 August 2021).
[17] "Pegasus" (2021), Northrop Grumman, online: <https://www.northropgrumman.com/space/pegasus-rocket/> (6 September 2021).
[18] "Horizontal Proposition" (2021), Air International, online: <https://www.airinternational.com/article/horizontal-proposition> (6 September 2021) [Horizontal Launches].
[19] Rebecca Mitchell, "A Conceptual Analysis of Spacecraft Air Launch Methods" (20 December 2012), *Department of Aerospace Engineering Sciences, University of Colorado, Boulder*, online: <https://www.colorado.edu/faculty/kantha/sites/default/files/attached-files/42797-36621_-_rebecca_mitchell_-_dec_20_2012_710_am_-_final_project_mitchell.pdf> (6 September 2021) at p 6 [Spacecraft Air Launch].
[20] *Ibid*.

of technical aspects, an airplane also imposes lateral forces on the rocket and increases the risk of damaging payload onboard.[21]

Although SpaceX has made the launch industry famous for the launching of its heavy- and super-heavy-lift Falcon 9 and Falcon Heavy rockets,[22] there are substantial benefits to rockets launched from the air, notably for smaller satellites. Recently, Virgin Orbit has branded itself as the optimal choice for the niche small satellite market.[23] Benefits of air launches begin with the amount of rocket propellant saved by transferring some portion of the rocket's journey to space from the thrust of the rocket itself to an aircraft whose jet engines are able to move more efficiently through the highly dense lower atmosphere, as compared with a rocket's combustion at that altitude.[24] At the point of deployment, the rocket is then able to travel more efficiently through the less dense upper atmosphere than the aircraft can and, at around the 100km mark, will eventually travel into the vacuum of outer space where rockets perform most efficiently and aircraft are completely unable to fly due to a lack of oxygen.[25] This efficiency enables the rocket to achieve greater thrust, thereby saving substantial amounts of fuel and in turn either increasing payload capacity or reducing the physical size of the rocket.[26] Less rocket fuel consumed also mean less toxic byproducts, including alumina and black soot, are emitted during the launch, when compared to a vertical liftoff.

There are also practical benefits of air-launched rockets, beginning with the added maneuverability and flexibility of an aircraft. While vertically launched rockets demand resource-intensive and time-consuming construction of a spaceport, airplanes avoid this need and

---

[21] Guy Norris, "Design Space" (2015) 177:2 *Aviation Week and Space Technology* 58.
[22] "Space Investment Quarterly – See the Dashboard" (1 July 2021), Space Capital, online: <https://www.spacecapital.com/quarterly> (6 September 2021).
[23] "Space for Everyone from Everywhere" (2021), Virgin Orbit, online: <https://virginorbit.com/vision/> (6 September 2021).
[24] Spacecraft Air Launch, *supra* note 19.
[25] Tom Benson, "Four Forces on a Rocket" (13 May 2021), NASA, online: <https://www.grc.nasa.gov/www/k-12/rocket/rktfor.html#:~:text=While%20most%20airplanes%20have%20a,dramatically%20during%20a%20typical%20flight.> (6 September 2021).
[26] M Sarigul-Klijn & N Sarigul-Klijn, "Flight Mechanics of Manned Sub-Orbital Reusable Launch Vehicles with Recommendations for Launch and Recovery" (9 January 2003), *41st Aerospace Sciences Meeting and Exhibit*, online: <http://www.spacefuture.com/archive/flight_mechanics_of_manned_suborbital_reusable_launch_vehicles_with_recommendations_for_launch_and_recovery.shtml> (7 September 2021).

require only a runway of appropriate length. The currently operational Launcher One rocket and the Boeing 747 which carries it, have a total weight of 250,000 kg,[27] meaning a runway of at least 1,800 to 2,200 meters[28] is required. Not only does this save infrastructure costs, but it also increases the number of potential takeoff sites. Furthermore, because of the mobility of an airplane, air launched rockets can simply be flown around bad weather until a suitable location is reached. The maneuverability of an airplane also allows air launched rockets to reach any orbital inclination, which is much more restricted for vertical launches at spaceports.[29]

The maneuverability of an airplane is also advantageous because it allows launch providers greater access to eastward launch trajectories, which is important because it is more efficient to use the Earth's west to east rotation to provide an additional boost during launch and thereby reduce the amount of fuel required to reach orbit.[30] If it is not possible to launch eastward, either due to the existence of hostile or unfriendly nations lying in the eastward direction, or because of the existence of heavily populated areas, then an airplane could carry a rocket to avoid these places and launch either over international waters or over a remote and uninhabited area of a friendlier country. This option is particularly beneficial for certain countries, either due to political issues, geographic issues, or both. For example, consider the cases of Israel and South Korea: Israel launches westward over the Mediterranean Sea to avoid eastward launches infringing the airspace of unfriendly nations, including Palestine, Syria, Iraq, Iran and others,[31] while South Korea launches due south over the East China Sea to avoid overflying Chinese airspace to the west, North Korean to the north, and Japanese to the east, as well as heavily populated areas in all three directions.[32]

---

[27] "Launcher One Service Guide" (August 2020), Virgin Orbit, online: at 7 <https://virginorbit.com/wp-content/uploads/2020/09/LauncherOne-Service-Guide-August-2020.pdf> (7 September 2021) [Launcher One Service Guide].
[28] "747-400 Airplane Characteristics for Airport Planning" (December 2002), Boeing, online: at 66 <http://large.stanford.edu/courses/2017/ph240/kau2/docs/d6-58326-1.pdf> (7 September 2021) [747 Specs].
[29] Launcher One Service Guide, *supra* note 27 at 8.
[30] Ashish Tiwari, "Why Are Rockets Launched From Areas Near the Equator?" (19 January 2022), Science ABC, online: <https://www.scienceabc.com/nature/universe/how-are-satellites-put-into-orbit-and-kept-up-there-for-so-long.html> (1 May, 2022).
[31] Miriam Berger, "Israel's relations in the Middle East, explained" (15 August 2020), The Washington Post, online: <https://www.washingtonpost.com/world/2020/08/15/israels-relations-middle-east-explained/> (1 May 2022).
[32] "South Korea tests solid-fuel space rocket, amid rising tensions" (31 March 2022), Aljazeera, online: <https://www.aljazeera.com/news/2022/3/31/south-korea-tests-solid-fuel-space-rocket-amid-rising-tensions> (1 May 2022).

The term, "commercial launch" in this thesis' means any rocketry transportation activity moving objects or humans into space for the purposes of producing a profit, such as a non-governmental launch provider accepting payment from a non-governmental telecommunications satellite operator for launching the operator's satellite into orbit. The term "private" includes all commercial launches, plus all non-profit seeking non-governmental rocket launches transporting objects or humans into space. A private launch may take the form of a non-governmental launch provider selling a payload slot to a university wishing to operate a weather satellite for scientific purposes. The even broader "civil" launch covers all commercial and private launches, as well as all non-governmental *and* governmental launches transporting objects or humans into space for any reason, *but not including launches for military purposes*. Civil launches would include, for example, those conducted wholly by a national government to deliver a remote sensing satellite into orbit for that government's natural resources department, but would not include any type of military-related launch, such as those delivering a recognizance satellite into orbit.

A typical launch scenario may begin, for example, when a governmental (i.e., US Air Force) or private (Sirius XM Radio) customer purchases a payload slot on a launch provider's (SpaceX) rocket (Falcon 9). After complex logistical coordination, contract negotiations, and regulatory compliance efforts, the orbital rocket will launch from a spaceport (Cape Canaveral) and deliver a payload (often multiple satellites or hardware) into orbital trajectories around the Earth (usually LEO), or less frequently, will transport humans (either astronauts or tourists) into space.

1.2: Uncrewed and Crewed Rocketry

"Space transportation" includes both uncrewed and crewed missions launching from Earth to outer space. Uncrewed missions deliver payloads to the outer space environment, including deploying commercial and government satellites in LEO or beyond,[33] resupplying the ISS with equipment, food, and other life necessities,[34] and launching scientific probes into deeper space to

[33] Gary Daines, "Earth Missions List" (3 August 2017), NASA, online: <https://www.nasa.gov/content/earth-missions-list> (13 July 2021).
[34] Mark Garcia, "Commercial Resupply Services Overview" (9 April 2019), NASA, online: <https://www.nasa.gov/mission_pages/station/structure/launch/overview.html> (13 July 2021).

explore the solar system.[35] Besides the Apollo missions that carried astronauts to the Moon, the destination for nearly all astronauts sent to space is the ISS.[36]

Of the 134[37] successful orbital launches in 2021, 126 were uncrewed and eight were crewed:[38] 3 of these 8 launches were performed by the American company SpaceX, 3 by Russia's Energia, and 2 by the Chinese government. From 1961 to January 2022, there have been a worldwide total of 357 crewed launches.[39] Three countries have the capability to launch humans into space, including SpaceX's Dragon spacecraft which can seat a maximum of seven people,[40] Russian Energia's Soyuz spacecraft seating up to three,[41] and the Chinese government's Shenzhou spacecraft also seating up to three.[42]

1.3: Launch Costs: Decreasing with Advanced Engineering

Costs of orbital launches vary depending on many factors including the design elements of the rocket itself. Reusable launch vehicles (RLVs), where at least some of the rocket can be recycled and used for a subsequent launch, require greater initial investment but become increasingly cost-effective with each additional successful use. Alternatively, expendable launch vehicles (ELVs) are used only once and, after reaching orbit, eventually either drift continuously around the Earth or disintegrate upon re-entry. Although ELVs are cheaper for a single launch, RLVs are more cost-effective in the long-term.

---

[35] Gary Daines, "Solar System Missions" (3 August 2021), NASA, online: <https://www.nasa.gov/content/solar-missions-list > (13 July 2021).
[36] Gary Daines, "Humans in Space" (3 August 2017), NASA, online: < https://www.nasa.gov/content/human-missions-list> (13 July 2021).
[37] "Global Orbital Rocket Launch Statistics" RocketLaunch.Live, online: <https://www.rocketlaunch.live/stats/2020> (16 January 2022) [Launch Stats].
[38] David Williams, "NASA Space Science Data Coordinated Archive" (10 February 2021), NASA, online: <https://nssdc.gsfc.nasa.gov/nmc/spacecraft/spacecraft/query> (29 March 2021) [Space Archive].
[39] *Ibid*.
[40] Paul Rincon, "NASA SpaceX launch: What is the Crew Dragon?" (31 May 2020), BBC, online: <https://www.bbc.com/news/science-environment-52840482> (24 July 2020).
[41] "What Is the Soyuz Spacecraft?" (27 June 2018), NASA, online: <https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-the-soyuz-spacecraft-k-4> (24 July 2020).
[42] "Shenzhou Manned Spacecraft Programme" Aerospace Technology, online: <https://www.aerospace-technology.com/projects/shenzhou-spacecraft-programme-china/> (24 July 2020).

The "size" of a rocket is not presented as its gross weight but as the weight of payload it can deliver, typically stated with the destination as LEO. As such, a rocket's cost-effectiveness may be expressed in "dollars per kilogram" launched. As technological and engineering efficiency developed, this benchmark has steadily improved. From 2010 to 2018, the price per kilogram had been reduced by a factor of 20 for general commercial launches and by 4 for commercial resupply missions to the ISS.[43] Currently, United Launch Alliance's (ULA) Delta IV rocket transports payload at the rate of US$17K/kg, Arianespace's Ariane 6 rocket for US$4.7K/kg, and Northrop Grumman's Minotaur VI for US$23K/kg.[44] SpaceX outcompetes all competition by transporting payload onboard its Falcon 9 rockets for US$2,720/kg[45] and Falcon Heavy rockets for US$1,406/kg.[46] SpaceX has reduced this price per kilogram mainly due to its unparalleled success of leveraging the cost-effectiveness of RLVs.

Maritime Launch Services (MLS), a newly formed launch provider, intends to launch the first orbital rocket from Canadian soil at its proposed launch site near Canso, a community on the north-eastern tip of Nova Scotia. The company will launch Cyclone-4M ELVs each capable of delivering 3,350 kilograms of payload to LEO for an estimated C$60 million per launch.[47] These rockets offer launch costs of US$14,200/kg (C$17,910/kg) which, although considerably more expensive than the Falcon 9, is less than other low-lift competitor's rockets including Rocket Lab's Electron at US$25,000/kg and newcomer Virgin Orbit's LauncherOne at US$24,000/kg.[48]

---

[43] Harry Jones, "The Recent Large Reduction in Space Launch Cost" (8 July 2018), *48th International Conference on Environmental Systems*, online: at 1 <https://ntrs.nasa.gov/citations/20200001093> (13 July 2021).
[44] A Tartar & Y Qiu, "The New Rockets Racing to Make Space Affordable" (26 July 2018), Bloomberg Business Week, online: <https://www.bloomberg.com/graphics/2018-rocket-cost/> (31 May 2020) [New Rockets].
[45] Wendy Cobb, "How SpaceX lowered costs and reduced barriers to space" (1 March 2019), The Conversation, online: <https://theconversation.com/how-spacex-lowered-costs-and-reduced-barriers-to-space-112586#:~:text=When%20the%20space%20shuttle%20was,is%20just%20%242%2C720%20per%20kilogram> (30 March 2021).
[46] New Rockets, *supra* note 44.
[47] B Ruskin & C Williams, "T-minus 1 year until rocket launch site construction starts in Nova Scotia" (15 March 2017), CBC online: <https://www.cbc.ca/news/canada/nova-scotia/t-minus-1-year-until-rocket-launch-site-construction-starts-in-nova-scotia-1.4023808> (25 November 2019).
[48] Doug Mohney, "The Coming U.S. Small Launch Crash, Thanks to SpaceX Rideshare" (3 February 2021), Space IT Bridge, online: <https://www.spaceitbridge.com/the-coming-u-s-small-launch-crash-thanks-to-spacex-rideshare.htm#:~:text=Leveraging%20the%20reusability%20of%20the,slightly%20less%20at%20%2424%2C000%2Fkg> (30 March 2021).

1.4: Launch Frequency: Four Major Space-faring Nations

In 2021, China was the most active orbital launcher in the world, successfully launching 52 rockets, with the USA slightly behind at 48.[49] As is evident in Table 1.1 and Figure 1.1, below, Russia has markedly reduced its launch frequency relative to other nations, having reached its greatest launch cadence in the last 7 years in 2015 with 23 launches, and then falling ever since.[50] France and the European Union have launched similar numbers of rockets since 2015, at around 11 per year.[51] Japan and India have remained consistent at around 4 or 5 successful launches annually.[52] Table 1.1 lists these statistics, plus annual numbers of successful orbital launches from Iran (2), Israel (2), and North Korea (1). As noted in the following subsection 1.5, around 5 percent of all orbital launches fail worldwide.

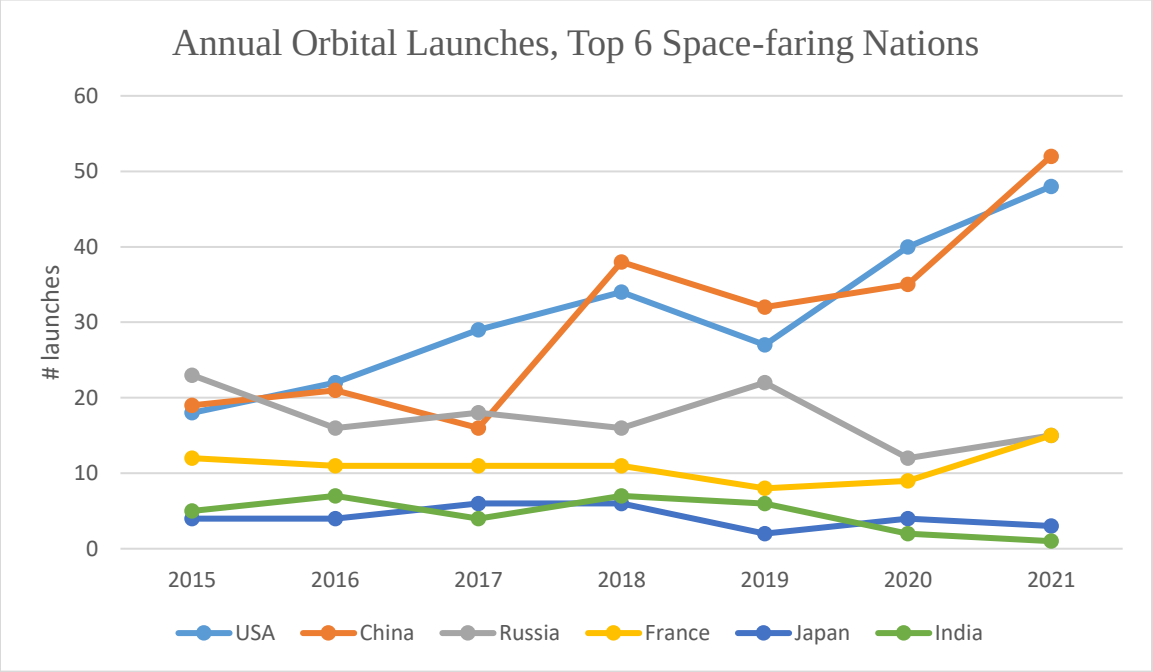
Table 1.1: Successful Orbital Launches 2015 – 2021,[53] by Nation

	USA	China	Russia	France	Japan	India	Iran	Israel	North Korea	Totals
2015	18	19	23*	12	4	5	1	0	0	82
2016	22	21	16	11	4	7	0	1	1	83
2017	29	16	18	11	6	4	0	0	0	84
2018	34	38	16	11	6	7	0	0	0	112
2019	27	32	22	8	2	6	0	0	0	97
2020	40	35	12	9	4	2	1	1	0	104
2021	48	52	15	15	3	1	0	0	0	134**
Totals	218	213	122	77	29	32	2	2	1	696

* includes 1 Ukrainian Dnepr rocket; Ukraine's rockets are of original Russian build
** greatest annual number of successful orbital rocket launches in human history

[49] "Launch History," RocketLaunch.Live, online: <https://www.rocketlaunch.live/?pastOnly=1> (6 July 2021) [Launch History].
[50] *Ibid*.
[51] *Ibid*.
[52] *Ibid*.
[53] Launch Stats, s*upra* note 37.

Figure 1.1: Successful Orbital Launches 2015-2021, Visualized by Nation



1.5: Risk of Launch Failure

The immense energy produced by a rocket's engine and required for liftoff means there is always a certain degree of associated risk of failure. Space law authors Frans von der Dunk and Fabio Tronchetti report, "On average, over the past 16 years [2001-2016], five percent of all launches [from every country in the world] resulted in failure."[54] Launching a rocket is the most vulnerable stage of any space endeavor,[55] when compared to payload deployment or re-entry. In 2011, 84 orbital launches were attempted worldwide, with 6 (7.1 percent) failing,[56] and in 2012, 77 launches were attempted and 5 (6.5 percent) failed.[57] Annual failure percentages for the last 7 years have been: 2015 (9.4 percent), 2016 (3.5 percent), 2017 (8.8 percent), 2018 (2.6 percent), 2019 (4.9 percent), and 2020 (8.8 percent), and 2021 (9.3 percent).[58] However, higher percentages are not indicative of the level of risk for the use of established rockets, as many of the failures in recent years have been by rockets that are still in their development stages and

[54] F von der Dunk & F Tronchetti, *Handbook of Space Law* (Gloucestershire, UK: Elgar Publishing, 2017) at 383 [von der Dunk & Tronchetti].
[55] *Ibid*.
[56] *Ibid*.
[57] *Ibid*.
[58] Launch Stats, *supra* note 37.

have yet to successfully reach orbit. Meanwhile, SpaceX's Falcon 9 launched its 126th successful consecutive mission on May 15, 2022[59] – the last failed Falcon 9 launch was on June 28, 2015.[60]

1.6: Rocketry Impacts on the Environment

Although it is possible to calculate the amount of a launch's emissions, the practical effects of these pollutants on Earth's environment are largely unknown.[61] Common chemicals emitted by rockets include: nitrous oxide, water vapour, carbon dioxide, black carbon (soot), and alumina.[62] Rockets produce about the same amount of carbon dioxide as a Boeing 777 trans-Atlantic flight,[63] but of greater concern are the more harmful and less understood black carbon and alumina.[64] Authors Martin Ross and Darin Toohey explain in their article published by the American Geophysical Union in 2019, that "Because of the unique nature of their combustion chemistry, rocket engines emit large amounts of black carbon when compared to, for example, a modern jet engine."[65] An airline jet produces only one percent of the black carbon emitted from an orbital launch.[66] Alumina is also problematic as it depletes the Earth's protective ozone layer by working in conjunction with black carbon.[67]

A meta-study conducted by researchers at the University of New South Wales in Australia reviewed over 40 studies that "considered a range of rocket and propellant types, and the resulting impacts on climate, stratospheric ozone, ecosystems and human health."[68] Every type of rocket fuel and propellant considered by the study contributed to the depletion of Earth's

---

[59] Launch History, *supra* note 49.
[60] *Ibid*.
[61] Loren Grush, "Why it's time to study how rocket emissions change the atmosphere," (31 May 2018), The Verge, online: <https://www.theverge.com/2018/5/31/17287062/rocket-emissions-black-carbon-alumina-particles-ozone-layer-stratosphere> (24 November 2020) [Rocket Emissions].
[62] *Ibid*.
[63] Brian Wang, "SpaceX Rocket Emissions Similar to Large Jets Crossing the Oceans" (16 December 2019), Next Big Future, online: <https://www.nextbigfuture.com/2019/12/spacex-rocket-emissions-similar-to-large-jets-crossing-the-oceans.html> (24 November 2020).
[64] Rocket Emissions, *supra* note 61.
[65] M Ross & D Toohey, "The Coming Surge of Rocket Emissions" (24 September 2019), Eos (American Geophysical Union), online: <https://eos.org/features/the-coming-surge-of-rocket-emissions> (7 April 2021).
[66] *Ibid*.
[67] *Ibid*.
[68] JA Dallas, et al., "The environmental impact of emissions from space launches: A comprehensive review" (2020) 255 *Journal of Cleaner Production*, online: <https://doi.org/10.1016/j.jclepro.2020.120209> at 9 (24 November 2020).

stratospheric ozone,[69] sped up climate change by emitting black carbon,[70] and negatively impacted ecosystems and human health by releasing toxic chemicals contaminating the air, water, and soil.[71]

This meta-study determined an abundance of research investigating the environmental effects of solid rocket fuels, such as those used by the Space Shuttle program until its 2011 retirement, exists although there is scarce research on liquid rocket fuels, including those used more extensively since 2011.[72] More targeted impact assessments would assist in law reform initiatives by providing information on the environmental impacts of today's launches, thus providing insight into how industries should be regulated to maintain healthy environments and ecosystems, and to slow trends in climate change.

1.7: History of the Commercial Rocket Launch Industry

From initial orbital rocketry in the 1950s until around 2000, or arguably as late as 2011, the entire field was driven by government-lead efforts. Only the State could afford to fund such expensive and risky orbital launch activities, especially when there were no viable opportunities to produce any revenue. The USSR, now the Russian Federation, began, and continues to, develop and manufacture its own rockets, while the USA has always procured launches and equipment from private companies. The USA has, however, significantly transformed its pre-2011 government-backed launch industry into a nearly entirely commercialized one.

The USA's 1984 *Commercial Space Launch Act* (*CSLA*)[73] and its 1988[74] and 2004[75] amendments, since recodified in *United States Code Title 51 – National and Commercial Space*

---

[69] *Ibid* at 4.
[70] *Ibid* at 6.
[71] *Ibid* at 8-10.
[72] *Ibid* at 3.
[73] *Commercial Space Launch Act, 1984*, Pub L No 98-575, 98 Stat 3055 (30 October 1984), govtrack, online: <https://www.govinfo.gov/content/pkg/STATUTE-98/pdf/STATUTE-98-Pg3055.pdf> (28 July 2021).
[74] *Commercial Space Launch Amendments Act of 1988*, Pub L No 100-657, 102 Stat 3900 (15 November 1988), govtrack, online: <https://www.govinfo.gov/content/pkg/STATUTE-102/pdf/STATUTE-102-Pg3900.pdf> (28 July 2021).
[75] *Commercial Space Launch Amendments Act of 2004*, Pub L No 108-492, 118 Stat 3974 (23 December 2004), govtrack, online: <https://www.faa.gov/about/office_org/headquarters_offices/ast/media/pl108-492.pdf> (28 July 2021).

Programs (*Title 51 USC*),[76] officially began the American privatization process by mandating NASA facilitate and encourage private spaceflight.[77] The *CSLA* tasked the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation (AST) with launch-related regulatory and authorization responsibilities,[78] and streamlined the licensing process for commercial companies mainly by simplifying the application process and eliminating excessive "red-tape".[79] In 2010, President Obama enacted the above *Title 51 USC*, effectively reorganizing and simplifying the current state of the law to encourage existing launch providers to expand their operations and for new companies to enter the US market.[80]

NASA develops and manages civilian space missions, and historically the organization purchased launch services from companies such as McDonnell Douglas, Grumman Aircraft, North American Rockwell, and Boeing, among others.[81] Today, NASA routinely purchases launch slots from companies including SpaceX,[82] ULA,[83] Northrop Grumman,[84] and Rocket Lab.[85] These same companies also provide launch services for the US Department of Defense's military missions.[86] While NASA has internally developed most of its own technology and equipment, it typically limits its activity to planning, implementing, and operating scientific

---

[76] *National and Commercial Space Programs*, 51 USC, Ch 509, Legal Information Institute at Cornell Law School online: <https://www.law.cornell.edu/uscode/text/51/subtitle-V/chapter-509> (1 February 2020) [*Title 51 USC*].
[77] *Ibid*, s 50901.
[78] *Ibid*, s 50921.
[79] "Origins of the Commercial Space Industry" Federal Aviation Administration, online: at 2 <https://www.faa.gov/about/history/milestones/media/commercial_space_industry.pdf> (1 March 2020).
[80] "Statement by the Press Secretary" (18 December 2010), The White House, Office of the Press Secretary, online: <https://obamawhitehouse.archives.gov/the-press-office/2010/12/18/statement-press-secretary> (2 March 2020); *Title 51 USC* was enacted when President Obama signed House of Representatives Bill 3237 during the 111th Congress.
[81] J van Nimmen, L Bruno & R Rosholt, "NASA Historical Databook" (1974), History of NASA, online: at 185 <https://history.nasa.gov/SP-4012v1.pdf> (28 October 2020).
[82] "Contracts" (2 May 2018), NASA, online: <https://www.nasa.gov/centers/johnson/news/contracts/index.html> (28 October 2020).
[83] *Ibid*.
[84] "NASA Awards Environmental Test, Integration Services Contract" (19 June 2019), NASA, online: <https://www.nasa.gov/press-release/nasa-awards-environmental-test-integration-services-contract> (28 October 2020).
[85] "NASA Awards Contract to Launch CubeSat to Moon from Virginia" (14 February 2020), NASA, online: <https://www.nasa.gov/press-release/nasa-awards-contract-to-launch-cubesat-to-moon-from-virginia> (28 October 2020).
[86] "Rocket Lab Successfully Launches U.S. Space Force Mission" (29 July 2021), RocketLab, online: <https://www.rocketlabusa.com/updates/rocket-lab-successfully-launches-u-s-space-force-mission/> (27 November 2021); Loren Grush, "The Defense Department picks three companies to develop rockets for national security launches" (10 October 2018), The Verge, online: <https://www.theverge.com/2018/10/10/17961832/defense-department-launch-service-agreement-ula-blue-origin-northrop-grumman> (27 November 2021).

missions through the extensive procurement of goods and services from commercial companies. The launch provider market has changed substantially in recent years, with new companies emerging either *de novo* or through mergers and acquisitions. Today, NASA plays a much smaller role in supporting the non-governmental orbital rocketry industry: for example, nearly 80 percent of all customers paying to launch small satellites are commercial entities.[87]

With a mix between privately owned and publicly traded companies, a total of 11 distinct nongovernmental entities have successfully launched orbital rockets as of May 15, 2022 most of which are American: SpaceX, ULA, Northrop Grumman, Rocket Lab, Virgin Orbit,[88] and Astra.[89] Two private Chinese companies, iSpace and Galactic Energy, achieved their first successful orbital launches on July 25, 2019,[90] and November 7, 2020,[91] respectively. Arianespace, a private joint venture between Airbus and Safran,[92] launches specifically for the European Union. The company was established in 1980 and was the world's first commercial launch provider.[93] Publicly traded Japanese companies Mitsubishi Heavy Industries[94] and IHI Corporation[95] both launch for the Japan Aerospace Exploration Agency (JAXA),[96] that country's equivalent to NASA. When this thesis was started in mid-2019 only seven non-governmental entities, four American, one French, and two Japanese, existed. That number has now grown and

---

[87] Luigi Scatteia, "Main trends and challenges in the space sector" (June 2019), PwC Space, online: <https://www.pwc.fr/fr/assets/files/pdf/2019/06/fr-pwc-main-trends-and-challenges-in-the-space-sector.pdf> (27 November 2021).
[88] "Upcoming Launches" (27 November 2021), Next Spaceflight, online: <https://nextspaceflight.com/launches/> (27 November 2021) [Upcoming Launches].
[89] *Ibid*.
[90] "Chinese rocket firm Galactic Energy successfully puts satellite into orbit, 1st private launch since COVID-19" (7 November 2020), Global Times, online: <https://www.globaltimes.cn/content/1206011.shtml#:~:text=Chinese%20private%20rocket%20firm%20Galactic,of%20the%20COVID%2D19%20epidemic> (30 November 2021).
[91] Launch History, *supra* note 49.
[92] "About Us: Our Shareholders" ArianeGroup, online: <https://www.ariane.group/en/about-us/our-shareholders> (23 July 2021) [ArianeGroup].
[93] Arianespace, online: <https://www.arianespace.com/> (6 July 2021).
[94] "MHI Launch Services: Launch Vehicles" Mitsubishi Heavy Industries, online: <https://www.mhi.com/products/space/launch_srv_lineup.html> (27 November 2021).
[95] "Rocket Systems and Space Exploration" IHI Corporation, online: <https://www.ihi.co.jp/en/products/aeroengine_space_defense/rocket_system/index.html> (27 November 2021).
[96] JAXA, online: <https://global.jaxa.jp/> (27 November 2021).

will quickly continue to expand, as another eight entities are scheduled to launch new orbital rockets of their own in 2022.[97]

In addition to the preceding non-governmental entities, there are also numerous state-owned launch providers, notably by China and Russia. The Russian launch program is still very centralized – the Russian Federation directly owns 38 percent of the country's sole launch provider, Energia and, through layers of subsidiary organizations, indirectly owns approximately 90 percent of the entity, despite Energia actually being publicly traded with stock ticker "RKKE" on the Moscow Exchange.[98] China is the most centralized launching nation on Earth and the vast majority of the country's launches are provided by the government of the People's Republic of China.[99] Even the few "private" Chinese launches are highly integrated with the State, as the country's "Military-Civil Fusion" initiative facilitates and demands collaboration between private companies and the People's Liberation Army, where sensitive and confidential secrets on advanced technology are shared between the sectors.[100]

1.8: Current Financial Activity in Space-related Industries, by Country

Foreign direct investment (FDI) are financial transactions between two parties in different national jurisdictions: an investor in one country sends FDI into a potentially profit-generating endeavor or entity in a different country. Factors attracting FDI are summarized by University of Delhi Faculty of Management Studies' researchers Neha Saini and Monica Singhania, as: "The established body of literature postulates potential determinants of FDI and categorizes them as economic, political, and institutional factors."[101] "Economic" factors reflect market efficiency, "political" reflect government stability and the quality of regulations, and "institutional" reflect

---

[97] "Upcoming" (17 January 2022), Next Spaceflight, online: <https://nextspaceflight.com/launches/?search=> (17 January 2022).
[98] "OAO Rocket and Space Corporation Energia after S.P. Korolev" *Energia*, online: <https://www.energia.ru/english/energia/history/oao.html> (18 November 2020) [Energia Space]; "RKK Energiya im. S.P. Koroleva PAO," Financial Times, online: <https://markets.ft.com/data/equities/tearsheet/summary?s=RKKE:MCX> (27 November 2021).
[99] Launch History, s*upra* note 49.
[100] "Military-Civil Fusion and the People's Republic of China" US Department of State, online: <https://www.state.gov/wp-content/uploads/2020/05/What-is-MCF-One-Pager.pdf> (12 September 2021).
[101] N Saini & M Singhania, "Determinants of FDI in developed and developing countries: a quantitative analysis using GMM" (2018) 45:2 *Journal of Economic Studies* 348-382 at 349, online: <https://doi.org/10.1108/JES-07-2016-0138> (11 September 2021).

how well interdependent government organizations interact with one another to facilitate societal functioning.[102] This thesis considers how improved legislation in Canada may lead to increased foreign and domestic investor confidence in Canada's launch industry.

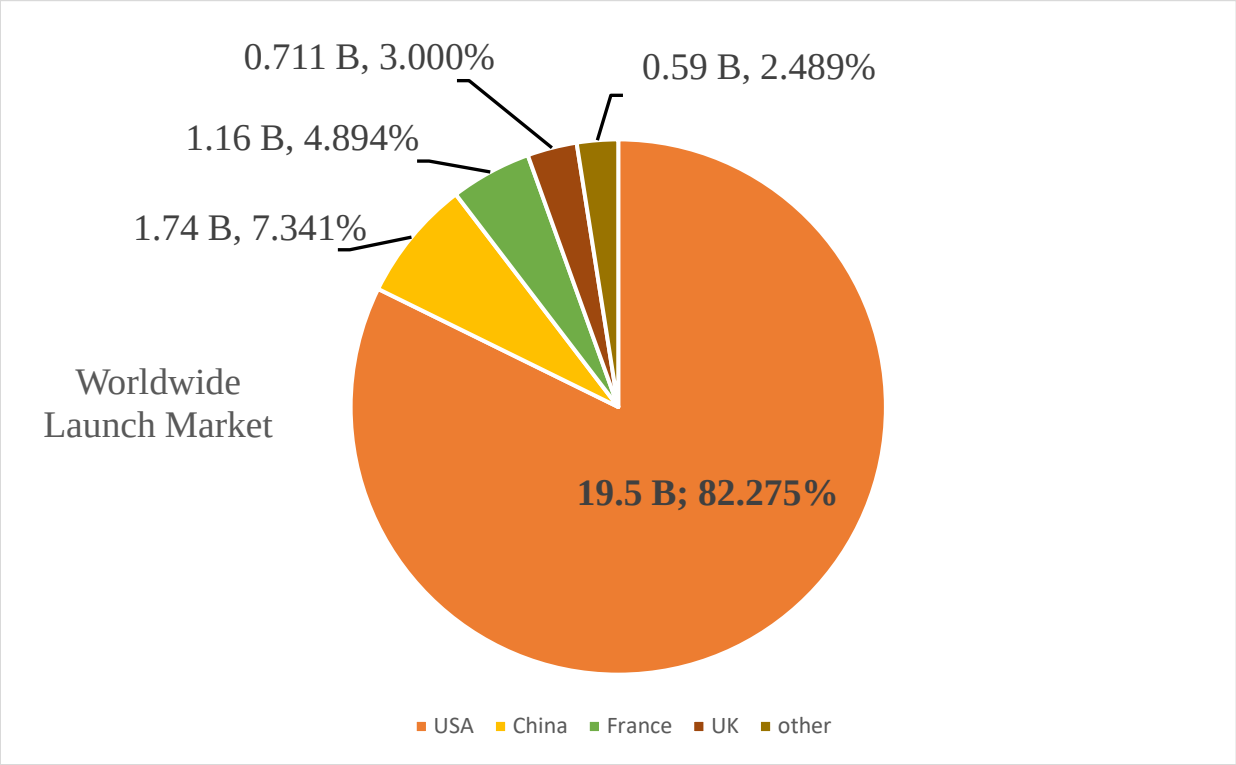
Space Capital is a venture capital firm focused on space-related markets and publishes its "Space Investment Quarterly" (SIQ), which presents unique data specific to the launch sector. The 2022 first quarter SIQ reported that $23.7 billion had been invested into launch providing entities since 2013.[103] The SIQ lists the home countries of these investment-receiving entities and is very telling of the American dominance within the worldwide industry – the USA accounts for 82.28 percent of all monies invested in the world. Meanwhile, the top four receiving countries account for 97.52 percent of the world total:

Table 1.2: Destination Countries for the World's Launch Market Investment (2013 – 2022)

World Rank	Country	Percentage Share of $23.6 billion World Investment	USD received (billions)
1	USA	82.28%	$19.5 B
2	China	7.34%	$1.74 B
3	France	4.90%	$1.16 B
4	United Kingdom	3.00%	$0.711 B or $711 M
---	Australia	0.40%	$94 M
---	Japan	0.097%	$23 M
---	Canada	0.0036%	$861,448
---	Russia	0.0035%	$827,612

[102] *Ibid*.
[103] "Space Investment Quarterly Q1 2022 – Interactive Desktop Version" (1 April 2022), Space Capital, online: <https://www.spacecapital.com/quarterly> (10 May 2022).

Figure 1.2: Destination Countries for the World's Launch Market Investment (2013 – 2022)



These investment figures are not determinative of the direct impact space-governing legislation has on drawing FDI into a country. Rather, the figures demonstrate the stark differences in investors' outlook and optimism on potential profitability in different launch markets around the world. America's FDI-inflow aligns with the general nature of its highly comprehensive, detailed, refined, relatively clear, consistently-applied, and predictable space- and launch-governing laws. Launch cadence statistics illustrate a near tie between the USA and China, although China's industry accounts for only 7 percent of all world launch-related investment, compared to the USA's 82 percent, both of which are largely implications of China's state-driven approach and the other's privatized and commercialized approach. As shown in Figure 4, above, Canada has actually surpassed Russia in terms of investment dollars received since 2013, an occurrence venturing out of scope of this thesis but of an interesting nature. Russia, once a direct competitor of the USA's launch program, has lost its prominence on the world rocketry stage – it remains unclear if Russia's government-centric launch program's stagnation will be repeated under China's similar state-centric approach. Note that exact correlations between FDI-

inflows and the effectiveness of national space-governing legislation are beyond the scope of this thesis.

1.9: Current Interest and Activity in Canada: Transport Canada and Maritime Launch Services

Neither the Canadian Space Agency (CSA), nor any private entity, has operated a domestic orbital rocketry program in Canada. This lack of launch capability means any Canadian astronaut or Canadian satellite bound for space must be launched onboard a foreign rocket. As discussed previously, options for space transportation are limited.

This may change in the coming years as private launch entities have expressed interest to the Canadian government in establishing operations in the country. In October 2020, Patrick Juneau, Director of Aviation Safety Policy and Intelligence at Transport Canada, announced the federal government's recent interest in acting as a launching State to oversee the authorization of orbital rockets launching from Canadian territory.[104] He noted that the government has considered the promising economic opportunities of such an endeavor, and more importantly the potential benefits for Canadians. Juneau stated on behalf of Transport Canada, "We're a socio-economic department at the end of the day."[105] In terms of legislation, Juneau further announced that: "The *Aeronautics Act*, which is the primary piece of legislation that I handle was not suited or built around space, but it does cover off at least some essential elements[.]"[106]

MLS estimates it will procure and launch 8 Ukrainian-built Cyclone-4M rockets into orbital trajectories annually, beginning in 2023.[107] The above comments made by Transport Canada indicate MLS is likely to have more government support in the coming years. MLS' strategic choice to launch from Nova Scotia has been due largely to the province's relatively northern latitude which offers strategic access to polar and sun-synchronous orbits, as well as the

---

[104] Marc Boucher, "Canada Decides it Wants To Be a Launching State" (29 October 2021). SpaceQ Media, online: <https://spaceq.ca/canada-decides-it-wants-to-be-a-launching-state/> (27 September 2021).
[105] *Ibid*.
[106] *Ibid*. Juneau further noted that regulatory modernization must facilitate business investment by establishing and improving the predictability of the industry, but that it must also address "… the safety issues as you talk about moving through airspace[.]"
[107] "Launch Services" (2019), Maritime Launch Services, online: <https://www.maritimelaunch.com/launch-services> (1 December 2019).

location's proximity to open ocean and access to key transportation networks.[108] The northerly latitude's freezing temperatures are not problematic as Cyclone-4M rockets have been developed from past Soviet rockets, all of which "were designed for much more extreme conditions [than American rockets]."[109] The ability for these rockets to withstand such cold temperatures is based largely on the Soviet's need during the Cold War to launch nuclear warheads, regardless of weather conditions.[110] Today, the Russian's Soyuz rocket is rated to launch crewed missions in temperatures from +50 to -40 degrees Celsius.[111]

To avoid its spent Cyclone-4Ms from becoming space junk, MLS has partnered with Nanoracks, an in-space repurposing services company, to recycle the Cyclone-4M rockets once they are in space and to use them to build infrastructure, such as fuel depots and storage centres, in orbit.[112] In terms of regulatory compliance, Nova Scotia's Environmental Minister has granted MLS an 18-month extension on the company's plans for spaceport development by mandating that construction on the project commence no later than December 3, 2022.[113] Finally, there are numerous tasks remaining for MLS, including obtaining adequate liability insurance, meeting environmental criteria, properly assessing all risks, planning for worst-case scenario disasters, ensuring proper storage, handling, and containment of dangerous goods, management of rocket fuel waste, meaningful stakeholder consultation, and site rehabilitation plans.[114]

1.10: Application of International Law and the Boundary Between Airspace and Outer Space

The public international law regime relevant to orbital rocketry also requires introduction. The United Nations' General Assembly (UNGA) adopted as resolutions the five multilateral treaties

---

[108] *Ibid*.
[109] Michael Cabbage, "Russia's Rockets Still do the Job" (29 October 2000), Orlando Sentinel, online: <https://www.orlandosentinel.com/news/os-xpm-2000-10-29-0010290137-story.html> (17 January 2022).
[110] *Ibid*.
[111] "The Russians always launch" (2 February 2012), Travels in Orbit, online: <https://www.travelsinorbit.com/the-russians-always-launch/> (17 January 2022) [Russians always launch].
[112] Frances Willick, "Canso spaceport partners with U.S. company to recycle rockets in space" (3 November 2019), CBC News, online: <https://www.cbc.ca/news/canada/nova-scotia/mla-nanoracks-repurpose-cyclone-4m-rockets-1.5344086> (17 January 2022).
[113] Keith Doucette, "Nova Scotia grants 18-month extension for work to begin on commercial spaceport" (17 March 2021), Atlantic CTV News, online: <https://atlantic.ctvnews.ca/nova-scotia-grants-18-month-extension-for-work-to-begin-on-commercial-spaceport-1.5350643> (7 April 2021).
[114] *Ibid*.

negotiated by States through the UN Committee for the Peaceful Uses of Outer Space (COPUOS) during the late 1960s to late 1970s to establish the foundational legal principles on the exploration and use of outer space. Four of these five treaties have been ratified by all space-faring nations and some of the treaties' principles have passed into customary international law.[115] The treaties were drafted to address a range of topics including the health and safety of astronauts, need for government licensing and authorization schemes for orbital launches, preventing the spread of weapons of mass destruction and proliferation of nuclear weapons into the outer space environment, recording, tracking, and managing the locations of physical satellites, spent rockets, spacecraft, space debris, and other space objects, and allocating frequency spectrum usage in space,[116] all to prevent outer space from becoming a domain of conflict and rivalry.[117] In 1967, shortly after the first of the five space treaties was signed, the United States Secretary of State David Rusk stated before the US Senate Committee on Foreign Relations:

> It is our earnest desire and our basic policy to continue to explore with the Soviet Union and others additional ways of reducing the danger of conflict and of promoting stability and security in the world…A task of prime importance at this time is the conclusion, for example of a treaty to prevent the further spread of nuclear weapons.[118]

The treaties govern activity directly occurring in the outer space environment but also have implications for all activities, regardless of where they occur, that affect space-based activities.

These treaties, however, do fall short in multiple areas, one of which is their lack of clarification on where exactly the airspace-outer space boundary exists, although practically this has little effect on the usefulness of these agreements.[119] For the purposes of this thesis, the reader can conceptualize the demarcation of the airspace-outer space boundary as existing at approximately

---

[115] Lyall & Larsen, *Space Law: A Treatise*, 2d ed (New York: Routledge, 2018) at 64 [Lyall & Larsen].
[116] "ITU Radio Regulatory Framework for Space Services" n.d., International Telecommunication Union, online: <https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf > (2 May 2022).
[117] Treaty on Outer Space: Hearings before the Committee on Foreign Relations United States Senate, 90th Cong. (1967) (Statement of Secretary of State Honorable Dean Rusk), online: <https://books.google.ca/books?id=YcdEAQAAMAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false> (2 May 2022).
[118] *Ibid* at 2.
[119] Bhavya Lal & Emily Nightingale, "Where is Space? And Why does that Matter?" (2014) *Space Traffic Management Conference* at 16.

the 100-kilometer altitudinal mark. This 100-kilometer vertical distance above the Earth, known as the Von Karman line, is the point at which there is inadequate oxygen for airplanes to generate the "lift" required to fly and where satellites can maintain the velocity necessary to retain an orbital trajectory.[120]

2: Strategic Approaches to Law Reform

The following introduces the arguments and theory used to critique existing legislation and guide the reforms proposed. Subsection 2.1 identifies the objectives of law reform as improving legislative "sufficiency" in terms of detail, clarity, comprehensiveness, and effectiveness. Subsection 2.2 describes three general reasons to regulate, including: stakeholder preference for effective regulation over deregulation, stakeholder interest in enhanced legal certainty and clarity, and the implications of businesses' inherent tendency to focus excessively on profits. Subsection 2.3 investigates qualities specific to the launch industry indicating a further need for reformed legislation, including the constantly evolving technological nature of rocketry, existence of negative externalities as a market failure, and the serious health and safety, national security, and environmental concerns presented by launch activities. Absent government intervention, the rocketry industry will fail to function efficiently, sustainably, or optimally.

Subsection 2.4 introduces the theoretical lens of legal instrumentalism, which guides the thesis' analysis. Subsection 2.5 develops details of this theoretical approach and applies it to the process of law reform, by first categorizing laws either as "rules" or "standards." 2.5 then presents the six factors of every law, and the cost-benefit analysis tool, to evaluate and improve legal schemes. Lastly, subsection 2.6 presents the thesis' author's goal of law reform as stimulating local economies and improving the quality of life for residents living nearby, while appropriately accounting for the high-risk nature of orbital rocketry activity.

2.1: Improving the Sufficiency of Regulatory Schemes

Black's Law Dictionary defines the term "sufficient" as akin to "adequate" and of such quality, number, force, or value as is necessary for a given purpose.[121] In the Supreme Court's (SCC)

---

[120] Eric Betz, "The Karman Line: Where does space begin?" (5 March 2021), Astronomy Magazine, online: <https://astronomy.com/news/2021/03/the-krmn-line-where-does-space-begin> (12 September 2021).
[121] *sufficient*, *Black's Law Dictionary* (10th Edition, 2014).

Tataryn v Tataryn Estate, [1994] 2 SCR 807[122] decision, the SCC defined "adequate" as ranging anywhere from adopting a "needs-based test"[123] to providing as much as reasonably possible given the resources available.[124] For purposes of this thesis, the term "sufficient" may be taken to mean at least "meeting the minimum requirements", "to be acceptable", and "to be reasonable", but possibly more, depending on the resources available to law reform efforts. Accordingly, this thesis' objective is to, at a minimum, offer proposals that improve the currently inapplicable and ineffective legislation governing the orbital launch industry, and develop and adopt a legislative scheme that enables the rocketry industry to safely and sustainably develop. If implemented, the proposals will result in new law that adequately and sufficiently meets the industry's present and future governance needs.

2.2: General Reasons to Regulate

Market studies are discussed in subsection 2.2.1, indicating that investors, business leaders, and stakeholders of all industries appreciate well-informed and well-drafted legislation. This contention is furthered by 2.2.2's investigation into the value created by improving the certainty in an industry and by 2.2.3's discussion of the implications of the inherent profit-seeking nature of all businesses.

2.2.1: Stakeholders Seek Effective Industry Regulation Rather than Deregulation

Kearney, a global management consulting firm, produces an annual report discussing the global investment environment. Its two most previous reports, the 2020 Foreign Direct Investment Confidence Index (FDICI)[125] and 2021 FDICI,[126] both list the first and second most prominent factors influencing investment decisions as "tax rates and ease of tax payments", followed by

---

[122] [1994] 2 SCR 807.
[123] *Ibid* at 819.
[124] *Ibid* at 823.
[125] P Laudicina & E Peterson, "Entering the Storm: anticipating risk in an uncertain world – The 2020 Foreign Direct Investment Confidence Index" (March 2020), Kearney, online: <https://www.kearney.com/documents/20152/17744880/The+2020+Kearney+Foreign+Direct+Investment+Confidence+Index.pdf/18e45f29-867f-2cad-1899-8294b94e89d5?t=1608470571000> (7 July 2021) [2020 FDICI].
[126] P Laudicina & E Peterson, "On Shaky Ground: The 2021 FDI Confidence Index" (24 March 2021), Kearney, online: <https://www.kearney.com/documents/3677458/88299256/On+shaky+ground%E2%80%932021+FDI+confidence+index.pdf/4f8fd544-ce57-d498-96e3-dfb5fd81f77e?t=1616536746000> (7 July 2021) [2021 FDICI].

"technological and innovation capabilities".[127] For the third most influential factor(s), the 2020 FDICI lists "regulatory transparency and lack of corruption",[128] while the 2021 FDICI reports a three-way tie for third between "research and development capabilities", "efficiency of legal and regulatory processes", and "transparency of government regulations and lack of corruption".[129] Both reports also indicate that investors, entrepreneurs, and suppliers have begun to view advancements in regulatory transparency and market efficiency, particularly in politically stable and developed countries, as a promising means of generating wealth since the beginning of the COVID-19 pandemic in March 2020.[130]

As indicated above, taxation ranked as the most desirable trait investors sought in both 2020 and 2021. This thesis focuses on reforming legislation to ensure Canada's orbital launch industry develops both safely and sustainably and improves local Canadians' quality of life for many years to come. Governments focusing solely on implementing favourable taxation schemes, but with no guidance or oversight from effective law, will undoubtedly attract greater FDI but deliver only temporary market growth due to uncoordinated utilization of that investment. Adopting legislation to successfully manage relatively lower levels of investment will improve chances of long-term market development by better utilizing available resources. This thesis contends that improved tax schemes are still a valuable means of attracting greater investment, although should only be adopted following legislation that will ensure orbital launches occur both safely and securely. The *STAR Act*, coupled with future hypothetical tax incentives, will likely grow the industry at a greater rate than relying on only one of these policy initiatives.

Deloitte, another consulting firm, succinctly reported that: "Competitiveness is key to economic prosperity."[131] Deloitte explains how enhancing a market's competitiveness will increase associated commercial and personal productivity, measured as output per hour worked, which in

[127] 2020 FDICI, s*upra* note 125 at 7; 2021 FDICI, *supra* note 126 at 9.
[128] 2020 FDICI, *supra* note 125 at 7.
[129] 2021 FDICI, *supra* note 126 at 9.
[130] 2020 FDICI, *supra* note 125 at 6; 2021 FDICI, *supra* note 126 at 8.
[131] C Alexander & A Ansari, "Making regulation a competitive advantage" (2019), Deloitte, online: at 1 <https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/finance/ca-en-making-regulation-comp-advantage-pov-aoda-v2.pdf?location=top> (7 July 2021) [Competitive Regulation].

turn improves standards of living.[132] Deloitte's report also writes "… a Business Council of Canada survey of its [own] members in early 2019 identified regulation as the single most important policy area for governments to make progress on."[133] The firm argues the correct mechanism to deliver valuable market competitiveness is by implementing "sound, effective regulation", rather than deregulating the market.[134]

Lastly, the *2022 Independent Review of the RSSSA* (the "*2022 RSSSA Review*") discussed how stakeholders appreciate and value predictability, certainty, and having the ability to learn about the licensing process and associated government bureaucracy of the *Remote Sensing Space Systems Act* (*RSSSA*),[135] which the *2022 RSSSA Review* summarizes as "Certainty is important to license holders."[136] In the context of the *RSSSA,* license applicants found there was "uncertainty in the language of the Act",[137] as there was often confusion around the differences in the definitions of "remote sensing" and other radar-specific terms. For example, industry stakeholders were confused as to whether "optical" sensing equipment, which was not contemplated when the *RSSSA* was adopted, would be included in the vague definition of "remote sensing" and thus require a license. The *2022 RSSSA Review* determined this ambiguity created "uncertainty for businesses about if and how the Act will be applied to their systems. Such uncertainty complicates business planning and limits opportunities to raise capital, among others."[138]

---

[132] Chad Stone, "Economic Growth: Causes, Benefits, and Current Limits" (27 April 2017), Center on Budget and Policy Priorities online: at 1 <https://www.cbpp.org/sites/default/files/atoms/files/4-27-17econ-testimony.pdf> (7 July 2021) [Stone Economics].
[133] *Ibid* at 2; citing: Business Council of Canada, *Member Survey*, January 2019.
[134] *Ibid*.
[135] *Remote Sensing Space Systems Act,* RSC 2005, c 45 [*RSSSA*].
[136] Space Strategies Consulting Ltd, "2022 Independent Review of the *Remote Sensing Space Systems Act (RSSSA)"* (March 2022), Global Affairs Canada, online: <https://www.international.gc.ca/transparency-transparence/assets/pdfs/remote-sensing-systemes-teledetection/2022-review-rsssa-examen-lsts-en.pdf> at 46 (3 May 2022) [*2022 RSSSA Review*].
[137] *Ibid* at 27.
[138] *Ibid*.

2.2.2: The Value of Certainty

According to the OECD, "Legal certainty, predictability and businesses' trust in justice systems facilitate investment decisions and promote competition."[139] As the author of "Facilitating Investment", Christiane Rudolph, explains, "All private sector companies, whether foreign or domestic, appreciate legal certainty."[140] His article argues how, in addition to legal certainty, upholding the rule of law also increases levels of incoming investment because "The rule of law makes it easier to assess – and manage – risks."[141] Ruth Sullivan, past faculty member of the University of Ottawa's Faculty of Law and current drafter at the Legislative Services Branch of the Department of Justice, discusses the tenets of the rule of law in her book, *Statutory Interpretation*,[142] one of which is to offer clarity: "The law must be set out in advance and with sufficient clarity so that subjects can know what is expected of them and of others, can achieve a measure of security, and can plan for the future."[143] This again speaks to the need to provide certainty to investors at a "sufficient" level.

The above sentiment is shared by Professor and Department Head of Law at Hong Kong University, Zhao Yun, who writes in his 2009 article "A Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space",[144] that "The development of space tourism no doubt calls for a legal regime to better regulate the market as well as to offer clear guidance and expected outcomes."[145] Laws of greater clarity provide more certainty to stakeholders attempting to understand the practical functioning of complex industries and also improve the accuracy of forecasting efforts. Yun concludes his article with, "The uncertainty … can make potential

---

[139] "Access to Justice" (2019), OECD, online: <https://www.oecd.org/gov/access-to-justice.htm> (1 December 2019).
[140] Christiane Rudolph, "Facilitating investment" (6 January 2019), Development and Cooperation, online: <https://www.dandc.eu/en/article/rule-law-essential-generating-employment-and-fostering-prosperity> (1 December 2019); Rudolph is the Director of Corporate Strategy and Impact for Deutsche Investititions – und Entwicklungsgesellschaft (DEG), and studied international politics, history, and economics at Fern Universitat in Hagen, Germany.
[141] *Ibid.*
[142] Ruth Sullivan, *Statutory Interpretation*, 2d ed (Toronto: Irwin Law, 2007) [Ruth Sullivan].
[143] *Ibid* at 34.
[144] Zhao Yun, "A Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space" (2009) 74 *Journal Air Law & Commerce* 959.
[145] *Ibid* at 961.

investors hesitant because any unknown future regulation may kill the business they are investing in."[146]

Legislation clarifying and describing the Canadian Transport Minister's launch license evaluation procedure will improve predictability within the orbital launch industry. Laws that describe the specific decision metrics informing and guiding the Minister's assessments, and that articulate the technical, financial, and organizational traits warranting approval, would be beneficial to investors, business leaders, and applicants. These types of laws would benefit prospective applicants because they would be able to develop launch plans that better align with Transport Canada's prioritized objectives. Additionally, applicants could more accurately forecast and estimate the likelihood their application may be approved or rejected. Finally, legislation that clearly describes ongoing federal commitments to supporting launch providers will facilitate growth in the industry. This could include support with regard to using the Claims Commission established under Article XIV of the *Convention on International Liability for Damage Caused by Space Objects* (*Liability Convention*),[147] and will be elaborated on further in chapter 3.

2.2.3: Milton Friedman's "Shareholder Theory"

A related reason to mandate government-imposed regulations is to account for the tendency of for-profit companies to neglect public health and safety and national security interests in favour of maximizing profits. This concept was articulated as the "shareholder theory" by the 1976 Economics Nobel Prize recipient Milton Friedman.[148] The theory argues that companies do not have any social responsibility to the public, but rather must maximize profit for shareholders. The result is that few, if any, corporate social responsibility initiatives or programs are forthcoming. Friedman's shareholder theory applies to all for-profit businesses and includes the private orbital launch market. Accordingly, launch providers will not prioritize important social welfare objectives and values, such as human health and safety, but rather will focus on

---

[146] *Ibid* at 968.
[147] *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 UNTS 187 (entered into force 1 September 1972), United Nations Office of Outer Space Affairs, online: <https://www.unoosa.org/pdf/publications/STSPACE11E.pdf> (24 July 2020) [*Liability Convention*].
[148] Milton Friedman, "The Social Responsibility of Business is to Increase its Profits" (13 September 1970), The New York Times Magazine, online: at 6 <http://umich.edu/~thecore/doc/Friedman.pdf> (4 November 2020).

maximizing profits for investors. For these reasons, governments often mandate corporations to conduct business operations responsibly by enacting regulatory schemes. As stated previously, policymakers must balance a law's ability to appropriately dictate and influence an entity's actions, without stifling innovation.

2.3: Specific Qualities Warranting Government Oversight of the Orbital Launch Market

Since the optimal degree of governance of an industry depends on the qualities of the industry itself, an additional three qualities of the space-transport market warrant further investigation. Specifically, the constant rate of change within the industry, the existence of market failures, and the serious health, safety, and security concerns presented by rocketry all warrant significant government oversight. Without an adequately restrictive legal scheme, the orbital rocketry industry will not sustain operations over the long-term because of the excessive risk of disaster it presents.

2.3.1: The Rapid Rate of Change within the Rocketry Industry

Effective law reform initiatives must be assessed in the long-term, by considering associated costs and benefits, particularly those spent on developing and implementing legal amendments. Well-crafted and well-implemented laws increase industry innovation and improve local markets and communities, while poorly developed and poorly implemented laws stifle innovation and fail to grow and develop.[149] In some industries, such as rocketry, regulations must be structured such that they may be regularly updated to keep pace with the industry's rapidly changing technology.

As the space economy continues to evolve, journalist Mike Wall states, "Private companies are doing a lot more in the final frontier today than they were 10 years ago, including ferrying supplies to the International Space Station (ISS), landing and re-launching rockets, and manufacturing products off Earth."[150] The constant progression of re-usable launch vehicle

[149] Luke Stewart, "The Impact of Regulation on Innovation In the United States: A Cross-Industry Literature Review" (14 November 2011), Information Technology & Innovation Foundation, online: <https://itif.org/publications/2011/11/14/impact-regulation-innovation-united-states-cross-industry-literature-review> (6 July 2021).
[150] Mike Wall, "The Private Spaceflight Decade: How Commercial Space Truly Soared in the 2010s" (20 December 2019), SPACE.com, online: <https://www.space.com/private-spaceflight-decade-2010s-retrospective.html> (13 November 2020).

(RLV) technology, specifically the reusability of rocket boosters and nose cone fairings, illustrate the importance of continually updating regulatory schemes.

Changes with regard to rocket boosters are significant for the industry because they are the most expensive components of a rocket.[151] Falcon 9 boosters account for 60 percent of the total cost of the rocket[152] and nose fairings account for 10 percent.[153] In December 2015, SpaceX conducted the first vertical landing of an orbital rocket booster,[154] then used this same booster for an additional launch on March 30, 2017.[155] From March 30, 2017, to May 15, 2022, SpaceX successfully landed 113 orbital class rocket boosters, and relaunched 92 of them.[156] It is estimated that this RLV technology reduces the cost to launch a Falcon 9 from an original price tag of $62 million when using all new components, to an new total of $36 million after reusing these rocket boosters and nose fairings[157] – a savings of $26 million or 42 percent. More conservative estimates place cost-savings at around 30 percent per launch.[158] As of May 2022, SpaceX is the only launch provider capable of reusing boosters and nose fairings,[159] although Blue Origin (USA),[160] ArianeWorks (France),[161] and iSpace (China)[162] are each developing their own partially reusable launchers. Rocket Lab has successfully recovered its Electron rocket

---

[151] Jonathan Amos, "Success for SpaecX 'reusable rocket'" (30 March 2017), BBC News, online: <https://www.bbc.com/news/science-environment-39451401> (13 November 2020).
[152] Michael Sheetz, "Elon Musk touts low cost to insure SpaceX rockets as edge over competitors" (16 April 2020), CNBC, online: <https://www.cnbc.com/2020/04/16/elon-musk-spacex-falcon-9-rocket-over-a-million-dollars-less-to-insure.html> (13 November 2020).
[153] *Ibid*.
[154] Mike Wall, "Wow! SpaceX Lands Orbital Rocket Successfully in Historic First" (22 December 2015), SPACE.com, online: <https://www.space.com/31420-spacex-rocket-landing-success.html> (13 November 2020).
[155] *Ibid*.
[156] "Falcon 9" (2020), SpaceX, online: <https://www.spacex.com/vehicles/falcon-9/> (17 January 2022).
[157] Rich Smith, "How Much Cheaper are SpaceX Reusable Rockets? Now We Know" (5 October 2020), The Motley Fool, online: <https://www.fool.com/investing/2020/10/05/how-much-cheaper-are-spacex-reusable-rockets-now-w/> (6 July 2021).
[158] Loren Grush, "SpaceX's last Falcon 9 upgrade could finally make reusable rockets cost-effective" (9 May 2018), The Verge, online: <https://www.theverge.com/2018/5/9/17254384/spacex-falcon-9-block-5-upgrade-rocket-reusability-savings> (13 November 2020).
[159] Ivan Mehta, "Private Chinese space company aims to rival SpaceX with a reusable rocket by 2021" (23 October 2019), The Next Web, online: <https://thenextweb.com/space/2019/10/23/private-chinese-space-company-aims-to-rival-spacex-with-a-reusable-rocket-by-2021/> (13 November 2020).
[160] *Ibid*.
[161] Elizabeth Howell, "Europe's ArianeWorks Aims for Reusable Rockets (with a Very SpaceX Look)" (10 September 2019), SPACE.com, online: <https://www.space.com/arianeworks-reusable-rockets-themis-callisto-video.html> (13 November 2020).
[162] Andrew Jones, "Chinese space launch firm iSpace raises $173 million in series B funding" (25 August 2020), Space News, online: <https://spacenews.com/chinese-space-launch-firm-ispace-raises-173-million-in-series-b-funding/> (20 November 2020).

booster four times – first in November, 2020, then May 2021, then November 2021, and in May 2022 – although the company has not yet relaunched any.[163]

2.3.2: Regulating Market Failures: Negative Externalities in the Space-Transport Industry

Issues causing economies to operate inefficiently, termed "market failures", take a variety of forms including monopolistic or oligopolistic competition, asymmetric information received by producers and consumers, and positive or negative externalities.[164] Government efforts to fix ineffective or outdated legislation may improve regulatory schemes to better address existing market failure(s) and improve economic efficiency.

Negative externalities accompany profit-generating transactions between producers (first parties) and consumers (second parties) while inequitably imposing harmful effects on third party bystanders such as local peoples, families, organizations, and governments.[165] While the producers and consumers enjoy the benefits of the activity, the third parties are left to either address, or endure, the harmful and inconvenient effects as no compensation is forthcoming from the first and second parties.[166] Negative externalities exist in the orbital launch industry – the launch provider acts as producer, payload customers as consumers, and residents of local cities, towns, and farms as third parties. Following the completion of a transaction between the launch provider and the payload customer, the two parties each benefit from the exchange while the third parties bear many of the costs without compensation.

---

[163] "How to bring a rocket back from space" (nd), Rocket Lab, online: <https://www.rocketlabusa.com/about-us/updates/how-to-bring-a-rocket-back-from-space/> (6 July 2021); Aria Alamalhodaei, "Rocktet Lab's Electron booster splashes down in the Pacific Ocean" (17 November 2021), TechCrunch+, online: <https://techcrunch.com/2021/11/17/rocket-labs-electron-booster-splashes-down-in-the-pacific-ocean/#:~:text=Rocket%20Lab%20has%20successfully%20recovered,the%20destruction%20of%20the%20payload.> (19 February 2022); Stephen Clark, "Rocket Lab briefly catches booster in mid-air after successful launch" (3 May 2022), Spaceflight Now, online: <https://spaceflightnow.com/2022/05/03/rocket-lab-briefly-catches-booster-in-mid-air-after-successful-launch/#:~:text=Rocket%20Lab%20used%20a%20helicopter,rocket%20recovery%20and%20reuse%20program.> (8 May 2022).

[164] "What is Market Failure?" Corporate Finance Institute, online: <https://corporatefinanceinstitute.com/resources/knowledge/economics/market-failure/> (13 July 2021).

[165] Will Kenton, "Externality" (26 October 2020), Investopedia, online <https://www.investopedia.com/terms/e/externality.asp> (7 September 2021) [Externalities].

[166] *Ibid*.

The harmful and inconvenient effects imposed on third parties include the obvious: misfired rockets endangering the physical safety of the local population and risk damaging or destroying nearby government and private property. Other impacts include an orbital launch jeopardizing national security interests, primarily because of the opportunity for hackers to override the electronics and computers onboard the rocket itself or at the launch control center. Rocket launches also create noise pollution which is particularly problematic for anyone living or working nearby. Even if a launch provider brings employment opportunities and economic growth to local communities, there are accompanying and complex drawbacks with respect to local crime rates, which fluctuate depending on market strength: poor economic conditions have been shown to decrease crime while greater employment opportunities have shown to increase crime.[167] Another major concern is the extent of environmental damage from rocket launches, particularly on air, soil, and water quality.

Governments can address these negative externalities by intervening and enacting legislation to equitably reallocate newly imposed costs. Specifically, governments need to "internalize" the costs borne by third parties by passing laws and regulations mandating producers and consumers adequately compensate these affected third parties.[168] This type of government intervention compensates third parties for the inequitably imposed costs and improves market efficiency, innovation, and sustainability.[169]

2.3.3: Orbital Rocketry Presents Unique Safety and Security Concerns

In addition to quickly evolving industries and the existence of market failures, there are certain industries requiring heightened government oversight solely because of the risk they pose to important societal values. As such, businesses whose operations compromise citizen health and safety, protection of property, and national security,[170] such as the satellite operations governed

---

[167] J Bothos & S Thomopoulos, "Factors influencing crime rates: an economic analysis approach" (17 May 2016) 9842 *Signal Processing, Sensor/Information Fusion, and Target Recognition XXV* at 8-9, online: <https//doi.org/10.1117/12.2223395> (1 September 2021).
[168] "Externalities – The Economic Lowdown Podcast Series" (nd) Federal Reserve Bank of St. Louis, online: <https://www.stlouisfed.org/education/economic-lowdown-podcast-series/episode-11-externalities> (7 September 2021).
[169] Gavin DeNyse, "How Can We Get There?" (2000), MIT, online: ay 23 <http://web.mit.edu/10.391J/www/proceedings/Sustainability&Markets_DeNyse2000.pdf> (7 September 2021).
[170] David Monk, "The Lessons of Airline Regulation and Deregulation: Will We Make the Same Mistakes in Space" (1992) 57:3 *Journal of Air Law & Commerce* 715-753 at 728 [Learning from Airline Deregulation].

by the *RSSSA*, must be more strictly governed than industries presenting minimal risks to such values. The highly disastrous consequences of a failed orbital rocket launch strongly militates in favour of stricter regulations to reduce the risk of such an event from occurring in the first place and, if an incident does occur, prevents and minimizes the harmful fallout. Due to the immense amount of highly combustible fuels used by rockets to reach space, this type of transportation will always involve some degree of risk for disastrous failure.[171] An additional reason to regulate the rocketry industry is its close relation with arms control concerns, as well as other issues present in the exploration and use of outer space, that are contained in the UN space treaties. As will be discussed further in chapter 2, it is important that Canada honour these obligations at international law for a variety of reasons, including to maintain the country's standing in the international community and facilitate foreign relations. Strengthening and maintaining international relations was also a consideration when the *RSSSA* was originally drafted.[172]

2.4: Law Reform through the Lens of Legal Instrumentalism

Having identified reasons why nearly all industries benefit from a certain degree of regulatory oversight, as well as considering factors specific to the launch market, this subsection 2.4 introduces the theory of legal instrumentalism and discusses how this theoretical framework may be used to connect the impacts of legislation to desired public policy goals. The policy objectives guiding the purposes of the law reform proposed in this thesis include both "intermediary" goals and "ultimate" goals. Intermediary goals of law reform are those objectives that are most often reached before, rather than after, ultimate goals can be attained, whereby the pursuit of intermediary goals may guide legislative reformers in the pursuit of the ultimate "end" goals. In this thesis, in the event an intermediate objective conflicts with an ultimate objective, the ultimate objective prevails, except national security which is considered of equal importance to the ultimate objectives. However, during times of amendment, national security shall follow this prioritization, the reasoning of which will be discussed later in this thesis. Normally, the

[171] Often more than 85% of an orbital rocket's total mass is the onboard fuel required to reach space; Don Pettit, "The Tyranny of the Rocket Equation" (1 May 2012), NASA, online: <https://www.nasa.gov/mission_pages/station/expeditions/expedition30/tryanny.html> (7 September 2021).
[172] "Space Policy and the *Remote Sensing Space Systems Act*" (25 March 2022), Government of Canada, online: <https://www.international.gc.ca/world-monde/issues_development-enjeux_developpement/peace_security-paix_securite/space-espace.aspx?lang=eng> (2 May 2022).

achievement of the ultimate goals implies the intermediary goals have also been reached, although not typically vice-versa.

This thesis' intermediary goals include: honouring obligations at international law, protecting the environment, protecting real and personal property of Canadians, maintaining the health and safety of Canadians, upholding national security interests, and improving the transparency of the government legislative decision-making process and associated outcomes. Once these intermediary objectives are achieved, it is contended that four ultimate goals can be attained, including: fostering and sustaining Canadian space-related industry and commercial development so as to improve Canadian launch competitiveness, strengthening innovation and technology development, investing the economic benefits attained from the growth of the industry back into communities across Canada to promote the research, use, and application of space technologies to Canadians, and increasing the wealth and improving standards of living and quality of life specifically for the most impacted Canadians – namely those living nearby launch sites, facilities, and rocketry business operations.

Professor Koen van Aeken, a scholar at the University of Antwerp, writing on the topic of legal instrumentalism notes that "when law is deployed, it should be so from a well-considered view, enhancing the policy with some of the intrinsic values of law."[173] Legal instrumentalism is a theory and strategy used by legal drafters to produce laws delivering benefits to citizens in an increasingly complex society.[174] Van Aeken further explains "instrumentalism assumes that law is created with a particular result or goal in mind[,]"[175] and that such a goal "lies outside the realm of law."[176] Instrumentalism may be used to "socially engineer"[177] a society for the better, beginning with properly identifying harmful societal issues. Policymakers use instrumentalism to create legislation that motivates stakeholders to either act, or not act, in a certain way and thus bring about change.

---

[173] Koen van Aeken, *Legal Instrumentalism Revisited* (2005), 67-92 at 68, in Luc Wintgens, *The Theory and Practice of Legislation* (Burlington: Ashgate Publishing Company, 2005) [van Aeken].
[174] *Ibid* at 69.
[175] van Aeken, *supra* note 173 at 68; citing: R Fortson, "Three Roles for a Theory of Behavior in a Theory of Law. A Commentary on a talk by Lewis Kornhauser" (1999) 1 *Stanford Journal of Legal Studies* 30-34.
[176] van Aeken, *supra* note 173 at 68; citing: R Summers, "Het pragmatisch instrumentalisme" *Standaard Wetenschappelijke Uitgeverij*, Antwerp/Amsterdam.
[177] van Aeken, *supra* note 173 at 69.

Legal realism and positivism, along with natural law theory, each informed the origins of legal instrumentalism and played a critical role in the continued development of the theory.[178] Legal realism was largely studied in the 1920s and 1930s by theorists Karl Llewellyn, Jerome Frank, and Walter Cook,[179] while positivism was furthered by H.L.A. Hart in the 1950s and 1960s.[180] Although distinct, both theories investigate the field of law from a practical and applied perspective. Realism takes the perspective that laws are subject to social interests and public policy,[181] and positivism holds that law is merely a creation of society, only authoritative because society wishes it to be, and exists regardless of how successfully or unsuccessfully it reaches its objectives.[182] Contemporaneously with Hart, notable legal theorist Lon Fuller studied natural law theory,[183] a framework based on the belief that law is grounded in human "morality" and nature[184] and only exists if capable of reaching its objectives.[185] Natural law theory studies the law to determine how it ought to be, rather than how it exists.[186]

The perspectives of Lewellyn, Frank, Cook, Hart, and Fuller were synthesized and studied together by others, notably by van Aeken and Robert Summers.[187] Both researchers prioritized the need to create practical legislation through the law reform process, rather than merely developing law that only offered value in theory.[188] Specifically, Summers wrote that effective theories of law must draw upon the most successful aspects of both positivism and natural law

---

[178] Robert Summers, "Pragmatic Instrumentalism in Twentieth Century American Legal Thought – a Synthesis and Critique of Our Dominant General Theory About Law and its Use" (1981) 66:5 *Cornell Law Review* 861-948 at 864, online: <http://scholarship.law.cornell.edu/clr/vol66/iss5/1> (10 October 2021) [Summers Instrumentalism].
[179] Summers Instrumentalism, *supra* note 178 at 864; citing: Llewellyn, "Some Realism About Realism – Responding to Dean Pound," (1931) 44 *Harvard Law Review* 1222.
[180] Summers Instrumentalism, *supra* note 178 at 872; citing: HLA Hart, *The Concept of Law*, (Oxford: Oxford University Press, 1961).
[181] Michael Sevel, Brian Leiter, "Legal Positivism" (5 October 2016), Oxford Bibliographies, online: <https://www.oxfordbibliographies.com/view/document/obo-9780195396577/obo-9780195396577-0065.xml> (12 October 2021).
[182] "Legal Realism" Cornell Law School Legal Information Institute, online: <https://www.law.cornell.edu/wex/legal_realism> (12 October 2021).
[183] Lon Fuller, *The Morality of Law* (New Haven: Yale University Press, 1969).
[184] Lawrence Solum, "Legal Theory Lexicon 068: Welfare, Well-being, and Happiness" (5 July 2020), Legal Theory Lexicon, online: <https://lsolum.typepad.com/legal_theory_lexicon/normative_theory/> (12 October 2021).
[185] Kenneth Himma, "Natural Law," (nd), *Internet Encyclopedia of Philosophy*, online: s 4 <https://iep.utm.edu/natlaw/> (12 October 2021).
[186] Summers Instrumentalism, *supra* note 178 at 874.
[187] Robert Summers was a faculty member at the Cornell Law School for 42 years.
[188] van Aeken, *supra* note 173 at 68.

philosophy, but also must be informed from more original thoughts and concepts specific to "pragmatic instrumentalism" itself.[189] The goal of creating legislation through pragmatic instrumentalism is to deliver practical value; this was well-described when Summers wrote with regard to Roscoe Pound that Pound was a pioneer of pragmatic instrumentalism, who "… borrowed from Rudolph Von Ihering's conception of law as a means to accepted ends."[190] This thesis' author uses Summers' and van Aeken's work on legal instrumentalism to guide the law reform endeavors proposed, with the objective of maximizing the practical functioning of the proposed *STAR Act* and avoiding the draft bill delivering only theoretical value.

In the following subsection 2.5, a complementary theoretical approach, titled the "economics of lawmaking", assists lawmakers in determining the type of a law to develop, the numerous contextual factors to identify and consider, and how to write laws of "optimal specificity"[191] to maximize net benefits.

2.5: Law Reform and the *Economics of Lawmaking*

A theory that is complementary to legal instrumentalism and relevant to law reform is found in Francisco Parisi and Vincy Fon's book, *The Economics of Lawmaking*, where the authors distinguish between two different categorizations of laws: "Standards and rules can be visualized as two extremes on a continuum representing the degree of precision of laws."[192] Parisi and Fon's work requires a three-step process to determine the optimal specificity of sought-after legislation. Their approach adopts the same law reform objective from Summers and van Aeken, namely maximizing practical benefits of law, but specifically achieves this by focusing on increasing legislative-related "benefits" over "costs". Parisi and Fon consider five uncontrollable contextual factors of legislation to guide development of the one factor that is controllable, that being the level of "specificity". As such, writing a law of appropriate specificity, or detail, will maximize accrued net benefits. Stated differently, the objective is to write the text of legislation

[189] Summers Instrumentalism, *supra* note 178 at 863.
[190] *Ibid* at 869; citing: Rudolf Von Ihering, *Law as a Means to an End* (Boston: The Boston Book Company, 1877, Eng. trans. 1914).
[191] F Parisi & V Fon, *The Economics of Lawmaking* (New York: Oxford University Press, 2009) at 4 [Parisi & Fon].
[192] *Ibid* at 10.

so it exists on the continuum between the extremes of complete detail and total obscurity where, given consideration of its contextual elements, its benefits are maximized over its costs.[193]

2.5.1: Step 1 – Altering "Specificity" to Create Law as either "Rules" or "Standards"

In Part I of *The Economics of Lawmaking*, Parisi and Fon distinguish between laws of high specificity, known as very detailed and complex "rules", and laws of low specificity, known as vague, obscure, and imprecise "standards".[194] High-specificity rules provide greater clarity, certainty, and predictability for stakeholders, although they are also very inflexible in their application.[195] Low-specificity standards provide little guidance for stakeholders, but are very flexible in their application.[196] Drafters must consider numerous interrelated qualities (Table 1.3) of a law and its contextual circumstances when assessing the optimal level of specificity to write into that law. The objective is to maximize the law's benefits ("value") over costs ("fixed" plus "variable") over a pre-determined time frame (Table 1.4).

A rule's greater clarity and detail is a product of the extensive, in-depth, and resource-intensive research required to produce it. A standard's broad applicability results from its vague composition, which requires less resources during drafting stages, as compared with the development of a rule. Parties attempting to interpret and apply standards, including the public, lawyers, and judiciary, must allocate more resources and exercise greater discretion to account for these laws' lack of clear direction and clarity.[197] Meanwhile, a rule's rigidity may cause its integration with existing legal frameworks to be difficult as well as limited in its length of relevancy. All laws eventually require costly amendment or even complete replacement, so the longer a law applies the more value is gained from the resources it cost to create it. Lastly, a standard's flexibility allows for broader application to different contexts, greater adaptability to changing environments, and lengthier relevancy and applicability. These qualities will be discussed again in section 2 of chapter 5, where they will guide efforts to reform the laws

[193] *Ibid* at 4.
[194] *Ibid* at 11.
[195] *Ibid.*
[196] *Ibid*.
[197] *Ibid* at 6.

currently governing Canada's orbital launch market. The unique differences between rules and standards inform the drafting of the *STAR Act*.

Whether a rule or standard is more appropriate depends on the contextual circumstances of the targeted industry. Although the value of a law is a function of its legal precision, such that highly specific rules provide more value to stakeholders than generalized standards, analyses must also consider associated costs of lawmaking. Upon analyzing these contextual factors, drafters can calibrate the new law's specificity in a way that maximizes benefits over costs. Additionally, since judges utilize complex statutory interpretation concepts when adjudicating laws, including the "modern principle" adopted by the SCC in *Rizzo v Rizzo Shoes*,[198] there is always the risk the judiciary will not arrive at an optimal conclusion.[199] It follows there are pragmatic considerations influencing whether lawmakers should draft a law as a rule or standard: rules require greater short-term costs but are less likely to fail during application as they inherently limit judicial discretion, while standards present less expenses in the short-term but are more likely to fail during the application stage because they require greater judicial discretion.

2.5.2: Step 2 – Implications of the 6 Factors of a Law

According to Parisi and Fon's approach, lawmakers may maximize benefits over costs by altering the one factor they can control – specificity – and thereby indirectly addressing five other uncontrollable yet interrelated factors. Following Step 2's discussion of the six factors, Step 3 investigates the factors' inter-related relationships and aggregate effects on ensuing benefits and costs.

[198] [1998] 1 SCR 27 at para 21 [*Rizzo*].
[199] Ruth Sullivan, *supra* note 142 at 30.

Table 1.3: The Nature of the 6 Factors of Every Law

Factor	Denoted as	Application
Frequency of application	Nu "N"	Higher N means more frequent application of a law
Degree of specificity	"s"	Higher s means more detailed and more valuable laws
Rate of obsolescence	Omega "ω"	Higher ω means greater risk of legal obsolescence
Harmonization efforts to integrate new legislation with existing laws	Lambda "λ"	Higher λ means greater efforts required to integrate new with old
Judicial expertise	Sigma "σ"	Higher σ means judges possess more specialized knowledge
Change in operating environment	Kappa "κ"	Higher κ means more volatile environment

2.5.2.1 Frequency of Application ("N"):

Regularly litigated laws require greater cumulative judicial efforts to properly interpret, apply, and often govern recurring societal problems with shared characteristics.[200] The larger the value of "N", the more frequently the law is applied, with smaller values of N indicating rarer application.[201] A law's specificity "s" is positively correlated with its N, meaning the more a law is applied, the greater the cost-effectiveness of a detailed rule.[202] Spreading expensive drafting costs over many applications reduces a rule's unit adjudication costs. Alternatively, governments expecting a law to have minimal applicability, usually those governing niche subject areas, will opt for standards.[203] Legislation of limited applicability will not provide much total value to society, so smaller amounts of resources should be spent on their creation.

2.5.2.2 Legal Obsolescence ("ω"):

Every law loses relevancy and applicability with corresponding increases in detail, indicating a negative correlation between "ω" and value.[204] A more specific rule obsolesces quickly because

[200] Parisi & Fon, *supra* note 191 at 14.
[201] *Ibid* at 13.
[202] *Ibid* at 18.
[203] *Ibid* at 16.
[204] *Ibid* at 13.

its detailed structure is inflexible and cannot adapt to changing contextual circumstances, especially in the long-term. As a result, a rule's limited applicability from its high risk of obsolescence forces the government to enact costly amendments, or even complete replacement, thereby offsetting the net benefit, or value, it produces for stakeholders. In terms of ω, governments must balance the greater value produced by a rule with the faster rate at which rules become outdated and need to be fixed.[205] Meanwhile, standards must be assessed by weighing the limited value they produce with their longer period of applicability and relevancy.[206] Also consider how well established an area of the law may be, as legislation that has been developed and honed over time and in instances of little environmental change, will be less prone to amendment then legislation governing entirely new industries that have only been regulated for a short period of time, or even never before.

2.5.2.3 Difficulty of Harmonizing the New Law within Existing Regulatory Frameworks ("λ"):

All newly drafted laws require different extents of harmonization and coordination efforts to ensure proper integration with existing legal frameworks. The factor "λ" negatively influences costs, as more complex harmonization efforts require the use of more resources than laws more easily synchronized.[207] Low-specificity standards are vague but flexible, meaning they are simpler to coordinate with existing structures. Within any industry, "Law is organized in a rigorous scheme …"[208] and so integrating complex legislation into already highly regulated industries requires more resources then coordinating simpler laws into deregulated markets.

2.5.2.4 Level of Specialization of the Judiciary and other Adjudicators ("σ"):

The jurisdiction of an adjudicative body applies both geographically and by subject matter. Courts of first instance, such as Provincial Courts, retain judges possessing more generalized knowledge enabling them to interpret and apply a broader scope of the law, while courts analyzing niche topics governed by complex legislation, such as the Tax Court of Canada, retain

[205] *Ibid* at 16.
[206] *Ibid*.
[207] *Ibid* at 14.
[208] *Ibid* at 19.

judges with narrow but highly specialized expertise.[209] The correlation between "σ" and the adjudication cost is negative, wherein specialized judiciaries, including administrative decision-makers, with narrow scopes of practice more efficiently interpret and apply high-specificity rules.[210] Although σ is negatively correlated with adjudication costs, it is positively correlated with the specificity of a law. The extensive time and money spent on creating a rule is only worth the cost if the rule can be accurately adjudicated, otherwise its value is wasted.

2.5.2.5 Degree of Complexity of the Operating Environment ("κ"):

The operating environment, or "reality", within which a law functions will unpredictably shift and change over time. "κ" negatively correlates with specificity and positively with fixed and variable costs, as environments experiencing volatile shifts are better governed by highly flexible and generalized standards.[211] Intuitively, rules are preferred when governments must enact a law to govern realities experiencing prolonged stability, ones where the value produced by the rule extends for lengthier periods of time and where costs are more spread out.

2.5.3: Step 3 – Calculating Benefits and Costs

Finite resources force governments to strategically allocate available funds to adequately finance the total costs of creating and enacting a law, with the expectation that greater benefits will accrue at some point in the future. The lawmakers' priority is to maximize the calculated net benefit. Table 1.4 summarizes the formulas used to conceptualize these figures.

2.5.3.1: Calculating a Law's Benefits, or Total "Value":

A law's total value, or "benefits", is calculated with the formula $N*V(s,\omega)$, where the law's frequency of application N is multiplied by the value realized by stakeholders for each single time the law is applied ("V").[212] This unit value V is determined by the balance between the

[209] *Ibid* at 15.
[210] *Ibid*.
[211] *Ibid* at 17.
[212] *Ibid* at 13.

law's degree of specificity s and its associated rate of obsolescence ω.[213] Every subsequent application of a law increases that law's total value. The correlation between V and s is positive, while between V and ω is negative:[214] highly detailed laws produce more value since they enhance the accuracy of readers' interpretation efforts, while laws risking quick obsolescence decrease a law's unit value as they will soon require costly amendment or even replacement.

2.5.3.2: Calculating Total Costs as "Fixed" plus "Variable"

The production of legal order is resource-intensive and combines short-term "fixed cost" and long-term "variable cost" investments.[215] Fixed costs are easier to estimate and include resources spent on initial legislative research and drafting, while variable costs are more difficult to forecast and are used to fund adjudication and implementation efforts. Fixed costs are calculated with the formula F(s,λ,κ), where "F" represents a law's "promulgation" costs used to fund lawmakers' drafting work.[216] F is equal to the sum of the amount of specificity (s), level of difficulty of harmonization (λ), and degree of environmental volatility (κ) of the law. These three factors are each positively correlated with F, wherein increases in s, λ, or κ will increase promulgation costs.[217] More thorough research endeavors, difficult harmonization efforts, and greater immediate need for amendment or replacement will be reflected in a more expensive F.

A law's total variable costs are described as "adjudication" costs and are determined by solving the equation N*C(s,σ,κ), where the frequency of application (N) is multiplied by the unit adjudication cost ("C").[218] C is negatively correlated with both s and σ, while positively with κ. The extensive and immediately incurred research costs associated with creating a rule are somewhat offset by the minimal resources required to fund a rule's longer-term implementation and adjudication. These longer-term expenses are less costly when considering rules because the lawmaker has already done much of the work in the early drafting phase. Next, when a court's level of specialized knowledge (σ) increases, the judiciary can more quickly, effectively, and

[213] *Ibid*.
[214] *Ibid*.
[215] *Ibid* at 12.
[216] *Ibid* at 11.
[217] *Ibid* at 13-14.
[218] *Ibid* at 14.

efficiently interpret and apply niche laws of narrow application.[219] Legislation governing a rapidly changing environment (κ) will incur greater C since resource-intensive amendments, or the need to completely replace the law, may be necessary sooner than when compared to laws in stable environments.

After using these formulas to project benefits and costs, lawmakers can more accurately determine whether a rule or standard is preferable and which will govern more effectively. Recall that specificity is the only factor lawmakers may control. Creating a law of the optimal level of specificity will address and accommodate for both the presence and extent of the other factors, with the goal of maximizing the final net benefit.

Table 1.4: Determining a Law's Benefits and Costs through Component and Factor Correlations

In chapter 5 the factors presented in this Table are assessed with respect to law reform concepts relevant to the orbital launch industry, as a way to suggest the level of warranted specificity.

Formula	Components of formulas (description)	Factors comprising components	Correlation between component and factor	Relationship between increases (↑) or decreases (↓) in factors and components
total "value" = N*V(s,ω)	N (application frequency)	n/a	n/a	↑N will ↑total value
	V (unit value)	s	positive	↑s will ↑V
		ω	negative	↑ω will ↓V
total "fixed" costs = F(s,λ,κ)	F (total fixed costs)	s	positive	↑s will ↑F
		λ	positive	↑λ will ↑F
		κ	positive	↑κ will ↑F
total "variable" costs = N*C(s,σ,κ)	N (application frequency)	n/a	n/a	↑N will ↑total variable costs
	C (unit adjudication costs)	s	negative	↑s will ↓C
		σ	negative	↑σ will ↓C
		κ	positive	↑κ will ↑C

[219] *Ibid* at 15.

2.6: Improving the Lives of Canadians, both Nationally and Locally

Ultimate policy objectives guiding the law reform proposed in this thesis are to improve the wellbeing of Canadians across the country and to improve the lives of Canadians living and working in those communities located nearby launch sites, facilities, headquarters, and/or business operations. In the case of MLS and Canso, a town having lost more than half its population since 2006,[220] there is a unique opportunity for improved economic growth that accompanies new launch activity, both in numbers of newly created high-paying jobs, improved access to specialized education and space-related research, increased levels of wealth for individuals, and improved government finances.[221]

Chad Stone, Chief Economist of the Center on Budget and Policy Priorities,[222] testified to the US House of Representatives in 2017 "about the causes of economic growth, the benefits associated with economic growth, and current limits on economic growth in the United States."[223] In Stone's speech he made two points: that economic growth provides fiscal stability and raises living standards, and when governments attempt to maximize economic growth it is important to attract *new* businesses rather than *small* businesses.[224]

Stone stated the two ways to improve economic development are by growing the size of the workforce and/or growing the rate of that workforce's productivity.[225] While either will further develop an economy, only increases in productivity improve per capita gross domestic product (GDP) and income and, accordingly, material standards of living.[226] The level of GDP alone does not provide an accurate assessment of standards of living, however, as changes in GDP must be weighed against non-quantifiable benefits such as access to healthcare and the success of preserving local environments.[227] Legal frameworks can be designed to protect important

---

[220] "Defunct N.S. town rocketing back to the cutting edge with spaceport plan" (14 March 2017), National Post, online: <https://nationalpost.com/news/proposed-spaceport-would-bring-defunct-n-s-town-back-to-the-cutting-edge> (15 December 2019).
[221] Tejvan Pettinger, "Benefits of economic growth" (14 December 2019), Economics Help, online: <https://www.economicshelp.org/macroeconomics/economic-growth/benefits-growth/> (5 July 2021).
[222] Center on Budget and Policy Priorities, online: <https://www.cbpp.org/> (6 July 2021).
[223] Stone Economics, *supra* note 132.
[224] *Ibid*.
[225] *Ibid* at 2.
[226] *Ibid*.
[227] *Ibid*.

societal values, although their restrictive nature usually also stifles and slows increases in GDP. Communities and societies must weigh the importance of material gains against the importance of all non-quantifiable benefits. Stone explains how to judge these two competing objectives:

> Well-conceived tax, regulatory, and public investment policies can complement labor force growth and private investment in expanding potential GDP. They can also reap public benefits that GDP does not necessarily capture, such as distributional fairness and health and safety protections. Poorly conceived policies, of course, can impede growth and hurt national economic welfare.[228]

He further explains how new businesses, rather than small businesses, are the "engine of job growth" in an economy.[229] Stone quotes Distinguished University Professor of Economics at University of Maryland, Mr. John Haltiwanger, by stating: "A challenge of modern economies is having an environment that allows such dynamic, high-growth businesses to succeed."[230] This emphasizes the importance of developing well-informed legislation that is sufficiently comprehensive, but also flexible enough to encourage innovation and encourage market and business growth. This thesis proposes reforms ultimately meant to improve Canadian's access to space-related careers, services, and education, and to improve peoples' standards of living, namely those who reside in communities near future rocketry sites and areas of rocketry activity; the reforms proposed are intended to strike a proper balance between pursuing material and non-material objectives.

3: Conclusion

Legal reform is only one of many ways a government may develop a space-based economy. Other options to develop a strong space economy include forming bilateral agreements with strategic international partners, incentivizing innovation and research and development, facilitating targeted industrial growth, coordinating efforts between the national government, regional governments, and key industries, prioritizing the most profitable projects and endeavors, and increasing citizens' interest in space engineering, transport, and exploration to retain future

---

[228] *Ibid* at 3.
[229] *Ibid* at 8.
[230] Jessie Romero, "Interview: John Haltiwanger" (July 2013) *Federal Reserve Bank of Richmond – Econ Focus Second Quarter* at 30, online: <https://www.richmondfed.org/-/media/richmondfedorg/publications/research/econ_focus/2013/q2/pdf/full_issue.pdf> at 30 (5 July 2021).

leaders of the sector and to further develop the country's space-based projects.[231] National space programs are most successful when developers consider the program's four essential components including policy, strategy, regulation, and implementation.[232]

As will be applied throughout the thesis, a national government that promotes understandable and straightforward policies "signals to investors that the country is committed to long-term success."[233] To reach a country's identified policy goals, its specific skills, knowledge, and resources will need to be obtained, organized, and retained. One of the means of growing Canada's rocketry industry is to implement regulatory schemes to accurately establish the parameters of the industry's operations and that are "strong but flexible."[234] A "flexible" strategy ensures dynamism in the developed plan, which is particularly important because space strategies must constantly adapt to changing contextual circumstances to work effectively and sustainably. Every industry must be governed by legislation specifically tailored to its context, and the space-based industry is no exception. The risk of disastrous and costly failure of orbital rocketry needs to be addressed by legal schemes offering an optimal balance between minimizing these extreme risks, on the one hand, and encouraging innovation and business and market growth, on the other. These insights and objectives inform chapter 5's proposal of the recommended draft bill.

In the Canadian context, Transport Canada can currently authorize orbital rockets to legally launch from Canadian soil, although no launches have been authorized to date. Addressing the shortcomings of the *Aeronautics Act*[235] (*AA*) and *Canadian Aviation Regulations*[236] (*CAR*) through law reform may better attract investors and business leaders to the market.

This chapter introduced legal instrumentalism and the economics of lawmaking – approaches that will be applied in section 2 of chapter 5. It is contended here that new laws can be oriented toward the fulfillment of ultimate policy goals, including that of facilitating sustainable growth in

---

[231] F Robert, et al, "Achieving Australian Leadership in Space" (2018), AT Kearney, online: at 7 <https://www.kearney.com/documents/1722225/1730674/Achieving+Australian+Leadership+in+Space.pdf/f930cacf-5c83-603f-0f0d-699b3e2be5fe?t=1542530548000> (12 September 2021) [Australian Space Leadership].
[232] *Ibid* at 3.
[233] *Ibid* at 9.
[234] *Ibid.*
[235] *Aeronautics Act*, RSC 1985, c A-2 [*AA*].
[236] *Canadian Aviation Regulations*, SOR/96-433 [*CAR*].

the space transport industry and improving the lives of Canadians both on the national and local levels. The benefits associated with these policy goals will materialize by improving the perceived and actual likelihood of the industry's success, while the legislation will account for the inherent drive of every business to maximize shareholder profits at the expense of corporate social responsibility, adapt to constant changes in rocketry technology, address the market inefficiencies caused by negative externalities, uphold and preserve national security concerns, and further diplomatic and foreign relations by honouring obligations at international law. Chapter 2 elaborates on the importance of complying with obligations stemming from international treaties, particularly when reforming laws governing space-based activities in Canada, while thesis' chapters 3 and 4 each undertake substantive domestic and foreign comparative analyses, respectively.

CHAPTER 2: THE FIVE UNITED NATIONS' SPACE LAW TREATIES

1: Introduction

This chapter introduces five multilateral treaties created through UNGA, four of which have widely been accepted by many countries, including all space-faring states. The treaties highlight important issues that a country, such as Canada, which may be developing national space legislation should consider. While space technology and types of space activities have changed dramatically since the treaties were adopted, the overarching principles promulgated within the agreements "set out the fundamental principles of international space law"[237], and continue to guide the efforts of many countries that have already adopted, or plan to adopt, national space legislation.[238] The United Nations Office for Outer Space Affairs prioritizes "promoting universality of the United Nations treaties on outer space…"[239] and encourages continually promotes more "Member States to become party to the United Nations treaties on outer space…"[240] The usefulness of the principles contained within the outer space treaties reappear in this thesis' chapter 5, with a discussion on how the treaties offer a foundational base from which to create an effective space-governing national legislation, presented as the *STAR Act.*

Four of the five UN space law treaties have been signed and ratified by Canada,[241] although not all treaty aspects have been fully implemented via domestic legislation.

---

[237] "Contribution of Space Law and Policy to Space Governance and Space Security in the 21st Century" (8 September 2016), United Nations Office for Outer Space Affairs, online: <https://www.unoosa.org/pdf/SLW2016/Other/2016_SLW_conclusions_and_recommendations.pdf> at para 13 (8 May 2022).
[238] *Ibid*.
[239] *Ibid* at para 23(i).
[240] *Ibid* at para 23(e).
[241] "Status of International Agreements relating to Activities in Outer Space" (28 March 2022), United Nations Office for Outer Space Affairs, online: <https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_10_0_html/AAC105_C2_2022_CRP10E.pdf> (2 May 2022) [Treaty Status].

Figure 2.1: Canada's Space Treaty Ratification Record

C. Status of international agreements relating to activities in outer space (as at 1 January 2022)

(R = ratification, acceptance, approval, accession or succession; S = signature only;
D = declaration of acceptance of rights and obligations)

	United Nations treaties					*Other agreements*											
State, area or organization	*(1) 1967 OST*	*(2) 1968 ARRA*	*(3) 1972 LIAB*	*(4) 1975 REG*	*(5) 1979 MOON*	*(6) 1963 NTB*	*(7) 1974 BRS*	*(8) 1971 ITSO*	*(9) 1971 INTR*	*(10) 1975 ESA*	*(11) 1976 ARB*	*(12) 1976 INTC*	*(13) 1976 IMSO*	*(14) 1982 EUTL*	*(15) 1983 EUM*	*(16) 1992 ITU*
Afghanistan	R					R		R	R							R
Albania														R		R
Algeria	R		R	R		S		R			R		R			R
Andorra														R		R
Angola								R								R
Antigua and Barbuda	R	R	R	R		R							R			R
Argentina	R	R	R	R		R	S	R					R			R
Armenia	R	R	R	R	R	R	R	R						R		R
Australia	R	R	R	R	R	R	R	R					R			R
Austria	R	R	R	R	R	R	R	R		R				R	R	R
Azerbaijan	R							R	R					R		R
Bahamas	R	R				R		R					R			R
Bahrain	R		R	R			R	R			R		R			R
Bangladesh	R					R		R					R			R
Barbados	R	R						R								R
Belarus	R	R	R	R		R			R				R	R		R
Belgium	R	R	R	R	R	R	S	R		R			R	R	R	R
Belize																R
Benin	R		R			R	R	R								R
Bhutan						R		R								R
Bolivia (Plurinational State of)	S	S				R		R					R			R
Bosnia and Herzegovina	R	R	R			R	R	R					R	R		R
Botswana	S	R	R			R		R								R
Brazil	R	R	R	R		R	S	R					R			R
Brunei Darussalam								R					R			R
Bulgaria	R	R	R	R		R			R			R	R	R	R	R
Burkina Faso	R					S		R								R
Burundi	S		S	S		S		S[a]								R
Cambodia			S													R
Cameroon	S	R				S		R					R			R
Canada	R	R	R	R		R		R		[b]			R			R
Cape Verde						R		R								R
Central African Republic	S		S			R		R								R
Chad						R		R								R
Chile	R	R	R	R	R	R	R	R					R			R
China	R	R	R	R		R		R					R			R
Colombia	S	S	R	R		R	R	R					R			R

The most comprehensive Canadian space-based legislation is the *RSSSA*, which is "the default mechanism to regulate [new space-related] activity even though it does not fit squarely within the confines of the *RSSSA*."[242] While most space-faring nations have dedicated legislation addressing new and emerging space issues and problems,[243] Canada does not. Examples include the USA's highly detailed, comprehensive, and complex *Title 51 USC* and *Title 14 of the Code of Federal Regulations*[244] (*14 CFR*) and the multiple laws enacted by the French, Russian, and Chinese governments to oversee and guide each state's national space programs and activities. These countries have enacted their own space-governing laws to "provide a legal basis to regulate new activities as they emerge rather than develop independent legislation for each new technology that finds a commercial application."[245]

---

[242] Ram Jakhu & Aram Kerkonian, *Independent Review of the Remote Sensing Space Systems Act*, (2017), Institute of Air and Space Law, online: <https://www.mcgill.ca/iasl/files/iasl/2017_review_of_canadas_remote_sensing_space_systems_act_en.pdf> (3 May 2022) [2017 *RSSSA Review*].
[243] *Ibid.*
[244] *Aeronautics and Space*, *Title 14 of the Code of Federal Regulations*, Legal Information Institute at Cornell Law School, online: <https://www.law.cornell.edu/cfr/text/14> (4 September 2021) [*14 CFR*].
[245] 2017 *RSSSA Review*, *supra* note 242 at 33.

The *RSSSA* was solely meant to regulate remote sensing satellites but its *de facto* scope has now increased to cover other applications, likely extending it beyond its intended scope and useful application.[246] There is a small number of other space-related legislative schemes in Canada, including the previously mentioned *AA* and its associated *CAR*, as well as the *Air Transportation Regulations*[247] (*ATR*), *Radiocommunication Act*[248] (*RA*), *Telecommunications Act*[249] (*TA*), and *Broadcasting Act*[250] (*BA*). The *AA* and *CAR* directly govern rocket launches in Canada although they lack important considerations and integral details, therefore leaving outstanding questions for stakeholders. The *ATR* contains the relevant insurance requirements for rockets but, like the *AA* and *CAR*, is not nearly specific enough for orbital rocketry. The *RA*, *TA*, and *BA* each govern specific aspects of satellite operation, while the *RSSSA* is more robust in terms of general satellite oversight.

Because the space-based economy has changed drastically since many of these Acts were adopted, Canada would benefit from a new and all-encompassing space-governing Act to guide all national space-based activities, rather than the current piecemeal system that currently exists. Such proposed legislation must also operate smoothly with other Canadian laws, including the *RSSSA*, *RA*, *TA*, *BA*, *AA*, *CAR*, *ATR*, and other associated regulations. The following subsections discuss the space treaties' key principles, obligations imposed on States Parties to the treaties, and integral aspects that may add value if integrated into legal frameworks governing emerging space-based economies, all of which is further discussed in chapter 5.

2: Investigating the Treaties

Through the UN, states negotiated and drafted five multilateral treaties in the 1960s and 1970s including the *Treaty on Principles Governing the Activities of States in the Exploration and Use*

[246] *Ibid* at 6.
[247] SOR/88-58 [*ATR*].
[248] *Radiocommunication Act*, RSC 1985, c R-2 [*RA*].
[249] *Telecommunications Act*, RSC 1993, c 38 [*TA*].
[250] *Broadcasting Act*, RSC 1991, c 11 [*BA*].

of Outer Space, including the Moon and Other Celestial Bodies,[251] known as the *Outer Space Treaty* (*OST*), the *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*,[252] known as the *Astronaut Rescue and Return Agreement* (*ARRA*), the *Convention on International Liability for Damage Caused by Space Objects*,[253] known as the *Liability Convention*, the *Convention on Registration of Objects Launched into Outer Space*,[254] known as the *Registration Convention*, and the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*,[255] known as the *Moon Agreement*, to establish the foundational principles of space law and the rights and obligations of States in the exploration and use of outer space. The first of these documents, the *OST*, entered into force in October 1967, and has been ratified by all major space-faring nations.[256] The *OST* is the most widely accepted of the five treaties, with each subsequent treaty garnering less signatures than the last. The final treaty, the *Moon Agreement*, never gained widespread recognition and even now lacks ratification from every space-faring nation.[257]

Together, the five multilateral space treaties establish key principles for nations engaged in space exploration and, arguably, space exploitation. While space-based activities have changed significantly since the 1960s and 1970s, the treaties continue to bind national governments in their unique roles of governing space activities. Important tenets of the treaties, discussed in the following subsections, were mostly articulated in the *OST* and then elaborated on in later treaties.

---

[251] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 October 1967, 610 UNTS 205 (entered into force 10 October 1967), United Nations Office of Outer Space Affairs, online: <https://www.unoosa.org/pdf/publications/STSPACE11E.pdf> (22 August 2021) [*OST*].
[252] *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, 22 April 1968, 672 UNTS 119 (entered into force 3 December 1968), United Nations Office of Outer Space Affairs, online: <https://www.unoosa.org/pdf/gares/ARES_22_2345E.pdf> (24 July 2020) [*ARRA*].
[253] *Liability Convention*, *supra* note 147.
[254] *Convention on Registration of Objects Launched into Outer Space*, 14 January 1975, 1023 UNTS 15 (entered into force 15 September 1976) United Nations Office of Outer Space Affairs, online: <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introregistration-convention.html> (24 July 2020) [*Registration Convention*].
[255] *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, 18 December 1979, 1363 UNTS 3 (entered into force 11 July 1984) United Nations Office of Outer Space Affairs, online: <https://www.unoosa.org/pdf/publications/STSPACE11E.pdf> (24 July 2020) [*Moon Agreement*].
[256] "Status of International Agreements relating to activities in outer space as at 1 January 2022" (28 March 2022), Committee on the Peaceful Uses of Outer Space, online: at 1 <https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_10_0_html/AAC105_C2_2022_CRP10E.pdf> (2 May 2022).
[257] *Ibid* at 2.

Integral tenets include the significance of conducting space exploration and use by peaceful, collaborative, and sustainable methods,[258] proper national licensing and authorization schemes of non-governmental entities engaged in space activities,[259] prioritization of the safety of astronauts,[260] consensus on applicable liability measures,[261] accurate record keeping and registration of space objects to improve State accountability,[262] and the paramount prohibition of nuclear weapons and weapons of mass destruction placed in Earth's orbit, installed on celestial bodies, and stationed in space.[263]

2.1: *Outer Space Treaty*, 1967

112 states are Parties to the *OST*[264] and membership may continue to grow in the coming years as the agreement is a "universal treaty, open to all states."[265] According to space law authors Francis Lyall and Paul Larsen, in their book, *Space Law: A Treatise*, "the Treaty applies to the space activities of individual states, to those of their national entities, to joint state activities and to the activities of international organisations of which a State Party to the Treaty may be a member."[266] Principles of the document include accepting that all nations have a shared interest in space-based activities, that space must be utilized for peaceful purposes and for the benefit of the international community, and that there is a need for mutual understanding and co-operation from as many states as practically possible. Lyall and Larsen further discuss these three fundamental principles by first considering the "place of law", which proposes that outer space is not lawless nor a place where "one is free of legal constraint or principle."[267] The second principle suggests outer space, the Moon, and other celestial bodies are free for exploration and use by all states on Earth, while the third fundamental principle prevents states from claiming national sovereignty over the Moon or celestial bodies by appropriation.[268]

---

[258] *OST*, *supra* note 251, Preamble, arts III, IV, and IX.
[259] *Ibid*, art VI.
[260] *Ibid*, art V.
[261] *Ibid*, art VII.
[262] *Ibid*, arts VIII, XI.
[263] *Ibid*, art IV.
[264] *Status of the Treaty*, online: United Nations Office for Disarmament Affairs <http://disarmament.un.org/treaties/t/outer_space> (1 April 2020).
[265] *OST*, *supra* note 251, art XIV(1).
[266] Lyall & Larsen, *supra* note 115 at 53.
[267] *Ibid* at 54.
[268] *Ibid*.

Article I of the *OST* describes the outer space environment as a place where all states may explore "irrespective of their degree of economic or scientific development".[269] While Article I applies to a nation's freedom of scientific investigation in outer space, it does not explicitly apply to commercial exploitation, which has resulted in disagreements over resource extraction in space that persist to the present day. In line with the third fundamental principle, Article II proposes the Moon and other celestial bodies are "not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[270] Lyall and Larsen argue the *OST's* Article II, along with its Articles I and III, have now passed into customary international law,[271] meaning even those states not Parties to the *OST* are bound by its content.

Article III describes that all states may explore and use outer space "in accordance with international law",[272] meaning they must operate by "maintaining international peace and security and promoting international co-operation and understanding."[273] The *OST* explicitly articulates that *exploration* of outer space is both acceptable, appropriate, and encouraged, although is silent on the *exploitation* of space. Article IV restricts any militarization of outer space, stating "The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes."[274] This Article IV prohibits weapons of mass destruction, including nuclear weapons, to be placed in outer space or installed on celestial bodies, including the Moon. This Article served a particular importance when the Treaty was drafted and adopted during the Cold War.

The *OST's* Article V designates astronauts as "envoys of mankind",[275] and ensures their safety is given the utmost importance during space-based endeavors. Astronauts must be provided with "all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas."[276] Article V further explains astronauts in distress must

---

[269] *OST, supra* note 251, art I.
[270] *Ibid,* art II.
[271] Lyall & Larsen, *supra* note 115 at 64.
[272] *OST, supra* note 251, art III.
[273] *Ibid.*
[274] *Ibid,* art IV.
[275] *Ibid,* art V.
[276] *Ibid*.

be safely and quickly returned to their home state, which is defined as the country having authorized and registered the astronauts' spacecraft. The Secretary-General of the United Nations (UNSG) must be informed and updated on specific dangers confronted by astronauts.

Article VI discusses liability regarding space-based incidents, where sole responsibility lies with the State having authorized the outer space activity causing the damage. If the party operating a space endeavor is a non-governmental entity, it is still the authorizing State that is responsible at international law[277] for all consequences of the mission, although these states will assuredly seek indemnification from the private entity having actually caused the damage. Article VII, addressing issues of liability for damage caused by a space object, incentivizes national governments to only authorize those entities possessing the technical competence to successfully launch, re-enter, or operate space objects, as well as those with the means of indemnifying the government following a costly disaster.[278]

Articles IX, X, XI, and XII address the essential component of cooperation that exists while exploring outer space. Article IX requires states consider and contemplate their space activities' impacts on the environment. Article XI requires states to inform the UNSG of all authorized space endeavors and space objects to ensure accurate data is recorded in an accessible international registry. This registry is meant to improve the transparency of national space operations, which was an especially pertinent issue to address in the midst of the Cold War, and its inclusion serves two notable purposes. First, it helps clarify which space object may have caused some sort of damage whether that damage occurs on Earth, in airspace, or in outer space, and second, it aids in determining which *State(s)* or *authority(ies)* are responsible and liable for those space objects involved in the incident.

[277] *Ibid*, art VII.
[278] Lyall & Larsen, *supra* note 115 at 60.

2.2: *Astronaut Rescue and Return Agreement*, 1968

ARRA currently has 99 States Parties, including all space-faring nations.[279] The document's 10 articles, particularly 1 through 4, frequently employ the term "launching authority", which is defined by *ARRA's* Article 6 as "the State responsible for launching, or, where an international intergovernmental organization is responsible for launching, that organization, provided that that organization declares its acceptance of the rights and obligations provided for in this Agreement…"[280] This definition is unique because it is broader than the term "launching state" used throughout the other treaties and, in addition to national governments, includes international intergovernmental organizations in its scope.

The *ARRA's* Article 1 describes the types of procedures countries must follow upon discovering personnel of a spacecraft, regardless of nationality, have suffered an accident in an area absent any state jurisdiction, such as the ocean.[281] Articles 1(a) and (b) mandate countries learning of these types of emergencies take adequate steps to inform the spacecraft's launching State and the UNSG. Article 2 is similar, although it applies to space personnel landing in a foreign state's territory and enables only the foreign State to conduct rescue operations and "the launching authority has to be invited if it is to participate in rescue operations."[282] Article 3 places further responsibility on the above countries by requiring they "extend assistance in search and rescue operations for such personnel to assure their speedy rescue."[283]

2.3: *Liability Convention*, 1972

The *Liability Convention* has 98 States Parties, again including all major space-faring nations.[284] The document discusses the liability of States when damage is caused by a space object that was launched either directly by that State or as a result of that State's procurement. Article I defines

---

[279] "Status of International Agreements relating to activities in outer space as at 1 January 2021" (31 May 2021), UNOOSA, online: at 10 <https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_22021crp/aac_105c_22021crp_10_0_html/AC105_C2_2021_CRP10E.pdf> (22 July 2021).
[280] *ARRA*, *supra* note 252, art 6.
[281] *Ibid*, art 1.
[282] *Ibid*, art 2.
[283] *Ibid*, art 3.
[284] Treaty Status, *supra* note 241.

“damage”, “launching”, “launching state”, and “space object”. “Damage” includes human injury or loss of life but also extends to property damage. “Launching” includes *attempted* launching resulting in any degree of failure. A “launching state” is a country that launches its own space object, procures the launching of a space object, or authorizes some entity to launch from its territory. “Space object” covers the object itself, such as a satellite, as well as the rocket that transported it to space.

Article II prescribes that “A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.” Article III requires authorizing states causing damage anywhere else to assume fault liability. Both Articles apply to incidents damaging space objects and/or harming persons onboard a space object regardless of if the involved entity is private or governmental.

To resolve a space-related incident, Article IX allows states to present compensation claims in three different ways: through the claiming state’s diplomatic channels, through a proxy state’s diplomatic channels, or in cases where direct diplomatic channels are not available, through the UNSG. If Article IX negotiations fail, Article XIV enables resolution through a Claims Commission, but only if the launching states apply on behalf of their implicated party. If the Claims Commission is pursued, Articles XV to XX detail the mandatory procedures of the process and the aspects participants have degrees of control over. For example, Article XV requires the plaintiff choose one of three adjudicators on the hearing panel, the defendant choose the second, and both parties agree on the third. The practical usefulness of a decision of the Claims Commission depends on whether the disputing parties agree to recognize panel decisions as binding, otherwise they are merely “final and recommendatory”.[285] The usual benefits of alternative dispute resolutions apply, including faster and less expensive procedures and greater party participation.[286]

[285] *Liability Convention*, *supra* note 147, art XIX(2).
[286] “Benefits of ADR” (28 June 2021), Government of Canada – Canadian Intellectual Property Office, online: <https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr04443.html> (26 August 2021).

While the Claims Commission presents a unique opportunity for private parties to resolve disputes more effectively than through domestic or foreign courts, such assertions are only hypothetical as the Claims Commission has never actually been used. Authors Elina Morozova and Alena Laurenava note in their *Planetary Science* article "International Liability for Commercial Space Activities and Related Issues of Debris," that a main reason for this lack of application is because only sovereign states are subjects of the *Liability Convention,* and of international law in general.[287] As such, it is only states that may choose to access the Claims Commission and decide whether to support their nationals throughout the process. Even if the injured party obtains the support of its authorizing state, it continues to be completely reliant on the state's continued and competent support throughout the entire claims process, meaning unpredictable and volatile state-party relationships, and states with limited resources, may cause claims to be abandoned at any point in the process. Although injured private parties may pursue their own legal action against other parties outside the options of the *Liability Convention,* preferably through the injured party state's own courts although potentially through a foreign court system, these alternatives are not always beneficial either. Pursuing any type of litigation is expensive, confusing, time-consuming, and often ineffective, and space-related legal proceedings are no different.[288]

For this reason, parties in the space-based economy rely extensively on acquiring insurance rather than attempting litigation or other forms of adjudication. National legislation often mandates private parties engaged in space-activities acquire liability insurance so their launching state, if responsible at international law for a costly disaster, is practically likely to receive financial indemnification from that party via its insurance company. Voluntary insurance may benefit the injured party itself as such insurance protects against property losses and nonreceipt of profits. Previously mentioned authors Elina Morozova and Alena Laurenava write on the topic further: "The major advantage of insurance for the private space sector is greater confidence in receiving compensation for damage and greater predictability of the amount and timing of

[287] Elina Morozova & Alena Laurenava, "International Liability for Commercial Space Activities and Related Issues of Debris" (23 February 2021), *Oxford Research Encyclopedia of Planetary Science,* online: at 14 <https://doi.org/10.1093/acrefore/9780190647926.013.63> (7 September 2021) [Commercial Space Liability].
[288] *Ibid* at 15.

payment."[289] Payments from insurance companies are often much prompter, reliable, and convenient than those following more complex, unpredictable, and time-consuming interjurisdictional dispute resolution mechanisms or through private litigation. Even if these latter methods of adjudication deliver a favourable result for one of the parties, a forthcoming payment is difficult to secure.[290]

If, after diplomatic negotiations fail to settle a dispute, and a national government decides it will actively support its nationals at the Claims Commission, that State may wish to promote this intent as a means of attracting investors and business leaders to its domestic market. With respect to signaling, launch providers may look favourably upon knowing they have the support of an authorizing state, either at the Claims Commission or, simply, in general. While national governments may wish to lend support to their nationals as a mean of increasing investment and attracting businesses, the Permanent Court of International Justice (PCIJ) in *Mavrommatis Palestine Concessions (Greece v UK)*[291] also stated:

> It is an elementary principle of international law that a State is entitled to protect its subjects, when injured by acts contrary to international law committed by another State, from whom they have been unable to obtain satisfaction through the ordinary channels.[292]

In this way, a national government representing its own subjects through international dispute resolution is the equivalent of that country asserting its own rights, and thereby upholding respect for international law itself – something that may be important for national ethical, moral, diplomatic, and political reasons. However, elsewhere in the same case the PCIJ discusses one of the major drawbacks of a country supporting its subjects who have been "injured by acts contrary to international law" as that such a State is also effectively taking on the claim as its own[293] – something a national government may not wish to become involved with or bind itself to.

---

[289] *Ibid* at 16.
[290] *Ibid*.
[291] *Mavrommatis Palestine Concessions* (*Greece v UK*), 1924 PCIJ (ser B) No 3 (Aug 30).
[292] *Ibid* at para 21.
[293] *Ibid* at para 22.

As discussed later in this thesis, investors and business leaders may also place a high value on well-developed and reliable national space-insurance laws as a means of potentially avoiding the complexities and costs of international dispute resolution altogether. Additionally, private parties may consider a government's international political position, access to resources, knowledge, and expertise related to international dispute resolution, as well as past favourable or unfavourable policies and historical interactions with the private space sector, when determining possible jurisdictions to operate in.[294] Integrating stronger and more applicable insurance requirements in the *AA*, *CAR*, and *ATR* may, by that reasoning, attract more launch providers and investors to the Canadian market.

2.4: *Registration Convention*, 1975

Similar to the preceding three treaties, all major space-faring nations are parties to the *Registration Convention*, with a total of 72 states having ratified the document.[295] This UN Treaty's 12 articles enable interested parties to monitor orbital positions of satellites and other space objects, predict future orbital positions of space objects, and estimate space objects' remaining time in orbit before re-entering the Earth's atmosphere.

Article II(1) mandates every launching State to maintain a national registry, complete with information on the satellites and other space objects that either it has launched or it has authorized to launch,[296] and to share this information with the UNSG. Article III mandates the UNSG to use this information to maintain its own registry, which must be accessible to all interested parties. Article IV lists the specific data to include in a national registry: (a) name of launching State or States; (b) appropriate designator of the space object or its registration number; (c) date and territory or location of launch; various (d) basic orbital parameters; and (e) general function of the space object.

[294] Commercial Space Liability, *supra* note 287 at 17.
[295] Treaty Status, *supra* note 241.
[296] *Registration Convention*, *supra* note 254, art VII.

2.5: *Moon Agreement*, 1979

The *Moon Agreement* was created 12 years after the *OST* and during a time when governments and other stakeholders were engaged in space-activities and beginning to more seriously consider the profitability of commercial opportunities in outer space. Previously in the 1960s, space-based activities were more resource-intensive and orbital missions were conducted only for scientific, military, and nation-building purposes rather than in any business or for-profit sense. As such, there were no revenue-producing launch providers that could sustain wholly-private operations in the space economy throughout the 1960s, 1970s, 1980s, and even into the 1990s.

The *Moon Agreement* is often described as a "failed" international treaty due to its few signatories and because none of its 18 ratifiers possess domestic orbital launch capabilities. One hypothesis explaining the limited ratifications of this Treaty is due to its emphasis on equitable sharing.[297] The *Moon Agreement*, specifically its Article 11(7)(d)), requires that resources extracted from outer space be shared "equitably" amongst all nations, according to parties' direct and indirect contributions to the cause. Intuitively, major space-faring states have little incentive or interest in equitably sharing their wealth with others,[298] "and its [the *Moon Agreement's*] widespread acceptance remains elusive."[299]

Emerging opportunities for space commercialization, the focus on equity-based redistribution systems, and continued need for international cooperation in space were all to be furthered by establishing an international regime under the *Moon Agreement's* Article 11(5). Such a regime was to govern and coordinate exploitation activities in space, on the Moon and on other celestial bodies, and facilitate more peaceful, efficient, sustainable, and equitable space endeavors. By

---

[297] Michelle Hanlon, "What is the Moon Treaty and is it still useful?" (17 January 2020), Filling Space, online: <https://filling-space.com/2020/01/17/what-is-the-moon-treaty-and-is-it-still-useful/#:~:text=Many%20consider%20the%20Moon%20Agreement,China%2C%20Japan%2C%20and%20Germany.> (2 May 2022).
[298] Vidvuds Beldavs, "Simply fix the Moon Treaty" (15 January 2018), *The Space Review*, online: <https://www.thespacereview.com/article/3408/1> (24 July 2020).
[299] Kai-Uwe Schrogl, et al, "Space Law Symposium 2019: The Moon Agreement Revisited: The Road Ahead" (1 April 2019), International Institute of Space Law (IISL) and European Centre for Space Law (ECSL), online: <https://www.unoosa.org/documents/pdf/copuos/lsc/2019/LSC_2019_IISL-ECSL_Symposium_Final.pdf> (2 May 2022).

adequately planning for future space activities, obstacles and problems would either be avoided, mitigated, or managed, and opportunities capitalized upon.

In a different context, the *United Nations Convention on the Law of the Sea (UNCLOS),* as it originally existed in 1982,[300] was also written with a contentious guiding principle of equitable wealth-redistribution, albeit in a much more detailed and refined manner than in the *Moon Agreement*. Specifically, *UNCLOS'* Article 140 reads: "The [International Seabed] Authority shall provide for the equitable sharing of financial and other economic benefits derived from activities in the Area through any appropriate mechanism…"[301] Article 1(1)(1) defines the "Area" as the "seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction." *UNCLOS'* benefit- and technology-sharing schemes mandated the "equitable" redistribution of profits of ocean exploitation projects, and more equitable transfers of advanced technologies between states, according to nations' "interests and needs".[302] There was to be a particular emphasis on allocating greater profits and improving access to advanced technologies[303] to developing[304] and land-locked countries.[305]

The *Moon Agreement's* redistribution scheme relies on countries' direct and indirect contributions to exploitation endeavors and is therefore narrower than *UNCLOS'* profit-sharing system based solely on "interests and needs". Accordingly, the *Moon Agreement's* proposed system may offer greater benefit to space-faring nations leading exploitation efforts since those parties receiving transfer payments must at least invest some amount of their own resources into the cause. In the *UNCLOS* framework outlined above, even nations choosing to not invest any resources into ocean exploitation may receive a portion of the profits.

---

[300] *United Nations on the Convention of the Law of the Sea,* 10 December 1982, 1833 UNTS 397 (entered into force 16 November 1994), United Nations Treaties, online: <https://treaties.un.org/doc/Publication/UNTS/Volume%201833/volume-1833-A-31363-English.pdf> (26 August 2021) [*UNCLOS* 1982].
[301] *Ibid*, art 140(2).
[302] *Ibid*, art 160(2)(f)(i).
[303] *Ibid*, art 144.
[304] *Ibid*, art 140(1).
[305] *Ibid*, arts 69, 160(2)(k).

Both agreements honour the principle of equity by including the term "common heritage of mankind" in their text.[306] Nancy Griffin explains, "common heritage is synonymous with common property or common ownership."[307] Although the *Moon Agreement* embraces the *OST's* guiding principle of international cooperation and addresses the unequal opportunities experienced by different countries, its low ratifications ultimately limit its applicability.

The resource-sharing problem within *UNCLOS* was eventually addressed with amendments to the Convention in 1994,[308] simply as a means of enticing more countries to sign and ratify the Agreement.[309] The newly enacted amendments essentially conceded on the originally proposed and more extensive redistribution framework so that now developed nations could retain a greater share of profits[310] and could sell their technology to others at market-value prices.[311] These 1994 amendments indicated that although honouring important principles in international law may be a necessary first step to ensuring more equitable results follow the development of new industries, there is no practical value when very few states are interested in agreeing to those terms.

When drawing analogies between the *Moon Agreement* and *UNCLOS*, the differences in the circumstances under which the documents were drafted and in each texts' identified objectives must be noted, including the space treaties' – notably the first four – emphasis on arms control and the need for international and peaceful cooperation in the exploration and use of outer space, and *UNCLOS'* prioritization of economic coordination, development, and equitable resource distribution with respect to international waters and the deep seabed. Like the amendments made to *UNCLOS*, similar changes to the *Moon Agreement* may result in it deviating from its original equity-based purpose and principles, but with the benefit of attracting more support and practical

---

[306] *Moon Agreement*, *supra* note 255, art 11(1); *Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea*, 28 July 1994, 1836 UNTS 3 (entered into force 16 November 1994), United Nations Treaties, online: <https://treaties.un.org/doc/Publication/UNTS/Volume%201836/volume-1836-I-31364-English.pdf> (26 August 2021) [*UNCLOS* 1994].
[307] Nancy Griffin, "Americans and the Moon Treaty" (1981) 46:3 *Journal of Air Law and Commerce* 751.
[308] *UNCLOS* 1994, *supra* note 306.
[309] Tullio Treves, "United Nations Convention on the Law of the Sea" (July 2008), Audiovisual Library of International Law, online: at Procedural History <https://legal.un.org/avl/ha/uncls/uncls.html> at Introductory Note (26 August 2021).
[310] *UNCLOS* 1994, *supra* note 306, art 7.
[311] *Ibid*, art 5.

application, although the further comparison and analysis required to produce definitive conclusions would be out-of-scope of this thesis.

3: Benefits of Honouring Space Treaty Obligations

Canada's federal executive branch has bound the country to honour obligations in the first four space treaties, which may require enactments in domestic law to ensure compliance. Treaty compliance may improve Canada's recognition and reputation internationally by demonstrating respect for international commitments and the rule of law. Harold Koh, former Legal Advisor of the U.S. Department of State and current Yale Law School Sterling Professor of International Law,[312] is author of the article "Why Do Nations Obey International Law?"[313] The article discusses the ongoing expectation from the international community that all countries must adhere to international laws and norms. When states stray from this adherence and disregard these types of obligations, friction is created between foreign states. Eventually, this friction pressures nations to comply with international responsibilities and obligations so relations may become smoother.[314]

Honouring space law obligations at international law may signal to stakeholders, including academics, business leaders, and potential investors, that the Canadian government is now paying more attention, and giving more priority, to the UN space treaties then it did in the recent past. It also demonstrates Canada's practiced respect for these stated commitments and, since countries binding themselves through domestic laws will be more incentivized to follow through on their international commitments, improves the predictability of the future policy directions of the federal government.

Examples of Canada's outstanding obligations at international law appear throughout the *OST*, *ARRA*, *Liability Convention*, and *Registration Convention*. First, Article IX of the *OST* requires Canada to provide launch information to interested parties and allow others to inspect orbital

---

[312] "Our Faculty" (nd), Yale Law School, online: <https://law.yale.edu/harold-hongju-koh> (27 July 2021).
[313] Harold Koh, "Why Do Nations Obey International Law?" (1997) *Yale Law School Legal Scholarship Repository* 2599 at 2655.
[314] *Ibid*.

launches and space operations, none of which is presently codified in the *AA* or *CAR*. Complying domestically with this provision would honour the principle of cooperation within the four space treaties, specifically by allowing other parties to learn from Canadian space-based activities.

Another outstanding obligation rests in *ARRA's* Preamble and Articles 1 through 5, which call for the development of rescue plans should astronauts be in danger or distress, and for the return of space objects launched into outer space to the appropriate launching authority. Canada has no legislated requirement for a protocol to guide rescue missions to save astronauts in danger, or, if necessary, to have its space objects launched into space returned to it, and formulating such a plan would not only improve the safety of people in space, but also in airspace and on the ground, and would ensure space objects are properly returned to Canada, if necessary. These plans will also provide certainty and predictability to people involved in the rescue missions and may improve chances of assessable and forthcoming financial reimbursement for costs incurred during those rescue and return missions.

Third, the *Registration Convention's* Article II(1) mandates countries maintain a national registry of all their space objects located in outer space, and transmit the specific information listed in Article IV, to the UNSG. While the UN's Register of Objects Launched into Outer Space[315] is publicly available, there is no obligation on States to provide the public with access to each of their own national registries. Some countries, like the United Kingdom, publish their national registries,[316] while others, like Canada, do not.[317] These requirements of the *Registration Convention* are not codified in the *AA* or *CAR*, although the CSA does still fulfill these obligations through internal processes,[318] and including them in future legislation would further act as a signaling mechanism to stakeholders by improving government transparency and accountability, and by indicating an enhanced interest by the federal government in supporting the domestic space economy.

---

[315] "United Nations Register of Objects Launched into Outer Space" (2022), United Nations Office for Outer Space Affairs, online: <https://www.unoosa.org/oosa/en/spaceobjectregister/index.html> (10 May 2022).
[316] "UK Registry: Outer Space Objects" (20 May 2021), UK Government, online: <https://www.gov.uk/government/publications/uk-registry-outer-space-objects> (2 May 2022).
[317] "Submission of Canada to the Office of Outer Space Affairs and the Office of Disarmament Affairs on its implementation of the report of the Group of Governmental Experts on Transparency and Confidence-Building in Outer Space Activities" (April 2017), United Nations, online: <https://www.un.org/disarmament/wp-content/uploads/2017/04/Canada-In-extenso1.pdf> (2 May 2022).
[318] *2022 RSSSA Review*, *supra* note 136 at 37.

Finally, it is noteworthy that the federal government has not committed to supporting Canadian-based entities at the Claims Commission. Although there is no obligation to do so, providing such support will attract more investors and business leaders to the domestic market. The *Liability Convention's* Articles XIV to XX discusses the mechanics of the Claims Commission, which requires nationals wishing to use the mechanism to obtain the support of their launching state. Adjudication through the Claims Commission is meant to resolve disputes between foreign parties using procedures that are faster[319] and more cost-effective,[320] transparent,[321] simplistic,[322] engaging,[323] accessible,[324] flexible,[325] and fair[326] compared to litigation in foreign or even domestic courts.

4: The Role of National Legal Systems: Addressing Gaps in UN Space Treaties

When the UN space treaties were created in the 1960s and 1970s, neither China, Russia, the USA, or France, had enacted any significant domestic space-related laws. During this time, orbital rocketry endeavors were entirely funded by the state, with an absence of both private launch providers and private customers. While private companies designed and manufactured rockets and spacecraft in the USA, this was only because NASA was willing to pay for the finished product. The private and commercial launch market did not materialize in any significant sense in the USA until at least 2011, when the retirement of the Space Shuttle Service opened opportunities for new entrants. In the remainder of the world, the commercialization and privatization of launch activities is nearly non-existent, perhaps with the exception of Arianespace in France. As discussed in chapters 3 and 4, the insight provided by the space treaties only informs law reform to a certain extent, upon which comparative analyses add value. Chapter 3 reviews, and learns from, the Canadian federal government's satellite-governing laws including the *RSSSA*, *RA*, *BA*, and *TA*.

---

[319] *Liability Convention*, *supra* note 147, at Preamble, arts XV(2), XVI(1), and XIX(3).
[320] *Ibid*, art XX.
[321] *Ibid*, art XIX(4).
[322] *Ibid*, art XVI(3).
[323] *Ibid*, art XV.
[324] *Ibid*, art XVI(4).
[325] *Ibid*, art XIX(2).
[326] *Ibid*, art XIX(1).

5: Summary and Conclusion

Canada's ratification of the *OST, ARRA, Liability Convention,* and *Registration Convention* place obligations on the State and guide the development of its space-governing laws. However, Canada has not yet codified all obligations into domestic law. Creating new legislation or amending existing legislation to honour these treaty commitments will improve investor confidence in the likelihood of the future stability of the Canadian launch market. The qualities listed in Table 2.1 summarize the obligations that will provide valuable guidance to the author when developing the *STAR Act* as a draft federal bill presented in chapter 5.

Table 2.1: United Nations Space Law Treaties Investigation Summary

Treaty	Recommended Legislative Enhancement	Treaty Section
OST	National governments shall explore and use outer space in accordance with international law, including the Charter of the UN, in the interest of maintaining international peace, security, cooperation, and understanding	I & III
	Both national governments, and their nationals, will not place nuclear weapons or weapons of mass destruction in orbit, install on celestial bodies, or station in space	IV
	National governments must authorize/supervise all space activity, whether conducted by the State or by that country's nationals	VI
	National governments shall retain jurisdiction and control of their authorized space objects that have been launched into outer space; space objects found beyond the limits of the State Party shall be returned to that State Party	VIII
	National governments shall undertake appropriate international consultations before proceeding with any outer space activity or experiment that may cause harmful interference with activities of other States Parties; national governments which believe that an activity or experiment planned by another State Party would cause harmful interference to their space activities may request consultation	IX
	National governments shall consider allowing other States Parties to observe launches and space objects in space, and shall allow other States Parties to visit space activities	X & XII
	National governments shall inform the public, the international community, and the UNSG of the nature, conduct, locations, and results of its activities in outer space	XI

ARRA	Develop a protocol to follow when astronauts are in danger and distress and require rescue, depending on where the astronauts are found; develop a protocol on how reimbursement will be pursued from foreign states when costs are incurred rescuing another State's astronauts	1 – 4
	Develop a protocol to follow when another State's space object has returned to Earth, depending on where the space object lands; develop a protocol on how to pursue reimbursement from the State(s) responsible for having caused the need for the space object return efforts	5
Registration Convention	National governments must maintain a national registry of space object information and transmit specifically listed information to the UNSG	II(1) & IV
Liability Convention	National governments assume absolute liability in the event their space object causes damage on Earth or in airspace	II
	National governments assume fault liability in the event their space object causes damage in outer space	III
	Upon having exhausted all negotiations through diplomatic channels, national governments may choose to commit to representing their nationals engaged in space-based activities, that have suffered costly injury, and that are seeking compensation from the injuring party, at the Claims Commission; nationals without the support of their national government cannot utilize the Claims Commission	VIII – XIV

CHAPTER 3: STRENGTHS AND WEAKNESSES OF CANADIAN SPACE-RELATED LEGISLATION

1: Introduction – History of Canadian Space Policy and its Highlighted Objectives

In 1967, Canada's Science Secretariat, a branch of the Privy Council Office, produced its *Chapman Report*[327] to inform and educate the government and other stakeholders on the state of the emerging field of space-based activities at the time. In 1974, Canada's Ministry of State for Science and Technology (MOSST) produced the country's first space policy paper, titled *Canadian Policy for Space,*[328] which recommended Canada strategically develop specific space applications emphasizing the importance of telecommunications satellites due to Canada's practical need to connect its citizens across large physical distances.[329] Eventually, remote sensing satellites were also prioritized because of the need to accurately monitor Canada's vast coastlines and survey its extensive natural resource deposits.[330]

MOSST produced another policy paper in 1981,[331] which was guided by the role of outer space in bringing both economic and social benefits to Canada,[332] then in 1985 released its *Interim Space Plan*[333] recognizing Canada's unfortunate inability to engage in the orbital rocketry industry, simply due to prohibitive costs.[334] Like the 1974 *Canadian Policy for Space*, the 1985 document promoted the country focusing its efforts "on a few areas where the probability of

---

[327] John Chapman et al., *Upper Atmosphere and Space Programs in Canada*, (Science Secretariat of Canada, 1967), online: <http://www.spaceq.ca/wp-content/uploads/2018/02/1967ChapmanReport.pdf> (27 September 2021).
[328] The author was unable to locate the original text of MOSST's 1974 *Canadian Policy for Space* and has relied on the work of: Aram Daniel Kerkonian, *New Law for New Space: The Case for a Comprehensive Canadian Space Law*, (Montreal: McGill Institute of Air and Space Law, 2020) at 107 (27 September 2021) [Aram Kerkonian]; and the summary of the text of the policy paper in: Ministry of State for Science and Technology, *Background Paper: The Canadian Space Program Plan for 1981/82 – 1983/84*, (Government of Canada: April 1981) at Foreword [*1981 Canadian Space Program Plan*].
[329] Aram Kerkonian, *supra* note 328; citing: Andrew Godefroy, *The Canadian Space Program: From Black Brant to the International Space Station*, (Springer: 2017), online: <https://dx.doi/org/10.1007/978-3-319-40105-8> (27 September 2021); Graham Gibbs & W Mac Evans, *Part 5: A History of the Canadian Space Program – Policies & Lessons Learned Coping with Modest Budgets*, (16 April 2017), The Commercial Space Blog, online: <http://acuriousguy.blogspot.com/2017/04/part-5-history-of-canadian-space.html> (27 September 2021).
[330] *1981 Canadian Space Program Plan*, *supra* note 328 at 6-7.
[331] Aram Kerkonian, *supra* note 328 at 108; citing: *1981 Canadian Space Program Plan*, *supra* note 328 at Foreword and at 1.
[332] Aram Kerkonian, *supra* note 328 at 109; citing: *1981 Canadian Space Program Plan*, *supra* note 328 at 2.
[333] Aram Kerkonian, *supra* note 328 at 114; citing: Ministry of State for Science and Technology, *Interim Space Plan 1985-1986*, (Government of Canada: March 1985) [*1985 Interim Space Plan*].
[334] *Ibid*.

achieving substantial benefits"[335] was the greatest, and which were detailed in a subsequent report released in 1986,[336] which discussed a prioritization of working on scientific space experiments in addition to continuing satellite development.[337]

The CSA was established in 1989, which then published its report *A New Horizon*, in 1994.[338] The document promoted further diversifying Canada's participation in space-based endeavors to include recruiting and training Canadian astronauts to assist international partners working on the ISS.[339] By 1999, the CSA began pivoting its organizational direction from one of scientific research and discovery to facilitating space-related industry development in Canada and enabling commercial actors to operate independent of significant government support.[340] Most recently, and in direct support of this thesis, Innovation, Science and Economic Development (ISED) noted in its 2019 space strategy report *Exploration, Innovation, Imagination*[341] the importance of deriving strategic benefit from improving national access to space as a means of job creation and economic stimulus.[342] The strategic report also noted a "modern regulatory framework"[343] would be required to more simply, clearly, and effectively govern commercial space activities and to ensure the industry develops safely, securely, and sustainably.[344]

Space-based activities have changed considerably since the *Chapman Report* in 1967. As countries continue developing and improving domestic licensing and authorization systems to responsibly govern commercialized orbital launches, many governments are now focusing efforts on more resource-intensive endeavors, such as NASA's Lunar Gateway and eventual

---

[335] Aram Kerkonian, *supra* note 328 at 114; citing: *1985 Interim Space Plan*, *supra* note 333 at 3.
[336] Aram Kerkonian, *supra* note 328 at 115; citing: Ministry of State for Science and Technology, *The Canadian Space Program: New Initiatives* (Government of Canada, May 1986) [*1986 Canadian Space Program*].
[337] Aram Kerkonian, *supra* note 328 at 116.
[338] *Ibid* at 117; citing: Canadian Space Agency, *The Canadian Space Program: A New Horizon*, (Government of Canada, 1994) [*Canadian New Horizon Space Program*].
[339] *Ibid.*
[340] *Ibid* at 120; citing *Canadian New Horizon Space Program*, *supra* note 338 at 11-12.
[341] Innovation, Science and Economic Development Canada, *Exploration, Imagination, Innovation: A New Space Strategy for Canada*, (Government of Canada, 2019), online: <https://www.asc-csa.gc.ca/pdf/eng/publications/space-strategy-for-canada.pdf> (3 May 2022) [*Exploration, Imagination, Innovation Plan*].
[342] *Ibid* at 7.
[343] *Ibid* at 16.
[344] *Ibid*.

journey to Mars.[345] The previous role of governments as the only "customers" willing and able to purchase entire orbital launches is now filled by private companies engaged in market transactions with launch providers.

Presently in Canada, the *AA* and *CAR* govern domestic aviation and aerospace-related activity, although with aspects that may be improved upon. For example, if Transport Canada more transparently, effectively, and predictably licensed and authorized orbital launches from Canadian territory, then investors, business leaders, and other stakeholders would benefit from improved and more sustainable operations and profitability.

As illustrated in Canada's previous space policies, developing the country's orbital rocketry capabilities and ensuring Canada's independent access to space was never prioritized nor pursued. Now, as space becomes increasingly affordable and accessible, new opportunities are emerging for Canada and other countries of similar economic size and power.[346] This chapter's section 1 discusses the aforementioned *AA* and *CAR*, as well as the *ATR*, by highlighting these laws' most valuable aspects as well as notable shortcomings. Sections 2 to 5 investigate the strengths and weaknesses of other domestic space-governing laws including the *RSSSA*, *RA*, *TA*, and *BA*. The chapter's overall analysis is applied when developing the proposed *STAR Act* in chapter 5.

2: Existing Laws Governing Rocketry: *Aeronautics Act*, *Canadian Aviation Regulations*, and *Air Transportation Regulations*

This section investigates the extent of Canadian law governing orbital launching activities in the country. Select sections of the *AA*, its associated *CAR*, and the *Canada Transportation Act's ATR* are explored in subsection 2.1 and critiqued in 2.2. Outstanding issues include a lack of clarity on the factors considered by the Transport Minister when evaluating license applications, inadequate insurance requirements for launch providers, unclear investigative procedures

[345] Brian Dunbar, "The Future – Human Spaceflight" (nd), NASA, online: <https://www.nasa.gov/specials/60counting/future.html> (27 September 2021).
[346] Luke Harding, "The space race is back on – but who will win? (16 July 2021)" The Guardian, online: <https://www.theguardian.com/science/2021/jul/16/the-space-race-is-back-on-but-who-will-win> (27 September 2021).

following a disastrous incident, and a current lack of national and provincial compliance with obligations at international law.

2.1 Application of Existing Legislative Scheme

The *AA's* section 4.2(1)(a) through (o) confers upon Transport Canada's Minister of Transport[347] regulatory oversight of rocket launches in Canada.[348] Section 3(1) of the *AA* defines "aeronautical product" as: "any aircraft, aircraft engine, aircraft propeller or aircraft appliance or part or the component parts of any of those things, including any computer system and software." "Aircraft" is also defined in 3(1) as: "any machine capable of deriving support in the atmosphere from reactions of the air, and includes a rocket." This definition only extends the *legal* scope of "aircraft" to include rockets, as it is incorrect as a technical definition: rockets contain all fuel necessary to propel themselves and do not derive any support from reactions with the oxygen in the atmosphere, unlike airplanes. However, as Ruth Sullivan again explains, this is not problematic from a legislative drafting standpoint "Because the legislature is sovereign, it may assign meanings to words that bear little or no relation to their ordinary meaning."[349] Another implication of including rockets within the definition of aircraft is this includes spaceports in the definition of "aerodrome",[350] while in reality the two are very different in terms of cost, security risks, and complexity of infrastructure.

Although the *AA* does not offer any specific definition of the term "rocket" itself, the *CAR's* section 101.01(1) defines rocket as: "a projectile that contains its own propellant and that depends for its flight on a reaction set up by the release of a continuous jet of rapidly expanding gases."[351] While rockets are accurately described by the definition in the *CAR*, they are also included in the *AA's* broader term "aircraft". Applying technical details of the Cyclone-4M integrated launch vehicle[352] (ILV) to *CAR's* section 101.01(1) definition of rocket reveals the

---

[347] *AA*, *supra* note 235, s 4.2(1).
[348] "Requirements for Launching High Power Rockets in Canada" (4 January 2000), Transport Canada, online: at 1 <https://www.canadianrocketry.org/resources/Documents/tc_hpr_reqs_jan00.pdf> (1 March 2020).
[349] Ruth Sullivan, *supra* note 142 at 68.
[350] *AA*, *supra* note 235, s 3(1).
[351] *CAR*, *supra* note 236, s 101.01(1).
[352] "Cyclone-4M SLS Abbreviated User's Guide" (15 May 2019), Maritime Launch Services, online: at 3-5 <https://www.maritimelaunch.com/sites/default/files/2019-08/UG_C4M%20abbreviated.pdf> (5 April 2021).

vehicle is within scope: the rocket is a two-stage-to-orbit projectile powered by four RD870 engines using its own kerosene and liquid oxygen in the first stage, followed by one RD861K engine using hypergolic propellants in the second stage.

Under section 7.1(1)(c) of the *AA*, the Transport Minister has the option to either temporarily suspend or outright cancel a previously-issued license, or refuse the approval of a launch license renewal application. Specifically, this section 7.1(1)(c) grants the Minister these abilities if he/she "is of the opinion that the public interest…warrant[s] it". The *AA's* section 4.9 provides the Governor in Council authority to make regulations respecting aeronautics, which includes provisions contained in the *CAR*. Pursuant to the *AA's* previously mentioned section 4.2(1)(o), the Minister of Transport may, in addition to the responsibilities included in the rest of 4.2(1), "undertake such other activities in relation to aeronautics as the Minister considers appropriate or as the Governor in Council may direct." This subsection 4.2(1)(o) is highly generalized and not only extends the Minister's decision-making abilities to those issues explicitly written in section 4.9, but also to anything the Minister "considers appropriate".

Specifically, section 4.9 lists subsections (a) through (w), of which (a), (b), (c), and (e) are of particular interest. First, 4.9(a) allows the Governor in Council to license (i) operators of aeronautics, and (ii) people responsible for designing, manufacturing, distributing, maintaining, and certifying aeronautics. 4.9(b) extends the Governor in Council's regulatory-making powers to include: "the design, manufacture, distribution, maintenance, approval, installation, inspection, registration, licensing, identification and certification of aeronautical products", and (c) to "the design, installation, inspection, maintenance, approval, and certification of equipment and facilities used to provide services relating to aeronautics," which, as based on the *AA's* definitions, captures rockets. 4.9(e) grants the Governor in Council control over regulating "activities at aerodromes", which, again based on the definitions, includes spaceports.

In terms of the *CAR*, two of its relevant sections include 602.43 and 602.44, which grant specific authorizing powers to the Transport Minister:

> 602.43: Rockets – No person shall launch a rocket, other than a model rocket or a rocket of a type used in a fireworks display, except in accordance with an authorization issued by the Minister pursuant to section 602.44.[353]
>
> 602.44: Authorization by the Minister – The Minister may issue an authorization referred to in section 602.42 [hot air balloons] or 602.43 where the release of the balloon or the launch of the rocket is in the public interest and is not likely to affect aviation safety.[354]

CAR only differentiates between "model rocket(s)" and all other rockets, as it defines model rockets as projectiles weighing less than 1.5 kilograms and that exert small amounts of energy. These types of rockets would typically be used by amateur rocketry enthusiasts in rural areas. A Cyclone-4M ILV is significantly larger[355] and more powerful[356] than a model rocket and does not return to Earth, thus fitting within scope of 602.43 and 602.44. For practical purposes, prospective applicants must submit a Launch Authorization request to Transport Canada, complete with a Special Flight Operations Certificate (SFOC), for assessment before receiving authorization to launch a rocket. Other than the 3,500 suborbital rockets launched from the Churchill Rocket Research Range by the federal government during the 1960s, 70s, and 80s, Transport Canada has authorized only one private high power suborbital rocket launch, and zero private orbital launches: the authorized suborbital vehicle was scheduled to liftoff from Saskatchewan in late 2004, but the launch was never attempted.[357]

Finally, section 606.02 of *CAR* prescribes liability insurance requirements for aircraft owners based on the number of passengers onboard and the maximum certified take-off weight (MCTOW), akin to the gross weight including cargo and passengers, of the craft. Again through *CAR's* definitions, these insurance requirements extend to rocket owners, regardless of whether the rocket has been registered in Canada or registered in a foreign State but operated in Canada. This section 606.02(1) refers the reader to section 7 of the *ATR*, which explains different formulas used to calculate the required amount of liability insurance that airline operators must acquire, depending on the weight of their "air carrier". Orbital rockets greatly exceed the last weight threshold of 8,165 kg, and thus formula 7(1)(b)(iii) is the correct one to apply:

---

[353] *CAR*, *supra* note 236, s 602.43.
[354] *Ibid*, s 602.44.
[355] Model rockets must weigh less than 1.5 kg; Cyclone-4M rockets weigh 274,700 kg.
[356] Model rockets must exert less than 0.16 kilo-Newtons (kN) during launch; Cyclone-4M rockets exert 3,130 kN.
[357] Emily Chung, "Canadian space flight dreams live on" (12 November 2010), CBC, online: <https://www.cbc.ca/news/science/canadian-space-flight-dreams-live-on-1.895322> (7 September 2021).

($595,000 * max number of passengers) + [$3,970,000 + ($655 * kg rocket exceeds 8,165 kg)]

The *ATR* defines "air carrier" as entities or persons operating domestic services or international services,[358] although does not offer any further definition of "services". However, following numerous definitions within the *AA*, "air carrier" eventually captures commercial rocketry launch providers in both the scope of the *AA* and *CAR*.[359] While the *ATR's* insurance provisions may apply well to aircraft carriers, they do not adequately apply to orbital rocketry, as will be discussed in section 2.2.3, below.

2.2 Shortcomings of the *AA*, *CAR*, and *ATR*

There are five qualities of Canada's current legislative scheme that present problems for further development of the Canadian rocketry industry and that would benefit from reform. The first two qualities relate to the orbital rocketry licensing system, beginning with the lack of guidance and clarity in the assessment criteria used by the Transport Minister to evaluate launch license applications. The second of these qualities involves the uncertainty of the Minister's ability, pursuant to section 7.1(1)(c) of the *AA*, to cancel previously-issued licenses. This is problematic for investors and business leaders in instances where a launch license may have been granted by the Minister of one political party, but is then at risk of subsequent cancelation by a newly elected government.

Third, *CAR's* liability insurance requirements, and specifically the *ATR's,* may be very effective when applied to the airline industry but are inadequate when applied to rocketry. As will be demonstrated, the calculation to determine minimum required insurance for an aeronautical activity depends on the number of passengers onboard and also on a linear relationship with gross weight, meaning the framework does not accurately reflect the greater risk involved in rocket launches nor that rockets are predominantly launched with cargo on board, rather than

[358] *ATR*, *supra* note 247, s 2.
[359] As defined in the *AA*: "air carrier" includes a person operating a commercial air service; "commercial air service" includes the use of aircraft for hire or reward; "hire or reward" extends to any payment received or demanded for the use of an aircraft.

passengers. Reforming these legislative sections will more accurately reflect the level of risk of a launch and ensure the federal government is more likely to be reimbursed for costly incidents.

Fourth, numerous obligations at international law from the UN space treaties still require implementation in Canada. Honouring these obligations will likely smooth tensions within Canadian diplomatic exchanges and further improve the likelihood the Canadian federal government will support this domestic industry. Fifth, there is a lack of certainty perceived by the public concerning contingency plans of the federal government in the event of a disastrous incident, such as specific safety plans for saving astronauts in distress and assisting those on the ground. Even if the federal government has developed sufficient plans in the event of an emergency, including investigation policies, risk identification strategies, and technical competency reviews, ensuring these strategies are publicly known, especially for stakeholders of the industry itself, will improve investor confidence and support.

2.2.1: Detailing Launch License Applications and Evaluations

CAR's section 602.44 provides two factors for the Minister of Transport to consider when assessing launch license applications, including: (1) the public interest, and (2) aviation safety. The lack of precision and clarity in these criteria means the Minister must exercise vast discretion to meaningfully apply them, in which case prospective applicants will have difficulty determining the likelihood that their submitted launch applications will be granted or rejected. The term "in the public interest" is unclear, ambiguous, and subject to interpretation. It undoubtedly involves different types of considerations of its own, including prospective financial and scientific benefits, risks to national security and sovereignty, effects on human and environmental health and safety, and many other factors. The term "aviation safety" may be clearer as this criterion would likely account for the protection of nearby air traffic, attempt to minimize effects on flight paths and airline schedules, and ensure adequate communication and dialogue occur between launch operators and air traffic controllers. Further descriptions and definitions of these terms would allow the Transport Minister to survey more relevant issues and consistently apply identical metrics when assessing every license application. This extra clarity

will also improve the Transport Minister's ability to approve only applications of the highest-performing, lowest-risk, and most cost-effective launch providers.

Beyond 602.44's two existing factors, ensuring other considerations are contemplated by the Minister would also add value and certainty for investors, business leaders, and stakeholders. For example, a broad category deemed "non-aviation safety" could be considered, which would include ensuring orbital launch providers respect and maintain public safety on the ground, minimize associated risks of damage to all types of property, prohibit the use of environmentally harmful and destructive rocket fuels and/or mandate use of certain types of less toxic propellants, and address the differing safety standards for crewed versus uncrewed launches, as well as for the size of the rocket itself.

Threats to national security must be addressed, particularly because these concerns will fall both within and outside the scope of acting "in the public interest", based on an application of sections 38, 38.01, 38.02, and 38.06 of the *Canada Evidence Act*[360] (*CEA*). The *CEA* allows the judiciary to prevent the disclosure of "sensitive" and "potentially injurious" information during a proceeding before a court, that could damage or compromise international relations, national defence, and/or national security.[361] Section 38.06 requires the judiciary, upon having determined certain information could damage national interests, balance the public interest in disclosure of the information against the public interest in non-disclosure of the information, to determine if the potentially injurious or compromising information should be released to the public.[362] Notably, these sections of the *CEA* were discussed in each of *Canada (Attorney General) v Khawaja,* 2007 CAF 342, *R v Ahmad,* 2011 SCC 6, and *Re Harkat,* 2014 SCC 37. Providing clarity on evaluation criteria and procedures will inform applicants of the specific qualities necessary to successfully obtain a launch authorization, particularly when certain factors, such when applying "in the public interest" to national security, can be interpreted differently.

[360] *Canada Evidence Act,* RSC 1985, c C-5 [*CEA*].
[361] *Ibid,* s 38.
[362] *Ibid,* s 38.06(2).

2.2.2: Appropriate Reasons to Cancel Previously-Issued Launch Licenses

A licensing scheme's clarity, reliability, and dependability would be improved by addressing the possibility that the Transport Minister may arbitrarily suspend, cancel, or choose not to renew license applications. Under the *AA's* subsection 7.1(1)(c), if the Minister is "of the opinion that the public interest … warrant[s] it [cancelation]", then a license may be terminated. While subsections 7.1(1)(a) and (b) serve the valuable purpose of enabling the Transport Minister to cancel launch licenses if an applicant demonstrates they are later unable to competently perform the launch, subsection 7.1(1)(c) grants the Minister an excessive amount of discretion that would be difficult to warrant and predict. While reasons falling within the scope of the "public interest" may be appropriate in certain circumstances, the extreme amount of power it confers on the Transport Minister means successful applicants could lose their approved license(s) even if they can still safely perform the launch. This uncertainty will reduce launch provider interest in the Canadian market by diminishing their abilities to accurately forecast business operations.

A solution to this uncertainty exists in learning from the Supreme Court of Canada's 1997 *Comeau's Sea Foods Ltd. v Canada (Minister of Fisheries and Oceans)*[363] [*Comeau's*] decision. In *Comeau's*, a fishing company incurred expenses converting one of the company's scallop-fishing ships into a lobster-catching vessel. The *Fisheries Act*[364] distinguishes between the Minister of Fisheries and Oceans' ability to "issue" licenses and "authorize [licenses] to be issued".[365] The difference is significant because "issued" licenses are those having been both approved and officially granted to the fishing company, and thus may only be revoked under certain narrow and objective criteria listed in the *Fisheries Act's* section 9. Meanwhile, licenses that are "authorize[d] to be issued", meaning they were approved but not yet officially granted, could be revoked by the Minister subject only to the "requirement of natural justice…"[366] with the result being "…an administrative scheme based primarily on the discretion of the Minister…"[367] This is similar to the preceding concern of the excessive Ministerial discretion lying within the *AA's* 7.1(1)(c).

---

[363] [1997] 1 SCR 12 [*Comeau's*].
[364] RSC 1985, c F-14.
[365] *Ibid*, s 7.
[366] *Comeau's*, *supra* note 363, at para 36.
[367] *Ibid.*

To address the uncertainty of the Minister's ability to cancel a license in "the public interest", section 47 of the proposed *STAR Act* limits the Transport Minister to only cancelling granted licenses because of risks to public safety, protection of property, environmental health, and/or national security. Eliminating the ability for the federal government to cancel a launch license for purely subjective and political reasons will improve investor confidence in the future of the industry while also maintaining the safety of Canadians.

2.2.3: Tailoring Liability Insurance Requirements to Rockets: the *Air Transportation Regulations*

The *AA* and *CAR* do not appropriately distinguish between different sizes of rockets, nor address the *ATR* calculation's reliance on passenger numbers, when determining minimum liability insurance requirements for rockets. Throughout this subsection, note the different MCTOWs of a Boeing 747-8, Cyclone-4M, and Falcon 9, and note the payload limits for the two rockets:

Table 3.1: Problematic Insurance Calculations

Craft	Max Passengers	MCTOW	Payload to LEO
Boeing 747-8	410	447,696 kg	-
Cyclone-4M	0	272,000 kg	5,000 kg
Falcon 9	0	549,000 kg	22,800 kg

With respect to passenger numbers, the *ATR's* section 7(1)(a) prescribes the relevant formula for air carriers, which also includes rockets, as:

$595,000 * max number of passengers

Since 98 percent of rockets are uncrewed, this results in $0 of insurance for the first half of the equation for a typical cargo rocket launch. A Boeing 747-8's maximum carrying capacity of 410 passengers,[368] however, results in insurance requirements of:

$595,000 * 410 passengers = $243,950,000

[368] "Boeing 747-8: Technical Specs" Boeing, online: <https://www.boeing.com/commercial/747/> (14 September 2021).

Next, the second part of the calculation described in 7(1)(b)(i)-(iii) produces different insurance minimums for the two rockets and the 747-8, which the *CAR* could address by adding new weight caps and thresholds into its text. Currently, *CAR* distinguishes only between a "model rocket", as those weighing less than 1.5 kg,[369] and every other rocket weighing anything more. The practical result is that all orbital rockets are grouped together and recognized identically by the law, which is inappropriate due to the significant differences in risk and potential disaster between rockets of various sizes, and the differences in tolerances for levels of risk depending on whether a rocket is launching an uncrewed or crewed mission. Additionally, *CAR* fails to adequately distinguish between *different* types of rockets because it relies on MCTOW rather than payload weight. The typical means of classifying rockets in the industry depends on the amount of payload deliverable to LEO, termed as either small- (<2 tonnes (t) payload), medium- (2-20 t), heavy- (20-50 t), or super-heavy- (>50+ t) lift vehicles.[370]

The Cyclone-4M is a medium-lift rocket capable of delivering a maximum 5,000 kg of payload to LEO and has a total gross weight of 272,000 kg.[371] Note in Table 3.1 that the payload figures do not fluctuate in proportion to the MCTOW: Elon's Falcon 9 delivers four times the payload of a Cyclone-4M yet only weighs twice as much: 22,800 kg vs 5,000 kg payload; 549,000 kg vs 272,000 kg gross weight).[372] In terms of insurance requirements, it is more economical and cost-effective for providers to launch heavier rockets rather than lighter ones, as demonstrated in the following calculations:

ATR section 7(1)(b) prescribes different formulas based solely on the MCTOW, which includes payload onboard, where crafts weighing:

(i) less than 3,402 kg require $1,985,000 of insurance;

(ii) between 3,402 kg and 8,165 kg require $3,970,000; or

[369] *CAR*, *supra* note 236, s 101.01.
[370] "Draft Launch Propulsion Systems Roadmap" (November 2010), National Aeronautics and Space Administration, online: <https://www.nasa.gov/pdf/500393main_TA01-LaunchPropulsion-DRAFT-Nov2010-A.pdf> (16 August 2021).
[371] Alain Chabot, "Tsyklon-4M (Cyclone-4M) prepares a move to Canada" (16 March 2017), Russian Space Web, online: <http://www.russianspaceweb.com/tsyklon4m.html> (7 September 2021).
[372] "Falcon 9: Overview" SpaceX, online: <https://www.spacex.com/vehicles/falcon-9/> (20 July 2021).

(iii) more than 8,165 kg require [$3,970,000 + ($655 * number of kg by which the rocket exceeds 8,165 kg)].

This means that, upon applying the appropriate formula (iii), a Boeing 747-8[373] must be insured with a minimum of $292 million:

$3,970,000 + ($655 * (447,696kg – 8,165 kg)) = $3,970,000 + $287,892,805 = $291,862,805

Due to the Cyclone-4Ms weight also being over 8,165 kg, the appropriate formula is also (iii), and means the Cyclone-4M requires a minimum level of insurance of $177 million:

$3,970,000 + ($655 * (272,000 kg – 8,165 kg)) = $3,970,000 + $172,811,925 = $176,781,925

And similarly, the Falcon 9's minimum insurance is calculated using (iii), for a minimum amount of $358 million:

$3,970,000 + ($655 * (549,000 kg – 8,165 kg)) = $3,970,000 + $354,246,925 = $358,216,925

These calculations demonstrate how the operator of a Boeing 747-8 must acquire a total of $502 million ($244M + $358M) of insurance before operating the craft, while a Cyclone-4M operator would need $177 million and a Falcon 9 would require $358 million. The result is high power rockets may legally launch in Canada with less insurance than airplanes, despite presenting significantly more risk of disaster. Two key issues are evident, first that the *ATR's* scheme places too much emphasis on the number of passengers onboard a rocket, and second, the *ATR's* formulas only consider the MCTOW of the rocket itself and do not account for increases in value derived from more payload.

Although greater payload weight will be captured within the MCTOW, the *ATR's* formula should distinguish between the gross weight of the rocket and the weight of the rocket's payload, because one additional kilogram of the entire rocket increases launch costs while one additional kilogram of payload increases both launch costs and launch revenues. The disproportionate ratio that exists between the increase in weight of the rocket and the increase in amount of payload it

[373] "Boeing 747 8 Specs" Modern Airliners, online: <https://modernairliners.com/boeing-747-8/boeing-747-8i-and-8f-specs/> (14 September 2021).

carries means profitability improves with the size of the rocket. For example, Falcon 9 launches deliver 4.6 times[374] the payload, and thus 4.6 times the revenue, than the Cyclone-4M, while only requiring 2 times[375] the liability insurance because it only weighs 2 times as much. Launch providers could more than quadruple revenues while only doubling costs, meaning they will be incentivized to launch larger rockets over smaller ones. This is problematic because larger rockets consume more fuel and emit more toxic chemicals than lighter rockets and in turn cause greater negative externalities, including more damage to the surrounding environment and increased deterioration of local people's overall health. If a larger rocket failed at launch, the damage caused to the environment would be more significant and thus also would be the threat to national security, the physical safety of humans, and the quality of infrastructure and private property.

As will be discussed in chapter 5, it may be worthwhile encouraging providers to launch rockets of every size. In chapter 4, there is also a useful discussion of the USA's legislative approach to mandated insurance. Finally, because of the inadequacies of Canada's present insurance scheme, the federal government is at greater risk of failing to collect on the potentially millions of dollars owed to it by the nationals having actually caused such disasters. Although court-ordered indemnifications and compensation are one possible course of action, launch insurance throughout the world has proven to be a preferable means for governments and other third parties to mitigate against non-payment and to more realistically collect on amounts owed.[376]

2.2.4: Basing Domestic Law on International Treaties

As discussed in chapter 2, Canada's obligations under UN space treaties should be considered when developing new laws or updating existing ones. For example, recall that Article II of the *Liability Convention* requires a launching State assume fault liability when its authorized space object damages another space object in outer space. Article III prescribes a launching State assume absolute liability for damage caused by its authorized space objects either in airspace or on Earth. Since a launching State is always liable for a disastrous incident, whether it directly

[374] 22,800 kg / 5,000 kg = 4.56.
[375] $358M / $177M = 2.02.
[376] Australian Space Leadership, *supra* note 231 at 14.

caused the damage itself or not, reforming legal insurance stipulations provide a greater chance of Canada realistically receiving financial compensation for out-of-pocket expenses, and in turn will increase stakeholder confidence.

Legislation partially requires Transport Canada to comply with Article II of the *Registration Convention* by its administration of *CAR* section 202.69. Article II requires countries maintain a national registry of all state authorized space objects launched into orbit and to transmit this information to the UNSG. *CAR* section 202.69 mandates the Transport Minister "establish, maintain, and publish a register of aircraft, to be known as the *Canadian Civil Aircraft Register* … "[377] (CCAR). The CCAR is publicly available online[378] and is a searchable database containing aircraft registration information since 1982. In practice, the CSA is responsible for maintaining a national registry of space objects and collaborates with Global Affairs Canada (GAC), the government department which administers the *RSSSA*, to transmit space object registration information to the UNSG.[379]

Although there is value in the CCAR as it currently exists, since the *AA's* definition of "aircraft" extends to rockets, there is no legal requirement to register other space objects, such as satellites, in the database. Furthermore, neither the *AA* nor the *CAR* honour Article II's additional requirement that countries transmit space object information in its national registry to the UNSG. Foreign states have approached these obligations differently, such as the USA's *14 CFR* section 417.19,[380] and Denmark's 2016 Outer Space Act's section 10,[381] which both require their respective nations maintain a national registry with information on all authorized space objects and also to send this information to the UNSG.

---

[377] *CAR, supra* note 236, s 202.69(1).
[378] "CCAR – Quick Search" (nd), Government of Canada, online: <https://wwwapps.tc.gc.ca/Saf-Sec-Sur/2/CCARCS-RIACC/RchSimp.aspx> (16 August 2021).
[379] *2022 RSSSA Review, supra* note 136 at 37.
[380] *14 CFR, supra* note 244, § 417.19.
[381] Michael Listner, "A Comprehensive first look at Denmark's domestic space law" (31 May 2016), The Space Review, online: <https://www.thespacereview.com/article/2994/1#:~:> (24 July 2020).

2.2.5: Developing Federal Disaster Investigations, Equipment Monitoring, Safety Standards, and Emergency Plans

Other elements of existing laws that would benefit from further regulatory clarification include the extent, requirement, and permissibility of federal investigations into technical specifications of orbital rockets, federal monitoring of launch provider activities and spaceport operations, extent of allowable and mandatory launch provider testing of equipment and rockets, requirements for adequate risk identification, formulation of contingency plans to address significant risks, proper licensing of qualified spaceport operators, accounting for the moral and financial guarantees of the launch provider, assessing technical capabilities and competencies of the provider as an organization, background checks on key individuals involved in the launch process, and the safety of Canadian armed forces.

2.3: Summary and Implications of Shortfalls

The lack of past orbital launches in Canada, and associated lack of authorizations by Transport Canada, leaves prospective investors uncertain of what distinguishes a successful launch application from an unsuccessful one, or even the evaluation criteria used. Stakeholders do not know whether the reason for the lack of orbital launches is occurring because Transport Ministers' have consistently assessed applications by applying a very high standard, or because there have been very few, if any, launch applications submitted. As discussed throughout this thesis, there is great potential value in developing launching technology. The *Chapman Report* differentiated between science and technology as "science is useful and helpful but technology is commercialisable and exportable."[382] There is also benefit in providing greater clarity on the evaluation procedure used to assess applications, and in minimizing associated Ministerial discretion, as this will improve the accuracy of industry forecasting efforts, improve stakeholder confidence, and attract more business leaders and investors to the industry. Greater clarity on the type of decision matrix used by the Transport Minister would also allow for a more expeditious and comprehensive assessment, and a more accurate verdict on launch applications. Finally,

[382] Aram Kerkonian, *supra* note 328.

Aram Daniel Kerkonian stated it well in his 2020 Doctor of Civil Law thesis when he wrote that launch providers seeking to operate in Canada are in a "legally precarious position."[383]

3: Remote Sensing Satellites: Learning from the *Remote Sensing Space Systems Act*

Remote sensing satellites observe the Earth from orbit by emitting electromagnetic waves[384] and perform a variety of applications, including imaging changing vegetative growth to study climate change trends, deforestation, weather patterns, and water runoff patterns. Remote sensing satellites collect data for geological surveying purposes to gauge and estimate the existence and quantity of natural resources. The *RSSSA* was created to implement the *Agreement Between the Government of Canada and the Government of the United States of America Concerning the Operation of Commercial Remote Sensing Satellite Systems*, created in 2000.[385] This bilateral agreement was formed to improve governance of private remote sensing satellite operations of the two countries, mainly to protect national security and further foreign policy interests.[386]

The *RSSSA* governs remote sensing satellites and it states in its section 5: "No person shall operate a remote sensing space system in any manner, directly or indirectly, except under the authority of a license."[387] In accordance with the obligations imposed by the *OST* these types of space objects must be authorized by the federal government.[388] Entities wishing to launch a remote sensing satellite into orbit, and operate it accordingly, must seek authorization by applying for a license from GAC. Section 8(1) explains the factors that GAC's Minister of Foreign Affairs must assess when evaluating a license application including upholding national security interests, Canadian defence efforts and the safety of Canadian Military, the country's engagement in international relations including obligations at international law (such as UN space treaties), and any other "prescribed" factors.

---

[383] *Ibid* at 146.
[384] *RSSSA*, *supra* note 135, s 2.
[385] Global Affairs Canada, CTS 2000 No 14, (Government of Canada: 3 March 2014), online: <https://www.treaty-accord.gc.ca/text-texte.aspx?id=103522> (27 September 2021).
[386] Aram Kerkonian, *supra* note 328 at 150; citing: Ram Jakhu, *Regulation of Space Activities in Canada*, (2005) 48 Proceedings on L of Outer Space 267 at 276.
[387] *RSSSA*, *supra* note 135, s 5.
[388] *OST*, *supra* note 251, art VI.

Section 11(1) of the *RSSSA* allows the Minister of Foreign Affairs to suspend a license if satisfied a licensed remote sensing space system is likely to be "(a) injurious to national security, the defence of Canada, the safety of Canadian Forces or Canada's conduct of international relations; or (b) inconsistent with Canada's international obligations." Similarly, section 14(1) allows the Minister to interrupt or restrict a licensee's operation of a remote sensing satellite if its continued operation "would be injurious to Canada's conduct of international relations or inconsistent with Canada's international obligations." The 2017 *Independent Review of the RSSSA*[389] identified section 14 as problematic when it stated:

> This authority is unquestionably broad: there is no explanation as to what may constitute reasonable grounds, whether there is a maximum period of interruption or restriction, whether the Minister has to justify a restriction to the licensee (and if so, how) or whether a licensee affected by such an order has the opportunity to offer alternative solutions or mitigate the harm they are to suffer.[390]

Additionally, section 10 of the *RSSSA* allows the Minister of Foreign Affairs to amend the terms of licenses that have already been granted, under much wider circumstances compared to suspending a license, thus further increasing the applicable political discretion. The entirety of the *RSSSA* is very broad in scope and application,[391] the terms used are too imprecise, and they do not provide the adequate clarity, predictability, or certainty that effective legislation must offer stakeholders. The result is there is too much discretion and interpretation afforded to the Minister when determining whether to suspend a license under section 11, cancel a license under section 12, or interrupt satellite operations under section 14, and thus excessive uncertainty for those in the industry.

As discussed throughout the entirety of the *2022 RSSSA Review*, the *RSSSA* has become outdated due to changes in remote sensing technology and in light of the changing remote sensing satellite market.[392] While the Canadian government originally enacted the *RSSSA* with the intention of protecting foreign policy and national security interests, including the protection of Canadian

[389] 2017 *RSSSA Review, supra* note 242.
[390] *Ibid*, at 13.
[391] *2022 RSSSA Review, supra* note 136 at 25, 26, 46, 56.
[392] *Ibid* at 1-2.

Forces,[393] the widespread use and availability of the data collected by the many hundreds of remote sensing satellites that have now been launched by other nations has reduced the impact, and usefulness, of the relatively more stringent regulations on Canadian remote sensing satellite operators.[394] The result is that Canadian remote sensing businesses and entities are disadvantaged on the world market and many operators simply choose to conduct business elsewhere[395]: the *2022 RSSSA Review* found that 9 of 21 of its survey respondents (43 percent) reported that costs spent on navigating the licensing application process and other "red-tape" obstacles were either "Significant" or "Prohibitive".[396] The *2022 RSSSA Review* writes that

> It is a central thesis of this Independent Review that the original security and foreign policy risks that the *RSSSA* addresses have been overcome by events – government can now safely prioritize the use of space to support Canadian economic and social development over security concerns from remote sensing space systems.[397]

The *2022 RSSSA Review* provides valuable insight that the *RSSSA*, the only major piece of Canadian legislation that directly governs activities in outer space, has become outdated, and is in desperate need of amendments. In many ways, the *RSSSA* is much too imprecise, but in other ways, it is this lack of specificity that has allowed the Act to even continue applying as long as it already has.[398] Accordingly, drafting new legislation, such as the *STAR Act*, that governs quickly evolving industries, in ways that offer flexibility, adaptability, and, as will eventually become necessary for all legislation, the ability to easily amend, will be worthwhile.

The *RSSSA's* terms that are "prescribed by regulations", as mentioned previously, are listed in the Act's *Remote Sensing Space System Regulations*'[399] (*RSSSR)*. The *RSSSR's* section 8 lists prescribed factors as the ability of an applicant to comply with the *RSSSA* and *RSSSR*, as well as with the application itself, and that the competitiveness of the Canadian remote sensing industry will be enhanced both at the national and international levels by granting the application.[400] In terms of renewing a remote sensing license, the *RSSSR's* section 9 discusses the need to consider

---

[393] *RSSSA*, *supra* note 135, s 8.
[394] *2022 RSSSA Review*, *supra* note 136 at 1-2.
[395] *Ibid* at 2.
[396] *Ibid* at 1.
[397] *Ibid* at 47.
[398] *Ibid* at 46.
[399] SOR/2007-66 [*RSSSR*].
[400] *RSSSA*, *supra* note 135, s 8(b).

if applicants have any outstanding fees, fines, or penalties due under the *RSSSA*,[401] the risk of remote sensing satellites endangering the environment, public health, or safety of persons and property if they are not disposed of properly,[402] and the level of security of the transmission of raw data from remote sensing satellites to its recipients.[403] By explicitly listing the above, the federal government ensures a detailed and comprehensive evaluation framework is applied to all license applications.

The *RSSSR's* Schedule 1 provides further clarity on what must be included in license applications,[404] including the names and contact information of prospective operators, policies on applicant personnel screening and security clearances, and descriptions of the remote sensing space system itself.[405] Additionally Schedule 1's section 10 requires information on the proposed launch date, launch vehicle, and launch site to be used. Section 11 of Schedule 1 requires inclusion of the remote sensing system's orbital specifications, such as the satellite's intended axis, eccentricity, inclination, and right ascension. Lastly, section 22 to 29 of Schedule 1 mandates operators provide detailed information on security measures, such as electronic safeguards, used to prevent cyber-attacks targeting stored data. The *RSSSR's* Schedule 2 lists the specific financial penalties, ranging from a low of $1,000 to a high of $25,000, depending on which provision of the *RSSSA* or *RSSSR* is contravened and if the operator was acting as an individual or corporation.[406]

4: Uses of Radio in Canada: Learning from the *Radiocommunication Act*

Radiocommunication ("radio") and spectrum satellites broadcast frequencies from their orbital location to ground-based stations. While the *RSSSA* is administered by GAC, the *RA* falls under the jurisdiction of ISED and its Minister of Innovation, Science and Industry. Section 5(1) of the *RA* explains how the ISED Minister may,

[401] *RSSSR*, *supra* note 399, s 9(a).
[402] *Ibid*, s 9(b).
[403] *Ibid*, s 9(c).
[404] *Ibid*, Schedule 1.
[405] *Ibid*, Schedule 1(1)-(3), (9)
[406] *Ibid*, Schedule 2, s 24.

> taking into account all matters that the Minister considers relevant for ensuring the orderly establishment or modification of radio stations and the orderly development and efficient operation of radiocommunication in Canada, (a) issue (i) radio licenses in respect of radio apparatus, (i.1) spectrum licenses in respect of the utilization of specified radio frequencies within a defined geographic area…

The *RA* defines radiocommunication as: "any transmission, emission or reception of signs, signals, writing, images, sounds or intelligence of any nature by means of electromagnetic waves of frequencies lower than 3 000 GHz propagated in space without artificial guide."[407] The practical applications of radio satellites include telecommunications services, television broadcasts, internet-based communications, and all radio frequencies. Spectrum satellites are also governed by the *RA* and include the transmission of radio frequencies as well, but, unlike radiocommunication, only send messages and data within a defined geographic area.
The upward limit of 3,000 GHz aligns with the scope of the International Telecommunication Union's (ITU) *Radio Regulations,* which "apply to some 40 different radiocommunication services around the world, and cover frequencies ranging from 9kHz to 3000 GHz."[408]

The ITU was established in 1865, is the specialized agency for information and communication technologies for the UN,[409] and has 193 Member States.[410] "Pursuant to its Constitution, the ITU is responsible for the allocation of spectrum and registration of frequency assignments, and or orbital positions and other parameters of satellites in order to avoid harmful interference between radio stations of different countries."[411] The ITU's *Radio Regulations* are the product of collaboration within the international community to create a global regulatory framework. As such, "Complying with this framework is an essential task for ITU Member State administrations to ensure their services obtain international recognition and are compatible with the services of other ITU Member State administrations."[412]

---

[407] *RA, supra* note 248, s 2.
[408] Matthew Clark, "Celebrating the *Radio Regulations*" (May 2016), ITU News Magazine, online: <https://www.itu.int/en/itunews/Documents/2016-05/2016_ITUNews05-en.pdf> at 2 (3 May 2022) [Celebrating the *Radio Regulations*].
[409] "About International Telecommunication Union (ITU)" (2022), ITU, online: <https://www.itu.int/en/about/Pages/default.aspx> (3 May 2022).
[410] "List of ITU Member States" (2022), ITU, online: <https://www.itu.int/en/ITU-R/terrestrial/fmd/Pages/administrations_members.aspx> (3 May 2022).
[411] Celebrating the *Radio Regulations, supra* note 408 at 13, n 1.
[412] *Ibid* at 13.

Returning to the *RA*, and pursuant to subsection 5(1)(b), the Minister has unqualified discretion to "amend the terms and conditions of any license…", while 5(2) allows the Minister to suspend or revoke an authorization if the license holder has, under 5(2)(b)(i), contravened the Act, its regulations, or the terms and conditions of its license, under 5(2)(b)(ii), obtained the radio authorization through misrepresentation, or under 5(2)(c), failed to pay fees or interest.

Subsection 5(1)(e) of the *RA* states ISED may "plan the allocation and use of the spectrum", meaning its Minister may determine the operating parameters of satellites and ground-stations. Section 3 of the *Radiocommunication Regulations*[413] (*RR*) explains the tasks that licensed radio satellite operators may perform:

> 3(a) install, operate or possess radio apparatus to perform any of the following services … namely, (i) aeronautical service, (ii) amateur radio service, (iii) public information service, (iv) developmental service, (v) fixed service, (vi) intersatellite service, (vii) land mobile service, (viii) maritime service, and (ix) radiodetermination service; and (b) install, operate or possess radio apparatus at a fixed station, mobile station or space station ...."[414]

5(1)(c) of the *RA* gives the ISED Minister the option to "make available to the public any information set out in radio licences or broadcasting certificates",[415] thus offering the opportunity to increase transparency of Canadian radio satellite operations, where appropriate. Detailed information on granted licenses are available on the ISED website[416] and the database can be searched by authorization number, reference identifier, station, and/or call sign.

The *RA* requires ISED's electronic database report certain information to the public, although not precisely the information required by the UN space treaties. The data specifically requested by Article IV of the *Registration Convention*, and which is missing from ISED's database, includes the satellite's apogee and perigee, nodal period, and general function of the satellite, among other information. Amending domestic space-based legislation to ensure the appropriate Canadian government department properly records and transmits the above information to the UNSG will

---

[413] *Radiocommunication Regulations,* SOR/96-484.
[414] *Ibid*, s 3.
[415] *Ibid*, s 6.
[416] "Search for Virtual Licence or Certificate" Government of Canada, online: <https://sms-sgs.ic.gc.ca/licenseSearch/searchVirtualLicense?execution=e3s1&lang=en_CA> (7 November 2020).

further Canadian efforts to honour outstanding obligations at international law, increase transparency of federal government involvement in domestic space object applications and space-based activities, and improve and ensure Canadian accountability and responsibility for incidents occurring between space objects.

5: Transmission of any Radio Communications: Learning from the *Telecommunications Act*

Section 2(1) of the *TA* defines "telecommunications" as the "emission, transmission, or reception of intelligence by any wire, cable, radio, optical or other electromagnetic system, or by any similar technical system". Pursuant to the *TA's* subsection 16.3(3), the Canadian Radio-television and Telecommunications Commission (CRTC), which is itself established through the enabling *Canadian Radio-television and Telecommunications Commission Act*,[417] has the unqualified ability to amend any conditions of a license and, under 16.4(1), the CRTC may suspend or revoke an operating license when it believes the licensee has contravened the *TA*, its regulations, or any condition of its license. Under the same subsection, the licensee must be given written notice of the reasons for the suspension or revocation and be provided the opportunity to defend itself. Throughout the *TA*, notably in sections 9 and 16, reference is made to different "classes" of telecommunications service providers and how these different entities may be governed. The CRTC categorizes service providers within either the "facilities-based" class or "non-facilities-based" class, with an additional six types of sub-carriers within each category,[418] each of which are governed differently than the others. Similarly, Transport Canada could consider differentiating between uncrewed and crewed launch missions as opposed to the status quo of issuing only one generalized type of launch license.

Authorizing different types of launch licenses would also benefit the Transport Minister's license evaluation efforts, particularly by providing more detailed, useful, informed, and consistent assessment guidance. Crewed launches are much more complex than uncrewed ones, as they must do everything an uncrewed rocket can in addition to sustaining human life and operating with a lower risk of launch failure. Uncrewed rockets, meanwhile, may be designed and

---

[417] *Canadian Radio-television Telecommunications Commission Act*, RSC 1985, c C-22, s 3 [*CRTC Act*].
[418] "Responsibilities and Regulatory Obligations" (1 June 2020), CRTC, online: <https://crtc.gc.ca/eng/comm/telecom/resp.htm> (22 August 2021).

manufactured with a stricter focus on maximizing efficiency, performance, and payload deliverable to LEO, with no consideration for human habitability onboard the rocket. The factors that apply to one class may not apply to the other and thus the Minister of Transport may reach better-informed decisions while using the limited resources available to evaluate launch applications, by separating the two classes.

The more specialized knowledge required to administer and assess launch licenses under a system of multiple classes, and the already disparate and piecemeal approach of satellite and radio and spectrum frequency allocation in Canada, results in a very disjointed approach that could potentially benefit from being streamlined into a more focused government office or entirely new department. While out of scope of this thesis, the federal government may wish to consider establishing either a designated "space office" within Transport Canada, where responsibilities for license approvals and authorizations, insurance requirements, and safety and security standards, are all assessed, discussed, and administered. This initiative would be similar to the USA's approach where the AST was established within the larger FAA (which was itself established within the larger Department of Transportation).

An alternative, and perhaps more effective and efficient approach, would entail the federal government establishing an entirely new government entity altogether through legislation, akin to how the *Canadian Radio-television and Telecommunications Commission Act* establishes the CRTC,[419] mentioned previously. Like the CRTC, such a new space-specific entity could have enabling legislation which stipulates its governance structure,[420] staffing[421] and remuneration,[422] and that sets out its objects, duties, functions, and powers,[423] such as the ability to pass organizational bylaws.[424] In this approach, consideration could be given to further streamlining Canadian space governance, such as concerning satellite licensing and registration, by including all space-based regulatory administration and/or decision-making within this newly created and specialized entity. This would involve transferring legislated responsibility for each of the launch

[419] *CRTC Act*, *supra* note 417, s 3.
[420] *Ibid*, s 6.
[421] *Ibid*, s 8.
[422] *Ibid*, s 7.
[423] *Ibid*, ss 12, 13.
[424] *Ibid*, s 11.

license and authorization aspects of the *AA* and *CAR* from Transport Canada's Transport Minister, the *RSSSA* from GAC's Minister of Foreign Affairs, the *RA* from ISED's Minister of Industry, the *TA* and *BA* from ISED's Minister of Industry and the CRTC, and space object registration responsibilities from the CSA, to the newly created department.

The researchers of the *2022 RSSSA Review* also conducted a survey to gather the opinions of stakeholders from government, industry, and academia on the *RSSSA* and Canada's space-governance in general. One of the questions asked was how difficult respondents felt it was to deal with multiple government departments when licensing space systems, such as working with GAC to license remote sensing systems or ISED when licensing spectrum satellites.[425] Of 25 respondents, 2 indicated working with multiple departments was "straightforward", 12 indicated it was "burdensome", 5 indicated "very burdensome", and 6 replied "Don't know".[426] The 17 of 25 responses indicating the need to work within Canada's piecemeal system when operating space-based and space-related businesses was either "burdensome" or "very burdensome" lends further support to the need for an all-encompassing, comprehensive, and more highly specialized "space office" or "space department" to administer the country's space-governing laws, including licensing and authorizations systems.

In addition to consolidating all space-governance responsibilities to a new government department, the federal government could abolish the existing piecemeal approach to space legislation and adopt a comprehensive space law Act to further coordinate and streamline regulations and ease bureaucratic and "red-tape" burdens even further. This idea of a more coordinated approach to legislation will be addressed later in the thesis.

6: Transmission of Radio Frequencies to the Public: Learning from the *Broadcasting Act*

The *BA* defines "broadcasting" as the act of transmitting programs to the public.[427] The *BA* differs from the *TA* in that "broadcasting" is strictly confined to transmitting – rather than receiving – data and that the *BA* involves transmitting to the greater public, while the *TA* includes

[425] *2022 RSSSA Review*, *supra* note 136 at A-23.
[426] *Ibid*.
[427] *BA*, *supra* note 250, s 2(1).

transmissions both to the public and to private commercial entities or governmental recipients. Like the *TA*, the *BA* is administered by the CRTC. The *BA* applies to "spacecraft" facilitating broadcasting,[428] but more extensively to any transmission of "data" to the public, including information sent by electromagnetic signals, including radio waves and other means of telecommunications.[429] Therefore, the *BA* affects applications that occur from space, although its scope captures "any transmission of programs"[430], regardless of location of origin. Additionally, legislative interpretation expert Ruth Sullivan writes in her book, *Statutory Interpretation*, that the *BA* and *RA* are statutes *in pari materia*, meaning both Acts operate together to regulate a matter or problem and are meant to complement one another and aid in each other's interpretation[431] - this is also supported by section 15(2)(b) of the federal *Interpretation Act*,[432] which states: "15(2) Where an enactment contains an interpretation section or provision, it shall be read and construed … (b) as being applicable to all other enactments relating to the same subject-matter unless a contrary intention appears." This close relation is one of the reasons to include the *BA* in this analysis as it is, at least in terms of statutory interpretation, highly related to other legislation that *does* govern space-based activities.

Returning to the text of the *BA*, its section 9(1)(b) ensures all granted licenses expire after 7 years, but with the option under 9(1)(d) to renew for an additional 7 years. To maintain an approved broadcasting license, the licensee must continually comply with the CRTC's mandates and objectives.[433] The *BA* also grants power to the CRTC to suspend, revoke,[434] amend,[435] or renew[436] all licenses.[437] Section 11 allows the CRTC to establish fee schedules to be paid by licensees of the *BA*, with amounts due depending on the revenues earned by licensees,[438] performance levels in terms of reaching national CRTC objectives,[439] and the particular market

[428] *Ibid*, s 4(2).
[429] *Ibid*, s 2.
[430] *Ibid*, s 2(1).
[431] Ruth Sullivan, *supra* note 142 at 129, n 5.
[432] *Interpretation Act*, RSC 1985, c I-21.
[433] *BA*, *supra* note 250, s 9(1)(b)(i).
[434] *Ibid*, s 9(1)(e).
[435] *Ibid*, s 9(1)(c).
[436] *Ibid*, s 9(1)(d).
[437] *Ibid*, s 18.
[438] *Ibid*, s 11(2)(a).
[439] *Ibid*, s 11(2)(b).

served by the licensee.[440] Section 18 directs the CRTC to hold public hearings to gather stakeholder comments and concerns related to the issuing, suspending, revoking, amending, or renewing of specific broadcasting licenses.[441] Public consultations shall also be held when new national performance objectives of the *BA* are established, or whenever the CRTC simply mandates these types of hearings occur. Section 20 allows the CRTC to establish panels of three or more individuals to adjudicate licensing disputes. Finally, *BA* sections 32 and 33 penalize broadcasters operating without a license and licensees violating the terms or conditions of their licenses, respectively. Financial penalties vary depending on whether the broadcaster is an individual or corporation and range from $25,000 to $500,000.[442]

Possible legislative improvements to glean from the *BA* include: mandating Transport Canada place expiration dates on licenses, allowing for the renewal, suspension, or revocation of authorized licenses, financially penalizing those violating the Act, holding public hearings to improve stakeholder involvement and to gather opinions and comments, and forming hearing committees to adjudicate disputed matters. These qualities will improve such legislation's specificity as well as learn from the unique insights of, and demonstrate greater respect for, interested stakeholders.

7: Summary and Conclusion

Applicants receiving a launch license from the Transport Minister will be legally authorized to launch an orbital rocket from Canadian territory. However, outstanding questions and concerns leave uncertainty around the future of the industry and deters investors, business leaders, and the public from participating in and supporting this nascent activity. While lawmakers will benefit from international comparative legal analyses, there are certainly topical aspects of the above domestic laws to study, learn from, and apply to current reform efforts.

[440] *Ibid*, s 11(2)(c).
[441] *Ibid*, ss 18(1)(a)-(b).
[442] *Ibid*, s 35.2.

Table 3.2: Domestic Comparative Legal Analysis Summary

Comparator Statute(s)	Recommended Legislative Improvements as Stated in Comparator Law [reflected in section # of *STAR Act*]	Comparator Law Section
RSSSA	[34] When authorizing a license, consider: [b] Canada's national security interests, Canadian defence efforts, and safety of Canadian Forces; [c] engagement in international relations, and [e] outstanding international obligations particularly stemming from United Nations space law treaties.	8(1)
	[47] Amend licenses	10
	[47] Suspend licenses	11
	[47] Revoke licenses	12
	[throughout] written with the flexibility and adaptability to apply to changing operating environment and easy to eventually amend	[throughout]
RSSSR	[35] Practicalities of applying for a license: [a] contact details; [b] specifications of the rocket and launch provider involved; [c] description of the satellite itself and its orbit; [d] guaranteeing all registration info will be provided to the government; et cetera	Schedule 1
	[50] Information on penalties for non-compliance: depend on section violation and if the operator is an individual or a corporation; fines can range in value	Schedule 2
Radiocommunication Act	[7] Establish an electronic database enabling public access to information concerning issued radio licenses and broadcasting certificates	5(1)(c)
	[47] Amend licenses	5(1)(b)
	[47] Suspend or revoke licenses	5(2)
Telecommunications Act	[34][o] Award [i] & [ii] uncrewed launch licenses or [iii] crewed launch licenses, with each classification fulfilling different operational and safety criteria	16.2(3)(a)
	[47] Amend licenses	16.3(3)
	[47] Suspend or revoke licenses	16.4(1)
	consider establishing newly designated and specialized office within Transport Canada, or legislation establishing entirely new government department, to better coordinate space-based regulatory administration and decision-making	N/A

Broadcasting Act	[46] Expiry dates on licenses	9(1)(b)
	[36] Renew licenses	9(1)(d)
	[47] Suspend or revoke licenses	9(1)(e)
	[31] Requires licensees to pay a fee to have an application reviewed	11
	[34][n] Conduct public hearings to gather stakeholders' comments and concerns on government decisions affecting particular licenses	18
	[32] Establish a panel of three individuals to adjudicate license applications	20
	[50] Financial penalties for operating without a license or in violation of a license's terms; can range in value	32 – 34

Table 3.2's specific legislative enhancements from the *RSSSA* will add pragmatic value to the *STAR Act* by providing clearer guidance to the Transport Minister when evaluating license applications. Enhancements to the *STAR Act* originating in the *RSSSR* will clarify how applications should be created and submitted, which will benefit investors and business leaders. The enhancement from the *RA* ensures the *STAR Act* honours outstanding obligations from the *Registration Convention*, specifically maintaining a space object national registry and transmitting its information to the UNSG. The *TA's* quality of distinguishing between classes of licenses is particularly important given the key safety-related differences between uncrewed and crewed missions. Lastly, the *BA's* option for license renewal will improve the Transport Minister's scope of control over launch licenses, the mandatory stakeholder consultations will ensure insightful feedback and comments are received during assessments, and establishing the three-member panel will ensure adjudications are conducted by industry experts with specialized knowledge and that resolutions will be both well-informed, well-analyzed, and fair. The need to allow the Transport Minister the ability to amend, suspend, or revoke licenses was evident in all Acts.

CHAPTER 4: FOREIGN COMPARATIVE ANALYSES

1: Status of the International Industry

As illustrated in chapter 1's Table 1.1, only 9 countries have successfully launched orbital rockets from their territories within the last seven years, of which only six have launched at least once every year. Of these six, the national rocketry-governing laws of the top four most active, including China, Russia, USA, and France, are further investigated. Each of these countries' legal schemes illustrate unique approaches to regulating domestic orbital rocketry.

China's disjointed and imprecise legislative framework has largely been symbolic because these laws apply mostly to the country's nearly non-existent commercial launch market. The Chinese government launches almost all domestic rockets and the nation's private launch sector has only begun to emerge within the last few years. Meanwhile, the USA has a highly complex, detailed, and comprehensive applicable legal framework that encourages a commercialized domestic industry that continues to grow. Although American launches offered by private providers have historically been purchased by the US government, they are now increasingly purchased by commercial customers. While China's lack of respect for the rule of law, including classified and unavailable legislation and the existence of Military-Civil Fusion, may present problems of uncertainty for those investing in China, the American framework's greater reliability is somewhat offset by its overly bureaucratic and complicated legislative framework and government administration, all of which are time-consuming and expensive to interpret and navigate.

The two remaining countries, France and Russia, function within legal frameworks at less extreme ends of the spectrum. Distinctly from the industry's situation in China, and particularly different then in the USA, France and, for the majority of its launches, Russia, rely on only one domestic launch provider for all access to space although France's Arianespace is private while Russia's Energia is mostly governmental.[443] In terms of legislation, French, rather than Russian, space-governing laws more closely resemble the USA's approach of offering reliability, albeit

[443] ArianeGroup, *supra* note 92; Energia Space, *supra* note 98.

without the same amount of detail and "red-tape." However, both French and Russian legislative frameworks are much less complex and detailed than the American statutory regime.

Russia, once a very active launching nation able to compete with the USA, has recently failed to keep pace with the Americans and has actually decreased its launch frequency since 2015.[444] Although China launches approximately the same amount of orbital rockets as the USA, the historical downward trend in Russia's launch frequency may indicate the future of Chinese rocketry efforts – and of any centrally-planned program – as slowing considerably with time. Although Arianespace's launch cadence has stalled in recent years,[445] the similarities between the French and USA's private-centric approaches may prove beneficial to the EU's future participation in the launch industry.

American law and, to a lesser extent, French law, offer value to Canadian legal reformers because of the greater similarities between the nations' legal systems in general, as opposed to the Chinese and Russian frameworks. However, there are also very useful components to learn from the distinctiveness in the Chinese and Russian schemes. All four countries offer insight into how levels of specificity may be written into legislation to honour obligations at international law, exemplify state reliability, dependability, and transparency, and show respect for citizen concerns related to upholding national security, the environment, and health and safety standards. Finally, mandatory liability insurance requirements from all four legal systems are discussed.

2: Foreign Approaches to National Orbital Rocketry and other Space-based Activities

The most active launching nations of the world have changed within the last 5 or 6 years, as China has considerably increased its participation in space-based activities and now rivals the USA in terms of annual launches.[446] These two countries, plus France and Russia, were the four most active launching states in 2021, each achieving its launch numbers through a different mix of private and government launches. China launched 52 times throughout 2021, compared to the

[444] See Table 1.1 in Chapter 1.
[445] *Ibid*.
[446] Launch Stats, *supra* note 37.

USA's 48, Russia's 15, and France's 15.[447] The only other nations with successful orbital launches in 2021 were Japan (3 launches), and India (1).[448] Meanwhile, two unreported Iranian launches failed in 2021, the first on June 12 and the other on December 30.[449]

Worldwide launches have generally increased every year since the early 2000s, although numbers peaked in the late-1960s to mid-1980s.[450] Recently, in years 2018 and 2020, 114 launches were attempted:[451] 10 of these 114 launches failed in 2020 while only 3 of 114 failed in 2018.[452] Numbers of private and governmental launches by country vary considerably, as is evident between the USA and China: in 2021, 100 percent of American launches were private while 100 percent of Chinese were governmental.[453] 13 of Russia's 15 launches were conducted by Energia, an entity that is significantly controlled by the State,[454] while the remaining 2 were by the Krunichev State Research and Production Space Center, itself a wholly state-owned enterprise.[455]

Arianespace, launching for France, collaborates with numerous private entities and government organizations throughout the entire supply chain process.[456] The entity's ownership must be traced through multiple layers of subsidiaries and, because of this complex organizational structure, it is difficult to pinpoint the exact ratio of private to government involvement. Although Arianespace became wholly privatized in 2015, when the French space agency Centre national d'etudes spatiales (CNES) sold its entire 35 percent stake in the company to Airbus Safran Launcher,[457] the organization is still influenced by the French government. CNES President Jean-Yves Le Gall notes France has maintained significant oversight of the company

---

[447] *Ibid*.
[448] *Ibid*.
[449] *Ibid*.
[450] Ed Kyle, "Worldwide Orbital Launch Summary by Year" (31 December 2021), Space Launch Report, online: <https://www.spacelaunchreport.com/logyear.html> (18 January 2022).
[451] Launch History, *supra* note 49.
[452] *Ibid.*
[453] *Ibid.*
[454] *Ibid.*
[455] "Launch Vehicles" (nd), Krunichev State Research and Production Space Center, online: <http://www.khrunichev.ru/main.php?id=23> (18 January 2022).
[456] Supply chain process includes the development, testing, and manufacturing of rockets and launch-related equipment, and the operations, financing, and marketing of Arianespace's launch services.
[457] "Repartition of Arianespace capital" (7 January 2021), Arianespace, online: <https://www.arianespace.com/company-profile/> (7 June 2021) [Repartition of Arianespace].

despite its diminished formal control and because the ESA's launch sector largely remains a government-enabled industry through strategic policy efforts.[458]

Finally, investigating foreign legislation is not only valuable from a comparative analysis perspective, wherein useful aspects of other approaches to legal governance can be ascertained, it is also valuable from the perspective of studying how the content of national laws aid in the interpretation of international law, namely through the implementation of the rules that have become customary international law, including the existence of *opinio juris*. To establish if an international legal rule has become customary, in the sense that all nations are bound by it whether or not they have agreed to it, "it is necessary to ascertain whether there is a general practice that is accepted as law"[459], known as *opinio juris*. It is not enough only that nations adopt, implement, and enforce the rule as a general practice, but when doing so the rule must also be "accepted as law"[460], or *opinio juris*, which is "distinguished from mere usage or habit"[461] and rather "must be undertaken with a sense of legal right or obligation."[462] Authors Lyall and Larsen discuss the application of customary law and *opinio juris* to the UN space treaties, largely relying on the International Court of Justice's decision in the *North Sea Continental Shelf Cases*,[463] discussing how there are various elements to consider when determining if a rule has passed into customary international law:

> These include the lapse of time between the coming into force of the relevant treaty and the point at which international customary law is alleged to have appeared, whether non-party states have objected to the treaty-rule being sought to be categorized as one of custom, and the numbers and nature of the states party to the treaty.[464]

Lyall and Larsen discuss each of these points and their application to the *OST*, first by writing that there is widespread acceptance of the *OST*, state practice with respect to the *OST* is

---

[458] Peter de Selding, "France giving up Arianespace Ownership, but not Oversight" (19 June 2015), Space News, online: <https://spacenews.com/france-giving-up-arianespace-ownership-but-not-oversight/> (1 November 2021) [Peter de Selding].
[459] "Draft conclusions on identification of customary international law" (2018), United Nations, online: <https://legal.un.org/ilc/texts/instruments/english/draft_articles/1_13_2018.pdf> at 2 (8 May 2022).
[460] *Ibid* at 3.
[461] *Ibid*.
[462] *Ibid*.
[463] *North Sea Continental Shelf Cases (Germany v Denmark; Germany v Netherlands)*, ICJ Reports 1969, p3, online: <https://www.refworld.org/cases,ICJ,50645e9d2.html> (8 May 2022).
[464] Lyall & Larsen, *supra* note 115 at 66-67.

extensive and uniform, the *OST* has been in force for a considerable amount of time, there are no "persistent objectors" to the *OST*, and that numerous resolutions of UNGA which deal with outer space have relatively easily been adopted.[465] The authors also investigate the nuance that exists within *opinio juris*, that "The practice [of an international rule] need not be wholly uniform, but must be undertaken in the belief it is binding and required by law as opposed to being merely convenient or mutually beneficial."[466]

Lyall and Larsen argue "Both practice and *opinio juris* are present [in the *OST*] since the various parties clearly recognize that compliance with these principles is the way to proceed and they act accordingly."[467] In this way, there is unique value in reviewing and analyzing foreign national space legislation, because such laws aid in the understanding of the international laws themselves, from which the national legislation is influenced. The legislation of each of the countries of China, Russia, the USA, and France all provide valuable aspects which may be incorporated into domestic Canadian space-governing legislation, and may then further be used to hone and refine such Canadian law as these foreign laws offer insight into how the UN space treaties have actually been interpreted, implemented, and applied.

2.1: China: Strong Government Rocketry but Nearly Non-existent Commercialization

The Chinese government launched its first orbital rocket in 1999.[468] In 2003, China became the third nation to launch a crewed mission, onboard its Shenzhou 5 spacecraft[469] atop a Long March 2F rocket. Although China's participation in the launch sector is almost entirely government-provided, the country did enact two measures in the early 2000s: one to comply with registration obligations and the other to administer a rocketry licensing system. The 2001 *Registration Measures*[470] fulfills obligations under the UN's *Registration Convention*, namely by ensuring the Chinese government maintains a national registry of space objects and transmits this information

---

[465] *Ibid* at 70-72.
[466] *Ibid* at 38.
[467] *Ibid* at 71.
[468] Suzanne Deffree, "China launches 1st Shenzhou spacecraft" (November 19, 1999), EDN Network, online: <https://www.edn.com/china-launches-1st-shenzhou-spacecraft-november-19-1999/> (30 May 2021).
[469] *Ibid*.
[470] *Measures for the Administration of Registration of Objects Launched into Outer Space* (*Registration Measures*), Order No 6 of the Commission of Science, Technology, and Industry for the National Defense and the Ministry of Foreign Affairs of the People's Republic of China, 8 February 2001.

to the UNSG.[471] The 2002 *Permit Measures*[472] fulfill obligations of the *OST* and *Liability Convention* by enabling the Chinese government to authorize its nationals' launching activities through a system of permits.

There is a hierarchy of laws in the Chinese civil law system, with the country's *Constitution*[473] holding the highest priority and "ministerial regulations" the lowest.[474] Both the *Registration Measures* and *Permit Measures* are "ministerial regulations" and, as the ANGELS[475] initiative, a joint project between the University of Adelaide Law School and the International Aerospace Law & Policy Group, explains: "the two measures highlight China's lack of emphasis on the development of their space legal regime as opposed to their significant efforts toward their space program itself.[476] Joan Liu, curator at Fudan University Library and former associate curator at the New York University Law Library, explains in her article "UPDATE: Finding Chinese Law on the Internet"[477] how the lack of a reliable and disorganized Chinese legal information system further contributes to the uncertainty and lack of understanding surrounding that country's legal system. For example, search tools and citation standards are not well established, poorly organized, and often outdated, meaning "Without a comprehensive legal information system, which is the foundation of legal study and practice, legal research cannot be conducted accurately and efficiently."[478]

Additionally, the rule of law in China is not widely respected by the Chinese Communist Party (CCP), which "has largely observed a technical, *de jure* [by law] separation between itself and

---

[471] "Space Licensing in China" Australian Navigational Guide Explaining Laws for Space, online: <https://spacelaws.com/articles/space-licensing-in-china/> (30 May 2021) [Chinese Space Licensing].
[472] *Interim Measures on the Administration of Permits for Civil Space Launch Projects* (*Permit Measures*), Order No 12 of the Commission of Science, Technology, and Industry for National Defense and the People's Republic of China, 21 November 2002.
[473] *Constitution of the People's Republic of China, 1982,* National People's Congress, online: <http://www.npc.gov.cn/zgrdw/englishnpc/Constitution/node_2825.htm> (4 September 2021).
[474] Jingjing Liu, "Overview of the Chinese Legal System" (January-March 2013) 1:1 *Environmental Law Reporter* online: at 4 <https://elr.info/sites/default/files/chinaupdate1.1.pdf> (4 September 2021).
[475] ANGELS stands for Australian Navigational Guide Explaining Laws for Space and the initiative is funded by the Law Foundation of South Australia.
[476] Chinese Space Licensing, *supra* note at 471.
[477] Joan Liu, "UPDATE: Finding Chinese Law on the Internet" (October 2021), GlobaLex, online: <https://www.nyulawglobal.org/globalex/China1.html > (4 May 2022).
[478] *Ibid*.

the state, including the legal system … and often disregarding and devaluing the law …"[479] The authoritarian national government bypasses and disregards state legal requirements,[480] leaving much up to the CCP's discretion and conflicting with the pieces of legislation that are reliably and publicly available. In a report for the American Congress, Congressional Research Service authors Susan Lawrence and Michael Martin, both designated Specialists in Asian Affairs, write: "A long-standing source of frustration for U.S. government officials is the seeming inability or unwillingness of their Chinese counterparts to enforce policies, decisions, regulations, and laws, much less the State constitution."[481] Explicitly stating the weak rule of law in China, the authors write: "The [Chinese Communist] Party is widely perceived to support rule *by* law – law as a tool for governance – but not rule *of* law [emphasis in original]."[482]

Returning to the Chinese national legislation, the *Registration Measures'* Article 4 places registration responsibility on any Chinese launching entity, whether public or private. Article 5 requires the government department, the Commission of Science, Technology, and Industry for National Defense (COSTIND), now SASTIND,[483] administer the National Register of space objects. Article 6 discusses the specific information which must be included in the National Register, while Article 12 designates China's Ministry of Foreign Affairs the responsibility to transmit the Register's information to the UNSG. Finally, Article 14 grants the Ministry of Foreign Affairs interpretative powers over the Articles of the *Registration Measures* related to the maintenance of China's National Register.

The *Permit Measures* are more detailed than the *Registration Measures* and, as described in *Permit Measures* Article 1, are meant to facilitate civil growth in the Chinese launch market, maintain national security interests, and fulfill obligations at international law. Article 2 of the *Permit Measures* defines "civil" as encompassing all non-military launches, while Article 3 addresses how launch permits will be allocated to authorize the nation's civil space launch

---

[479] Jamie Horsley, "Party Leadership and Rule of Law in the Xi Jinping Era" (September 2019), Global China, online: <https://law.yale.edu/sites/default/files/area/center/china/document/horsley_china_party-_legal_development.pdf> at 1 (4 May 2022).
[480] *Ibid*.
[481] Susan Lawrence and Michael Martin, "Understanding China's Political System" (20 March 2013), Congressional Research Service, online: <https://sgp.fas.org/crs/row/R41007.pdf> at 17 (4 May 2022).
[482] *Ibid*.
[483] State Administration for Science, Technology and Industry for National Defense (SASTIND)

activities. Article 4 appoints SASTIND as the government department responsible for examining, approving, and supervising all civil launches, namely through issuing permits.

Article 5 of the *Permit Measures* lists 6 conditions every permit applicant must comply with to receive authorization to launch. Article 6 places a deadline on application submissions at 9 months prior to requested launch dates, although Article 7 requires SASTIND either issue the license or reject the permit application upon 30 days of receipt. Upon rejection, Article 8 allows applicants to re-submit their application to SASTIND or apply for administrative review of the rejection. Article 10 explains what applicants must include in submitted permit applications.

Permit Measures' Articles 11 and 15 describe how each granted permit is only valid for its specific launch activity and specific date range and cannot be altered or re-used for subsequent launches. Article 19 requires launch providers acquire adequate liability insurance. Article 20(a) mandates the launching entity provide SASTIND with documents specifying launch-related technical conditions, quality control, flight test outline, and security and confidentiality processes and plans. Article 22 necessitates providers update SASTIND on the result of the launch itself within one month after launch date. Article 23 grants SASTIND the power to supervise and inspect the provider's equipment and operations to ensure technical capabilities are met. Article 24 penalizes applicants who conceal the truth, act in fraudulent ways, or cause damage to the State by imposing administrative penalties in addition to any applicable criminal charges. Lastly, Article 27 grants SASTIND final interpretive powers over the *Permit Measures.*

According to the aforementioned ANGELS initiative, "Whilst China has a robust space program, it lacks the comprehensive space legislation of other space-faring States."[484] Although China's space program is very active in terms of launch frequency, nearly every launch from Chinese territory is provided by the government rather than a private entity like in the United States. The *Permit Measures* application to civil launches means military missions are exempt from its scope. The Chinese private launch industry, defined as launch activities conducted by non-government entities, only emerged in 2018 and has not grown significantly since.[485] As such, the

[484] Chinese Space Licensing, *supra* note 471.
[485] Launch History, *supra* note 49.

Permit Measures apply to a narrower range of orbital launch activities than the *Registration Measures* which apply to all Chinese launches, whether civil or military. Because of these laws, China has enacted the requisite legislation to comply with the *Registration Convention* and the *OST* and *Liability Convention* licensing requirements, since 2001 and 2002 respectively.

Despite the slow growth of China's private launch market, the country's *Registration* and *Permit Measures* are more detailed, clear, and comprehensive than Canada's *AA* and *CAR*. However, while Canada's current framework governing orbital launches is underdeveloped, the country has legislated more effectively on numerous satellite applications, namely by adopting the *RSSSA*, *RA*, *TA*, and *BA*. Canada has taken a piecemeal approach to its national space legislation and, since its historical involvement in space activities have been limited mostly to satellite operations, the preceding laws appear to govern adequately. If Canada's scope of space-based capabilities increases in coming years, there will be a need for a more comprehensive governing legal scheme – an idea further addressed in chapter 5.

China's 2019 *Commercial Carrier Rocket Measures*[486] (*CCR Measures*) broadens the scope of the existing Chinese legislative framework and specifically targets the commercial launch industry. The document's purpose is to promote "the technological innovation of commercial carrier rockets, relevant matters of scientific research, production, testing, launching, safety and technical control …" Whether the *CCR Measures* extend to crewed as well as uncrewed missions is unclear. Articles 2 and 3 elaborate on the uses of orbital rocketry and the goals of research and development efforts. Article 5 reiterates the *Permit Measures'* Article 4, restating that SASTIND is responsible for managing the licensing and authorization process. Article 10 limits ground launches to occur only from "space launch sites" that have been recognized by the Chinese government. Articles 13 to 16 describe how Chinese launch providers must abide by domestic laws governing affected industries, such as dangerous chemicals, explosives, and export control.[487] Article 17 explains how the Chinese government must take steps to support its

[486] *Circular of SASTIND Central Military Commission Equipment Development Department on Promoting the Standardised and Orderly Development of Commercial Launch Vehicles, 2021,* online: BHO Legal <https://www.bho-legal.com/wp-content/uploads/2021/02/2019-Development-of-Commercial-Launch-Vehicles-CN-EN-courtesy-translation.pdf> (4 September 2021) [*CCR Measures*].
[487] *Ibid,* s 14.

commercial launch providers and encourage this emerging industry. Article 18 mandates the Chinese government continue to improve innovation within the orbital rocketry industry, as well as create new laws and policies, and amend existing ones, as needed. Finally, the government must support space-related government organizations with the intent of improving the accessibility of launch services and provision to its private launchers.

2.2: Russia: Rudimentary Space-governing Law with Minimal Application to Private Launching

The major Russian launch provider, Energia, is listed on the Moscow Exchange with the stock ticker RKKE.[488] However, the company is not privatized – the Russian Federation's State space agency, Roscosmos, directly and indirectly controls 92.53 percent of Energia's capital.[489] Bruce McClintock notes in his 2017 article "The Russian Space Sector: Adaptation, Retrenchment, and Stagnation", published in the Space & Defence Journal of the United States Air Force Academy, that "Since the collapse of the Soviet Union, Russia focused on its public space sector and consciously chose not to cultivate competitive, private space companies."[490] As mentioned earlier, the other launch provider in Russia, the Krunichev State Research and Production Space Center, is owned entirely by the Russian Federation.

Although every Russian launch is highly connected to the State, this does not mean Energia offers uncompetitive launch services. Customers launching with the entity realize especially strong non-financial benefits compared to launching with American providers, namely less bureaucratic procedures and minimized "red-tape" obstacles. Secondary interviews from stakeholders reveal that Baikonur, a major Russian launch site leased from Kazakhstan, is a facility with relatively few operating restrictions in place when compared to US launch sites.[491]

---

[488] "RKKE Quote" (5 June 2021), yahoo! Finance, online: <https://ca.finance.yahoo.com/quote/RKKE.ME/profile?p=RKKE.ME> (5 June 2021).
[489] "2019 Financial Statements" Energia, online: at 133 < https://www.energia.ru/en/corporation/consdocs/rpt_2019-2018.pdf> (7 September 2021) [Energia Financials].
[490] Bruce McClintock, "The Russian Space Sector: Adaptation, Retrenchment, and Stagnation" (2017) 10:1 *Space & Defence Journal of the United States Air Force Academy*, online: <https://www.rand.org/content/dam/rand/pubs/external_publications/EP60000/EP67235/RAND_EP67235.pdf> (5 November 2020) [Bruce McClintock].
[491] Stephen Clark, "AsiaSat CEO says Cape Canaveral has its drawbacks" (6 September 2014), Spaceflight Now, online: <https://spaceflightnow.com/falcon9/012/140906capecanaveral/> (1 March 2020) [AsiaSat & Cape Canaveral].

Baikonur operates more quickly and efficiently and allows customers to use their limited time more effectively.[492] Additionally, Baikonur's streamlined logistical operations allow for more expedient payload integration and launching capabilities.[493] Russian rockets' ability to withstand temperatures as low as -40 degrees Celsius and more powerful winds then typical American rockets means launches are less likely to be "scrubbed" (postponed).[494]

The 1996 Russian *Statute on Licensing Space Operations* (*SLSO*)[495] establishes procedures governing Russian launch applications and provision. The law's Article 1 requires launching entities obtain a license when aiming to conduct space activities, including launching, related to either scientific or commercial endeavors. Article 2 describes how the government must consider multiple factors and interests when evaluating launch license applications including: national interests, national security, international obligations, other domestic legislation, development of the country's space services market, and protection of the interests of users of the space market. Article 4 tasks Roscosmos with responsibility to oversee all the country's licensing and authorization procedures.

Article 5 (a) through (i) lists specific information applicants must submit to Roscosmos, including technical details on the rocket itself, health and safety plans, and details on the launch provider including its organizational form, address, account number, constitutive documents, State registration, tax agency registration, and proof of payment to Roscosmos for application examination. The technical information of the rocket must address the ecological health and safety of the propellant, personnel health and safety associated with launch procedures and procurement, and documents attesting to the proven reliability of the rocket. Providers must undertake to maintain and protect State secrets and, in compliance with the *Registration Convention*, provide space object information to Roscosmos for entry into the national registry.

---

[492] *Ibid*.
[493] *Ibid*.
[494] Russians always launch, *supra* note at 111.
[495] *Statute on Licensing Space Operations*, Resolution No 104 of the Russian Federation Government, 2 February 1996.

Following submission of the above documentation, *SLSO's* Article 7 grants Roscosmos the authority to investigate applicants' space equipment as necessary. Once Articles 5 and 7 are fulfilled, Article 10 stipulates a launch license will be issued by Roscosmos to the applicant. Article 12 places a 30-day deadline for the application to either be approved or rejected and Article 13 ensures launch licenses remain valid for at least 3 years. Article 21 describes how launch licenses are only valid for the specific type of space operations that were applied for and that licenses may not be transferred or sold.

Article 25 explains Roscosmos has the right to cancel any license if the licensee:

- fails to comply with instructions or orders of State entities;
- discontinues operations as a legal entity, including as a sole proprietor, in conformance with Russian law;
- provides false information in submitted application documents; or
- violates any condition(s) of the license agreement.

Finally, Article 33 ensures entities or individuals guilty of carrying out unlicensed space operations shall be held responsible under the relevant legislation of the Russian Federation.

2.3: USA: Comprehensive, Clear, and Detailed Space-Governing Legislation Facilitate the World's most Active Private Launch Market

Not only has the USA outpaced Russia in annual launch frequency since 2016, but the country's consistent emphasis on encouraging its commercial launch provider market is relevant and applicable to the Canadian context, due to the two countries' similarly open economies. Russian launches not only occur less frequently than those in the USA but are also conducted by entities owned and controlled by the Russian Federation,[496] rather than owned privately. While the USA and China have recently traded off as the world leader in terms of successful launches, albeit through very different approaches, the USA's commercialized approach is more similar to Canada's market strategies than compared to China's centrally-planned industries, and the

[496] Energia Financials, *supra* note 489; Bruce McClintock, *supra* note 490.

USA's legal scheme is more similar to Canada's due to its transparency and accessibility, especially when compared to China's censored legal framework.

President Obama enacted *Title 51 USC* in 2010 by compiling previous space-governing legislation including the 1984 *CSLA* and its various amendments, the 2015 *US Commercial Space Launch Competitiveness Act*, and aspects within each of *Title 15 Commerce and Trade*, *Title 42 The Public Health and Welfare*, and *Title 49 Transportation*[497] into the more user-friendly document. *Title 51 USC* does not amend or add anything new to the existing law but rather it is meant to streamline the process for prospective or current launch providers wishing to launch from the USA. While *Title 51 USC* encompasses extensive amounts of content, only its *Chapter 509's* sections 50901 to 50923 warrant discussion in the thesis.

Section 50903 tasks the US Department of Transportation's (DOT) Secretary of Transportation (SOT) with the responsibility of administering the entirety of Chapter 509, although it is more specifically the FAA's AST that licenses, regulates, and promotes the industry through application of *14 CFR*.[498] Objectives of the industry's functioning are to facilitate and promote commercial space launches in the USA, and importantly maintain a "laser focus on public safety."[499] Section 50904 furthers American compliance with the *OST* by requiring prospective launch providers to acquire proper government authorization through a licensing process, when wishing to either launch or conduct re-entry activities, or when operating a spaceport. Section 50905 expands on 50904 by describing how prospective launch providers will only be granted a license provided they appropriately consider America's interests in maintaining public health and safety, security of property, national security, and foreign policy interests. 50905 also places additional license requirements on entities launching crewed missions, including demonstration of necessary health and safety precautions for the astronauts but also spaceflight participants (i.e., passengers) on board.

---

[497] Rob Sukol, "Positive Law Codification of Space Programs: The Enactment of Title 51, United States Code" (Spring 2011) 37:1: *Journal of Space Law* 1-40 at 2, online: <https://airandspace.confit.dev/pdfs/jsl-37-1.pdf> (7 September 2021).
[498] *14 CFR*, *supra* note 244, s 401.3.
[499] Wayne R Monteith, "Office of Space Transportation – update letter" (3 April 2020), Federal Aviation Administration, online: at 1 <https://www.faa.gov/about/office_org/headquarters_offices/ast/media/AST_Update_Letter_April_2020.pdf> (11 September 2021).

Section 50907 stipulates the SOT may delegate an officer of the American government to observe operations at launch and re-entry sites, at production facilities or assembly sites, and where payloads are integrated with the rocket. Section 50908 discusses circumstances warranting the suspension and/or revocation of launch licenses, such as when an applicant fails to comply with requirements within the license itself and when the suspension or revocation is necessary to protect public health and safety, government and private property, national security, and/or foreign policy interests. Section 50909 gives the SOT the power to control the operation of any American launch or re-entry site and to close such sites if continued operation would result in a detriment to the USA's interests.

50914 specifies that launch providers must possess adequate liability insurance or financial reserves to properly indemnify third parties for the "maximum probable loss" (MPL) resulting from the provider's failed launch (no more than US$500 million) as well as the MPL sustained by the US Federal Government (no more than US$100 million), for a total of US$600 million. The SOT determines the actual amount of MPL upon consultation with NASA, the Air Force, and other relevant government departments.

With respect to the MPL value calculated, American launch providers must obtain insurance, or demonstrate adequate financial reserves, equal to the MPL of their proposed launch, in the event of failure, to adequately indemnify the government.[500] The FAA uses a very detailed and complex computer-based statistical approach to simulate a range of launch scenarios and outcomes, which produces a calculation of the MPL for specific launches.[501] The three major elements[502] of the MPL calculation, each comprised of smaller calculations and considerations themselves, includes:

1. "number of estimated casualties" meaning the number of resulting deaths following a launch failure, and requires estimating the:

[500] *Title 51 USC, supra* note 76, s 50914.
[501] "Commercial Space Launch Insurance – Weakness in FAA's Insurance Calculation May Expose the Federal Government to Excess Risk" (March 2017), United States Government Accountability Office," online: <https://www.gao.gov/assets/gao-17-366.pdf> at 10 (5 May 2022) [GAO FAA Insurance Weaknesses].
[502] *Ibid* at 6-7.

a. total area of the expected debris field that would be caused should a specific rocket fail mid-launch and its self-destruct system activated as a safety measure; and
b. estimated area within that expected debris field that would cause a casualty if a person were within it.

Upon estimating 1(a) and 1(b), the calculation estimates the number of "direct" casualties, those caused by the parts of the exploding rocket itself, by multiplying the area within 1(b) by the maximum population density of the selected area (varies depending on if the launch occurs near a major city or in an unpopulated rural area or over open ocean). The FAA also accounts for the number of "secondary" casualties, such as those caused by fires and collapsing buildings, then adds the "direct" and "secondary" casualties together to estimate the total number of casualties.

2. "estimated loss per casualty" means the financial cost of a lost life, based on historic court-related judgments and settlements compensating for deaths; the FAA estimated this number to be $US3,000,000 per casualty, referred to as the "cost-of-casualty amount", in 1988 and has not ever updated it;[503] and
3. "estimated losses due to property damage" includes the financial loss of the value of both the rocket and payload onboard, and all unrelated property, including buildings and infrastructure on the ground, and is estimated at 50 percent of the estimated losses from total casualties; this is calculated by multiplying the numerical value in (1) with the financial value in (2) and then halving it.

Thus, MPL calculations are arrived at using the following formula:
[estimated casualties in (1) x cost-of-casualty amount in (2)] + [50% of [(1) x (2)]] = MPL

No matter the MPL calculation, the FAA imposes insurance caps of $500 million for third-party liability insurance and $100 million for government liability covering government losses.[504] Although there is no legislated minimum amount of insurance required for American launches,

[503] "Commercial Space Launch Insurance – FAA Needs to Fully Address Mandated Requirements" (January 2018), United States Government Accountability Office, online: <https://www.gao.gov/products/gao-18-57> (5 May 2022) [GAO FAA Mandated Requirements].
[504] *Title 51 USC*, *supra* note 76, s 50914.

the average third-party MPL in 2012 was calculated to be US$99 million, ranging from a low of US$23 million to a high of $267 million,[505] and in 2016 averaged US$51 million, ranging from a low of US$10 million to a high of $99 million.[506] Alternatively in the American legislative framework, if the private insurance market cannot offer large enough coverage, providers can purchase the "maximum liability insurance available on the world market at reasonable cost", if less than the legislated US$500 million and US$100 million listed above.[507] The American government must then pay for all damages exceeding $600 million, but only up to $1.5 billion.[508] Responsibility for additional launch-related remediation costs over $1.5 billion are not the responsibility of the government,[509] and are instead placed back on the launch provider, who would have been free to choose whether or not to insure for that amount or higher, as there is no legislated requirement to do so.[510]

Section 50917 assigns the SOT the right to investigate and conduct inquiries into launch and re-entry sites, manufacturing and assembly plants, astronaut training centers, and payload integration facilities, upon some incident occurring. The section goes on to impose maximum civil penalties of US$100,000 for those violating any section in *Chapter 509*, including any regulation prescribed under this chapter or any term of an issued license. Section 50918 explains how the SOT shall consult with other government departments to gain specific and valuable information, including national security information from the Secretary of Defence and foreign policy information from the Secretary of State, as needed.

The content in *Title 51 USC*, and the detail provided by *14 CFR*, is significantly greater than any of the other three national laws analyzed in this comparative analysis and provides much more clarity than the *AA* and *CAR*. Despite its already extensive legislative framework, space-based laws are a frequent topic of debate in American politics, as bills promoting the industry continue to be introduced in Congress. The following are either currently in the lawmaking process or have recently been passed as law:

---

[505] GAO FAA Insurance Weaknesses, *supra* note 501 at 7.
[506] *Ibid*.
[507] *Title 51 USC*, *supra* note 76, s 50914.
[508] *Ibid*, s 50915.
[509] *Ibid*, s 50915(d)(2)(D).
[510] GAO FAA Insurance Weaknesses, *supra* note 501 at 5.

Table 4.1: Topical American Space-Governing Bills and Laws

Name	Status	Impacts	Currently exists as
American Space Commerce Act of 2021[511]; Bill HR 1369	Referred to the Committee on Finance on June 8, 2021	Offers bonus depreciation for rockets and rocketry parts[512] by amending the *Internal Revenue Code's*[513] depreciation section 168(k); Applies to both vertically- and air-launched rocketry[514]; applies specifically to smaller launch providers[515];	---
Space Preservation and Conjunction Emergency Act of 2020, (*SPACE Act*)[516]; Bill S 4827 / HR 1304	Referred to the Subcommittee on Asia, the Pacific, Central Asia and Nonproliferation on August 4, 2021	Expands the Department of Commerce Bureau of Space Commerce's responsibilities to licensing remote sensing technologies and coordinating and promoting policies to advance commercial space activities; developed to "out-compete China in key emerging technology areas critical to our [American] national security …"[517]	*Countering Communist China Act*[518]
21st Century Space Grant Modernization Act	Passed Senate and onto House of Reps on June 8, 2021	Prioritizes American over foreign rocketry suppliers; improves support for American space-related science,	*US Innovation and Competition Act of 2021*[521]

[511] US, Bill HR 1369, *American Space Commerce Act of 2021,* 117 Cong (2020-2021), congress.gov, online: <https://www.congress.gov/117/bills/hr1369/BILLS-117hr1369ih.pdf> (1 August 2021) [*Space Commerce Act*].
[512] *Ibid,* at Preamble, s (c)(11)(A)(ii).
[513] *Internal Revenue Code,* Pub L No 99-514, § 2, 100 Stat 2095 (codified as *26 USC* § 168(k)), Legal Information Institute at Cornell Law School, online: <https://www.law.cornell.edu/uscode/text/26/168> (11 September 2021).
[514] *Space Commerce Act, supra* note 511, s (c)(11)(B).
[515] Julia Kagan, "Bonus Depreciation" (20 April 2021), Investopedia, online: <https://www.investopedia.com/terms/b/bonusdepreciation.asp> (1 August 2021).
[516] US, Bill S 4827, *SPACE Act of 2020,* 116 Cong (2019-2020), congress.gov, online: <https://www.congress.gov/bill/116th-congress/senate-bill/4827> (11 September 2021).
[517] "Young's Endless Frontier Act Passes the Senate" (8 June 2021), Todd Young: U.S. Senator for Indiana, online: <https://www.young.senate.gov/newsroom/press-releases/youngs-endless-frontier-act-passes-the-senate> (1 August 2021).
[518] US, Bill HR 4792, *Countering Communist China Act,* 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/117/bills/hr4792/BILLS-117hr4792ih.pdf> (18 January 2022).
[521] US, Bill S 1260, *US Innovation and Competition Act of 2021,* 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/117/bills/s1260/BILLS-117s1260es.pdf> (18 January 2022).

of 2021[519]; Bill S 360		technology, engineering, and mathematics research programs.[520]	
A bill to require a review of the National Aeronautics and Space Administration preference for domestic suppliers[522]; Bill S 1549	Referred to the Committee on Commerce, Science, and Transportation on May 11, 2021	Directs NASA to review its preferences of American over foreign suppliers and determine the extent the American government is currently funding foreign-owned companies or State-sponsored entities[523]	*US Innovation and Competition Act of 2021*
One Small Step to Protect Human Heritage in Space Act[524]	Became Public Law No: 116-275 on December 31, 2020	Requires NASA develop best practices on how to "protect and preserve" the "lunar landing sites of the Apollo 11 spacecraft"[525]; spacecraft operators must comply with the Act to receive authorization to conduct activities on the Moon[526]	---

[519] US, Bill S 360, *21st Century Space Grant Modernization Act of 2021,* 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/bill/117th-congress/senate-bill/360> (11 September 2021).
[520] *Ibid*.
[522] US, Bill S 1549, *To require a review of the National Aeronautics and Space Administration preference for domestic suppliers,* 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/bill/117th-congress/senate-bill/1549/text> (11 September 2021).
[523] *Ibid,* s 1.
[524] *One Small Step to Protect Human Heritage in Space Act,* Pub L No 116-275, 134 Stat 3358 (31 December 2020), congress.gov, online: <https://www.congress.gov/bill/116th-congress/senate-bill/1694/text> (11 September 2021).
[525] *Ibid,* ss 2(a)(6), 2(a)(8).
[526] *Ibid,* s 3(a)(1).

2.4: France / Europe: Space-governing Legislation Facilitating International Cooperation

An important contributor to Europe's self-sustainable launch capabilities, Arianespace operates with "An assigned mission of guaranteeing independent access to space for Europe."[527] Ownership of Arianespace is often reported according to country, although actual ownership belongs to 16 different organizations based within those 9 countries.[528] 74 percent of Arianespace is owned by Arianegroup,[529] which is in turn owned 50 percent each by publicly-traded companies Airbus and Safran.[530] Of the 74 percent that Arianegroup owns of Arianespace, around 84 percent of is held by the company's French operations and the remaining 16 percent by its German operations.[531] Accordingly, entities registered in France own a combined 64 percent of Arianespace while entities in Germany own a combined 20 percent.[532] The remaining 7 countries each own less than a 5 percent stake in Arianespace.[533] Because French organizations own the majority of Arianespace, that country's national legislation will be investigated rather than Germany's or any of the other 7 countries. Arianespace conducts business in France, but the company launches its rockets from French Guiana, a French territory part of the French Republic and thus subject to French laws, in South America, due to the additional velocity gained from launching in a west to east trajectory near the Equator and because of the nation's proximity to open ocean in the east in case of a misfired rocket.

France's uncrewed orbital launches are governed by its 2008 parliamentary statute *relative aux operations spatiales*[534] or *French Space Operations Act (FSOA)*. Similar to other nations' space-governing legislation, the *FSOA's* Article 1 defines important terms including "launching phase" and "phase of command", both of which are revisited in the *FSOA's* liability-related Articles 13-17. "Launching phase" is defined as a time period which begins when the launch of the rocket becomes irreversible and ends when the space object separates from the rocket. "Phase of

---

[527] "Company Profile" (7 January 2021), Arianespace, online: <https://www.arianespace.com/company-profile/> (7 June 2021).
[528] Repartition of Arianespace, *supra* note 457.
[529] *Ibid*.
[530] ArianeGroup, *supra* note 92.
[531] Repartition of Arianespace, *supra* note 457.
[532] *Ibid*.
[533] *Ibid*.
[534] "Centre for Space Policy and Strategy" (2021), The Aerospace Corporation, online: at 453-470, <https://aerospace.org/sites/default/files/policy_archives/French%20Space%20Ops%20Act%202008%20unofficial%20translation.pdf> (7 June 2021).

command" is also a period of time and commences at the conclusion of the preceding launching phase and continues until the planned or unplanned end of the mission itself.

Article 2 of *FSOA* describes how foreign providers launching from France, French providers launching from France or elsewhere, French entities procuring launch services, French persons or entities intending to conduct re-entry activities above foreign states, and French persons or entities intending to operate an object in space, all must obtain the proper licenses and authorizations from CNES. Article 4 of the *FSOA* stipulates that authorizations will only be granted when the applicant ensures the:

- requisite moral, financial, and professional guarantees of the provider;
- requisite moral, financial, and professional guarantees of the provider's shareholders;
- systems and procedures used to launch the rocket are compliant with the technical regulations listed within the Act;
- safety of persons and property will be respected;
- public health and the environment will be protected;
- national defence interests will not be jeopardized; and
- continued respect for France's international commitments.

Article 6 requires authorized launch providers acquire adequate insurance, or demonstrate some type of financial guarantee, to compensate the French national government, other French public bodies, the European Space Agency (ESA), ESA's Member States, and other parties involved in the space-based activity, for launch-related damages. Article 7 lists certain French agents who must be granted access to every launch- and rocket-related building, premises, and facility, while Article 8 grants CNES power to halt or assume control of launches in the case of an emergency jeopardizing launch personnel safety, public health, and the environment. Article 11 penalizes parties conducting unauthorized launches, re-entry activities, or operations of space objects, with fines of € 200,000. France fulfills its obligations under the *Registration Convention* with the *FSOA's* Article 12, which tasks CNES with establishing and maintaining a national register containing space object information.

The *FSOA's* Article 13 mandates all entities licensed for space-based operations comply with Articles II and III of the *Liability Convention*: operators shall assume absolute liability for damages caused on the ground or in airspace and will assume fault liability for damages caused elsewhere. Pursuant to Article VI of the *OST*, the French government, like all national governments, must "bear international responsibility" for costly incidents caused by its nationals. The *FSOA's* Article 14 addresses the risks of this obligation by allowing the French government to pursue indemnification from the provider having caused such damage. The amount the government may collect from its national entities varies depending on if the incident occurred during (Article 16) or after (Article 17) the launching phase. The exact amounts of reimbursement are noted in France's *Finance Act*.[535]

Article 21 explains how CNES must instruct the "special Police" to safeguard the Guiana Space Centre by controlling the technical risks of all stages of the launch. The jurisdiction of the special Police is described, both in terms of geographic limits and identified objectives including to protect the people, property, public health, and environment at the spaceport and ensure the provision of proper assistance during and after the launch. Article 22 extends the French *Intellectual Property Code*[536] to include inventions made by French persons in outer space, on a space object, or on celestial bodies. In this way, the *FSOA* uniquely complies with Article VIII of the *OST*, which requires governments retain jurisdiction and control over their authorized space objects and persons on board, specifically with respect to intellectual property. Finally, Article 26 explicitly excludes suborbital rockets from the scope of the Act. Crewed French orbital launches, meanwhile, are governed by separate intergovernmental agreements,[537] rather than by the *FSOA*.

---

[535] *Loi n 2019-1479 du 28 decembre 2019 de finances pour 2020, Journal Officiel,* 28 December 2019, 2020 Finance Law.
[536] *Loi n 92-597 du 1 July 1992 de Code de la propriete intellectuelle, Journal Officiel,* 1 July 1992, Intellectual Property Code.
[537] *International Space Station Intergovernmental Agreement,* (29 September 1998), *IGA*, online: s 11 <https://aerospace.org/sites/default/files/policy_archives/Space%20Station%20Intergovernmental%20Agreement%20Jan98.pdf> (11 September 2021).

2.5: Summarized Investigation of Chinese, Russian, American, and French Legislative Schemes

Canadian lawmakers wishing to honour obligations at international law and facilitate a sustainable and healthy domestic launch industry will benefit from reviewing the ways foreign countries have interpreted, tailored, and implemented different aspects of the treaties. Please see Table 4.2 starting on the following page for a summarized version of the various obligations at international law stemming from the treaties, as well as other useful aspects:

Table 4.2: Summary of Foreign State Compliance with UN Space Treaties

Reference notes with respect to Table 4.2:

- China: *Registration Measures (RM); Permit Measures (PM); CCR Measures (CCRM)*
- Russia: *Statute on Licensing Space Operations (SLSO)*
- USA: *Title 51 USC, 14 CFR*
- France: *French Space Operations Act (FSOA)*

Relevant Treaty – Obligation at International Law / Valuable Aspects	Evident within *National Law (Section/Article)*	Treaty Obligation / Aspect when applied to national law…
ALL 5 TREATIES – clarification on contextual understanding & procedural fairness	*51 USC (50901); RM (1)-(3); PM (1); CCRM (preamble),(2),(3),(17),(18); SLSO (1)*	Purpose of the national law
	PM (2); CCRM (1); 51 USC (50902); FSOA (1)	Definitions of the national law
	FSOA (26)	Activities that are out-of-scope of the national law
	51 USC (50903); RM (14); PM (27)	Government official shall carry out all sections/articles of the national law
	14 CFR (entirety)	Clarifies, elaborates, and details the content within the national law
OST (VI) – states shall bear international responsibility for national activities in outer space	*PM (3); SLSO (1)-(3); 51 USC (50904),(50909); FSOA (2)*	Civil/private launch providers require a permit/license and government authorization to engage in launch or re-entry activities, or to operate a spaceport; special regard for payload requirements
	PM (4); CCRM (5); SLSO (4),(7); 51 USC (50907)	Designates the government/regulator responsible for examining/investigating, approving, and supervising civil/private space launches

OST (VI) – states shall bear international responsibility for national activities in outer space	*PM (11)*	Each permit is only valid for the specific project/launch it was intended for
	SLSO (13)	Launch licenses expire
	PM (15)	If approved provider cannot meet launch schedule then permit/license is nullified
	PM (5); *SLSO (10)*	Upon meeting certain criteria, the government/regulator will issue the applicant a launch license
	SLSO (21)	License is only valid for the specific type of space operations it was intended for
	SLSO (25); 51 USC (50908); FSOA (9)	Reasons designated government agency may cancel an issued license
	CCRM (10)	Where to launch a rocket from
	PM (6)	Deadline to submit permit/license applications
	PM (7); SLSO (12)	Deadline for government to approve or reject applications
	PM (8)	Appeals procedure
	CCRM (13),(14),(15),(16)	Mandatory compliance with other national laws
	PM (22)	Provider must update government on launch outcome within 30 days of launch
	PM (1); SLSO (2); 51 USC (50905); FSOA (4)	Government must contemplate/consider various objectives and documents when assessing launch applications
	PM (10); *SLSO (5)(a)–(i); PM (20(a))*	Documents and information to include in a launch license application
	51 USC (50918)	Government official shall consult with other departments to gain specific and useful information to aid launching activity

OST (VI) – states shall bear international responsibility for national activities in outer space	*FSOA (8)*	Grants emergency authority to government during sudden high-risk scenarios
	PM (23); 51 USC (50917); FSOA (7)	Government/regulator able to access and inspect all buildings, facilities, and premises of the launch provider
	PM (24); SLSO (33); 51 USC (50917); FSOA (11)	Penalties for non-compliance with relevant national law
	FSOA (21)	Jurisdiction over spaceports granted to designated special police force
OST (V) & *ARRA* (general) – astronauts as envoys of mankind	*CFR Title 14 (417)*	Safety and rescue plan for crewed missions
OST (VII) & *Liability Convention* (II) & (III) – international liability	*FSOA (13)*	Launch operator held to international liability requirements (absolute for incidents on Earth or in airspace; fault for incidents anywhere else)
OST (VII) & *Liability Convention* (general) – international liability	*PM (19); SLSO (24)(b); 51 USC (50914); FSOA (6),(14)*	Applicants must have adequate insurance or financial reserves to indemnify government
	FSOA (14),(16),(17)	National government may pursue indemnification from its authorized launch provider; distinguishes between different types of launch-related damage
OST (VIII) – control over nationals	*FSOA (22)*	Nations must retain jurisdiction and control over all authorized space objects and persons on board
OST (XI) & *Registration Convention* (II) & (IV) – maintain registry of space object information	*CFR Title 14* (*417.19*)*; RM (4),(5),(6); FSOA (12)*	Government/regulator will maintain national register of space objects (*RC* II)
	RM (12),(13)	Government/regulator transmits information in national registry to UNSG (*RC* IV)

3: Summary and Conclusions

The international comparative analysis within this chapter 4 investigates each of the most successful launching nation's approaches to regulating this evolving industry. Although there are other countries with comprehensive space-governing laws, it is clear there are only four key players in the world. While each of the domestic laws of China, Russia, the USA, and France have been usefully tailored to their unique contexts, the same can be done for Canada. The differences in political approaches, and in turn, legislative texts, have had large effects on how each nation's industry has developed and will likely have large implications on the sustainability of each nation's launch market.

CHAPTER 5: LEGISLATIVE REFORM TO ENCOURAGE ORBITAL ROCKETRY AND PROTECT CANADIAN INTERESTS

1: Status Quo Compared to Comprehensive and All-Encompassing Space Law

The *2022 RSSSA Review* wrote that certain Canadian legislation, like the *RSSSA*, "… has been created to deal with specific space activities…"[538] which has led to a "loose patchwork of Canadian space governance…"[539] As such, Canada has "no overarching space legislation to comprehensively manage and coordinate the complete space portfolio."[540] As space technologies have evolved and the space economy has changed,

> Canada has addressed the oversight and regulation of emerging space activities through incremental changes to pre-existing legislation that overlapped with new space activities (e.g., airspace regulation by Transport Canada, radio frequency spectrum regulation by ISED), and with two pieces of space-specific legislation: the *RSSSA* and the *Canadian Space Agency Act*.[541]

The *2022 RSSSA Review* describes current Canadian space legislation, government mandates, and overall bureaucracy, as "incoherent"[542], "confusing"[543], "complex"[544], "fragmented"[545], and "incomplete"[546], that operates "independently"[547] and "at cross-purposes"[548], and that "fail to support and reinforce one another."[549] The *2022 RSSSA Review* identified various short- and long-term recommendations to the federal government, including the long-term strategy to develop and adopt a "comprehensive General Space Act"[550] to better govern quickly evolving space technology and its emerging and growing commercial applications.

---

[538] *2022 RSSSA Review*, *supra* note 136 at 30.
[539] *Ibid.*
[540] *Ibid*.
[541] *Ibid* at 31.
[542] *Ibid* at 53.
[543] *Ibid.*
[544] *Ibid*.
[545] *Ibid* at 35.
[546] *Ibid*.
[547] *Ibid* at 53.
[548] *Ibid*.
[549] *Ibid*.
[550] *Ibid* at 58.

The author of this thesis agrees with these conclusions of the *2022 RSSSA Review*, namely that Canada's long-term space governance strategy must be to eventually adopt all-encompassing and comprehensive space-governing legislation and repeal the existing piecemeal and patchwork approach. Additionally, as was discussed in this thesis' section 5 of chapter 3, it would be beneficial to implement enabling legislation to establish an entirely new and highly-specialized government department to oversee, better support, and further promote all types of Canadian space activities. The scope of such a department could range from existing applications such as radio and frequency spectrum satellite operations, to new opportunities including orbital launching, space tourism, space manufacturing, space mining and other resource-extraction efforts, on-orbit fueling, and more. Providing a "one-stop shop"[551] for stakeholders interested in establishing and maintaining space-related operations, whether commercial or related to research and development, through comprehensive national space legislation is a sentiment supported by 95 percent[552] of the survey respondents in the *2022 RSSSA Review*, and was listed as the report's medium-term Recommendation 5.[553]

However, this comprehensive approach will require extensive resources, including time, money, and contributions from highly-qualified, and well-retained, engineering advisors, policy analysts, legal drafters, and more, along with strong government support in general – all of which are, as discussed throughout the *2022 RSSSA Review* in the context of the *RSSSA*, currently in short supply. This lack of resources available to the government indicates that, at least in the short-term, the continuation of a piecemeal approach may be necessary and inevitable. This thesis' proposed *STAR Act* embodies a first step of incremental change and, while not indicative of the more ideal long-term strategy of adopting all-encompassing and comprehensive space legislation, will offer the advantage of easing the abruptness of the impacts of brand new laws and their real-world repercussions, to investors, business leaders, government bureaucrats, and others stakeholders who have become familiar with the status quo and existing legislation, like the *RSSSA*. Alternatively, repealing all space-governing laws and implementing an entirely new

[551] *Ibid* at 12, 54, 57.
[552] *Ibid* at 12.
[553] *Ibid* at 57.

Act all at once may be too much of a significant, jarring, and unexpected shift for those involved in the industry, and would not facilitate its sustained development.

The *STAR Act* fills existing gaps in legislation and strengthens the current regulatory regime, rather than adding confusion or unnecessary complexity. In time, it is the author's intention the *STAR Act* would eventually be amended to reflect changes in launch technologies, equipment, and capabilities, and eventually be completely repealed and replaced by an all-encompassing and comprehensive "general" space Act, provided adequate notice is provided to stakeholders. Additionally, not every space-faring nation has pursued the route of developing and implementing all-encompassing space legislation, particularly the USA which has pursued a very piecemeal approach – although has also usefully summarized and compiled its many different space laws into its *Title 51 USC* and *14 CFR*, as discussed throughout this thesis. While the United States Code and the Code of Federal Regulations are not binding law, they do greatly improve the ease of stakeholders' abilities to understand the country's rocketry- and space-governing legislation and presents the legislative scheme in a much more "user-friendly" manner.

Returning to the difficulty the Canadian context, the financial obstacles that the federal government will experience in prioritizing and promoting its domestic involvement in the use and exploration of outer space is troubling. In terms of financial support from federal budgets, "Leading scientists say the government's neglect of the CSA over the last decade has left Canadian space exploration in dire straits"[554], "with no plan for the future and no budget for significant new ventures …"[555] Gordon Osinski, a planetary geologist at Western University, states "It's a war of attrition. We are losing capacity, a bit, year after year."[556] The University of British Columbia published the study, *A Vision for Canadian Space Exploration*,[557] which found "The Canadian space exploration sector is currently underfunded. Canada spends the least on its

[554] Emily Senger, "Is Canada's space program slipping out of orbit? (10 December 2018), Maclean's, online: <https://www.macleans.ca/society/science/is-canadas-space-program-slipping-out-of-orbit/> (7 May 2022).
[555] *Ibid.*
[556] *Ibid*.
[557] Ilaria Caiazzo, Sarah Gallagher, and Jeremy Heyl, *A Vision for Canadian Space Exploration,* (9 August 2017), (Vancouver: University of British Columbia Library), doi: <10.14288/1.0352001>, online: <http://hdl.handle.net/2429/62531> (7 May 2022).

space program within the G8 countries in terms of actual dollars and the second lowest per capita."[558] If Canada were to spend comparable levels as a percentage of its GDP on space exploration to other G8 countries, it would have to increase its current spending "*more than ten times the current funding level* [emphasis in original]."[559]

However, a 2018 public opinion poll by Ipsos,[560] which surveyed Canadian citizens, found favourable and growing support from Canadians for the country to continue to invest in space activities, as 84 percent of respondents support further developing Canada's space sector, a 20 percentage point increase from a 2007 Praxicus survey. Canadians are also interested in supporting the commercialization of space in Canada, including 81 percent who support investing in satellite communications, 73 percent in space science, 71 percent in space robotics, and 67 percent in international space missions. 74 percent of Canadians disagree their country is too small to participate in the space economy and 95 percent agree Canadian astronauts are a source of national pride, with 90 percent agreeing that maintaining leadership in space robotics, such as the Canadarm, is important for Canada. However, when compared to alternative areas for spending, public support for investments in space fall behind, including when compared to education and healthcare: 53 percent of Canadians agree that, in general, less should be spent on the space sector because there are other, more important priorities, and 71 percent agree that Canada currently supports numerous scientific non-space programs offering more value and greater tangible benefits to taxpayers than pursuing space exploration.

When it comes to Canadians' opinions on space investments that could lead to benefits "back home", people were more supportive, including 87 percent supporting space investments to research new medical procedures, 83 percent to research ways to improve early detection of natural disasters and to better protect Canada's oceans, forests, wetlands, and farmlands from climate change, and 78 percent to prevent our nation's "best and brightest" from leaving to work in other countries. Seemingly problematic, many Canadians are not aware that Canada's space

---

[558] *Ibid* at 2.
[559] *Ibid*.
[560] Sandra Guiry, "Canadians' Support and Enthusiasm for Development in the Space Sector is Taking Off" (20 September 2018), Ipsos Public Affairs, online: <https://www.ipsos.com/en-ca/news-polls/space-sector-taking-off> (7 May 2022).

budgets have been decreasing: 55, 50, and 48 percent believe funding levels have remained the same over the past five years for international space missions, space robotics, and satellite communications, respectively. Meanwhile, 28 percent of respondents believe space investments have increased in recent years and only 10 percent hold the accurate belief such investments have decreased. Many of these sentiments were also shared by participants in a 2021 consultation with Canadians undertaken by the CSA,[561] including support for the establishment of space launch capabilities in Canada:

> Participants identified a number of issues that they felt should be addressed in order for this [the establishment of space launches in Canada] to take place, including identifying a flight testing location and associated rules regarding airspace restriction, ensuring a regulatory environment conducive to flight testing and launch, and conducting a study of environmental issues and impacts both on Earth and in orbit relating to launch.[562]

The particular aspects of space activities and space-related national objectives that appeal to Canadians, namely investing in space technologies offering real-world applications and improving the retention of highly-skilled Canadians in the country, offer strategic opportunities for the government to leverage and improve the political will for increasing government spending and support for space.

2: Balancing the *STAR Act's* Specificity and Simplicity to Achieve Law Reform Objectives

The *STAR Act* seeks the optimal balance between specificity and simplicity to guide government officials seeking to improve the confidence of investors, business leaders, and the Canadian public, and developing a more business-friendly rocketry industry, notably through streamlining the ease of bureaucratic obstacles and "red-tape". Law reformers may base the initial structure and foundation of this new law on principles promulgated by the UN space treaties, then elaborate on these tenets by incorporating valuable aspects identified during domestic and foreign comparative analyses. Additionally, guiding the law reform process through legal instrumentalism and the economics of lawmaking, and thereby drafting a law of optimal

[561] "What We Heard report: Consultation on a framework for future space exploration activities" (30 July 2021), Canadian Space Agency, online: <https://www.asc-csa.gc.ca/eng/astronomy/moon-exploration/what-we-heard--report-consultation-framework-future-space-exploration-activities.asp> (7 May 2022).
[562] *Ibid*.

specificity, will improve the newly created governing framework's likelihood of achieving its intermediary objectives and, in turn, ultimate objectives.

To recall, intermediary objectives include honouring obligations at international law, protecting the environment and personal and real property, prioritizing citizen and astronaut health and safety, upholding national security and defence interests, and ensuring launch providers acquire adequate amounts of insurance and obtain proper authorization through a transparent national licensing process. Ultimate objectives include increased and sustained economic stimulus and job creation through the growth of the domestic launch industry, improved development of space-related innovation and technologies, greater ability for Canadians to access space-related business, service, and education opportunities, and contributing to vibrant local communities and improved standards of living and quality of life for Canadians residing and working nearby launch sites and operations.

While both types of objectives are integral to the law reform efforts, ultimate goals take priority over intermediary goals, in the event the goals conflict with one another, except national security which is considered of equal importance to the ultimate objectives during times of initial drafting and adoption. However, during any subsequent amendments to the *STAR Act*, national security, as an intermediary goal, must follow this prioritization. While it is integral to appropriately consider national security concerns, it is also important not to unduly restrict the development of industry: the *2022 RSSSA Review* identified that the *RSSSA* continues to place too much emphasis on national security concerns that no longer exist, or at least have been drastically reduced, at the expense of the development of Canada's space economy.[563]

Space-based businesses anywhere attempting to operate within excessively-complex legislative schemes are presented with significant obstacles to overcome. *The Economist* reported that British space-based business Excalibur Almaz[564] stated "so far [the] company has spent as much [resources] on navigating the legal and regulatory paperwork as it has on buying and refitting its

[563] *2022 RSSSA Review, supra* note 136 at 45.
[564] Excalibur Almaz was a private spaceflight company specializing in developing crewed spacecraft, micro-gravity science, and payload delivery. The company was founded in 2005 and became defunct in 2016.

Soviet-era space capsules for lunar travel."[565] While there is value in high-specificity laws, there is also value in streamlined and understandable laws.

Satellite-operator AsiaSat launches with SpaceX from the US's Cape Canaveral spaceport. While serving as the company's President and CEO, William Wade explained:

> I think Cape Canaveral is a great place to launch, but it does have its downside, which is it's quite bureaucratic here. … There are a lot of regulations and clearances and restrictions, which I think hinders the processing of commercial satellites here. … I think that's too bad because it is a bit of a negative. … Unfortunately, I think that's one of the reasons that SpaceX is looking at doing commercial launches on their own satellite base down in Texas.[566]

Three years after Wade's 2016 statement, SpaceX completed construction of its South Texas Launch Site (known as "Starbase"). The company's first launch from Starbase was in 2019 and the location continues to be used by SpaceX for launching activities, although exclusively for its Starship rocket.[567] The spaceport is privately owned by SpaceX but must still comply with all government regulations, including licensing and authorizations, because the FAA oversees all rockets launching from American sovereign territory, as well as launches by American nationals outside the country, regardless of spaceport ownership. One of the major benefits of owning a private spaceport is the complete control over scheduling, as SpaceX does not need to compete with other launch providers for available launch slots and has significantly more, if not complete, discretion over all logistics. In terms of government-owned spaceports, Wade also described how Cape Canaveral launches are governed by strict rules and regulations making it difficult for foreign nationals, as paying customers, to attend the launch and manage final payload integration decisions. Wade stated the physical location of Cape Canaveral is a great benefit, although:

> In addition to just the nationality issues, there are just regulations that all people have to abide by here [Cape Canaveral], and it does make it more difficult from a commercial perspective when you have these regulations in processing, access to locations, weather restrictions and things like that, that you deal with here at the Cape that you don't typically have to deal with at other [such as Baikonur] locations.[568]

---

[565] "Stuck to the ground by red tape" (1 June 2013), *The Economist*, online: <https://www.economist.com/technology-quarterly/2013/06/01/stuck-to-the-ground-by-red-tape> (1 May 2020).
[566] AsiaSat & Cape Canaveral, *supra* note 491.
[567] "SpaceX Brownsville", Brownsville online: <https://visitbtx.com/spacex/> (11 September 2021).
[568] AsiaSat & Cape Canaveral, *supra* note 491.

There is a strong American political interest in developing that country's domestic commercial space and launch activities. Multiple space-governing bills have become law in the last few years and others are still within the legislative process. Republican Bill Posey expressed his concern on the future of the American space-based industry in a 2016 interview with the *Washington Examiner*: "Right now, American companies that want to be involved in space have to jump through hoops for three federal agencies and their armies of lawyers and bureaucrats."[569] These bills and laws were discussed in Table 4.1 in chapter 4.

3: Tailoring the Specificity of the Law to its Operating Context

This thesis has discussed Canadian space-governing laws as they currently exist including the *AA* and *CAR*. The analyses and conclusions of the first four chapters are guided by the concept of legal instrumentalism with an emphasis on the notion that legal drafters may improve the quality of a law using legal reform techniques. To do so, the drafter must first identify a specific industry-related objective of the reform endeavor and then address outstanding deleterious issues in the current context to "socially engineer"[570] the industry to more closely resemble it as envisioned. Authors Parisi and Fon suggest that legal drafters may directly control the specificity of legislation, which is only one of the six factors within every law, by either improving or limiting its clarity until the "optimal" or "sufficient" level is reached."[571] The greater specificity of rules is associated with inflexibility in terms of application, while standards of less specificity and more obscurity possess greater flexibility and more adaptability in their applications. Identifying the goal of law reform as maximizing benefits over costs, the "benefit" formula $N*V(s,\omega)$ must be maximized while the "fixed cost" formula $F(s,\lambda,\kappa)$ and "variable cost" formula $N*C(s,\sigma,\kappa)$ must be minimized, as was illustrated in chapter 1's Table 1.4.

Beginning with "N" (application frequency), aeronautics- and astronautics-governing laws will not, at least in Canada and in the short-term, be applied extensively within the industry or in

[569] Rudy Takala, "The red tape keeping private companies from getting us into space" (5 July 2016), *Washington Examiner*, online: <https://www.washingtonexaminer.com/the-red-tape-keeping-private-companies-from-getting-us-into-space> (March 15 2020).
[570] van Aeken, *supra* note 173 at 69.
[571] Parisi & Fon, *supra* note 191 at 3-8.

court proceedings. N cannot be controlled but drafters should acknowledge the positive correlation between it and the law's specificity (s). Specificity is a controllable factor and based on the cost-benefit formula above, it has a positive correlation with "V". Since legal obsolescence (ω) is negatively correlated with V, then any fluctuations in s will offset the same fluctuations in ω. "λ" represents the difficulty of harmonizing new laws with old frameworks and, considering the significant lack of clarity and comprehensiveness in the few relevant sections of the *AA* and *CAR*, it will be relatively simple to integrate the *STAR Act* within the existing framework. Any changes to other laws, including the *ATR's* liability insurance sections, will also be relatively simple.

In the context of rocketry incidents, both administrative boards and the courts may be involved in settling disputes, depending on the details of the case. The *Canadian Transportation Accident Investigation and Safety Board Act*[572] (*CTAISBA*) establishes the Canadian Transportation Accident Investigation and Safety Board[573] (the "Transportation Safety Board") to hear disputes between parties related to "aviation occurrences" in or over Canada.[574] The *CTAISBA* defines "aviation occurrence" as "any accident or incident associated with the operation of an aircraft,…"[575] and defines "aircraft" as "any machine, including a rocket, capable of deriving support in the atmosphere from reactions of the air …"[576] Administrative boards are typically comprised of individuals with highly specialized knowledge. Members of the Transportation Safety Board are "certified as pilots, aircraft maintenance engineers, air traffic controllers, and airworthiness engineers. They all have varied and extensive experience in the aviation industry."[577] In this case, the expertise of adjudicators (σ) will be high because of the specialized knowledge held by people working on the Transportation Safety Board. However, any decisions of the Transportation Safety Board undergoing judicial review through a court will lower the value of σ because the launch sector is underdeveloped in Canada and average Canadian judges will likely not have significant expertise in this nascent field of activity.

---

[572] SC 1989 c 3.
[573] *Ibid*, s 4(1).
[574] *Ibid*, s 3(1)(a).
[575] *Ibid*, s 2.
[576] *Ibid*.
[577] *Ibid*.

"κ" is the degree of complexity within the targeted environment and, in the launch sector in general, this factor will be high. Launch markets in every country are quickly changing as new technology is developed and new actors enter the field with lessening barriers to entry, namely in the form of reduced costs. As mentioned in chapter 1, SpaceX's accomplishment of viably utilizing partially reusable launch vehicles has significantly changed the industry and arguably quickened commercialization of the space economy in general.

Summarizing the above factors reveals:

- Limited applicability of the law (low N) warrants weak legal specificity;
- Greater legal obsolescence and likely amendments (high ω) warrants weak specificity;
- Simple integration within existing legal frameworks (low λ) warrants high specificity;
- Lack of judicial specialized knowledge (low σ) warrants weak specificity; and
- Volatile and evolving industry (high κ) warrants weak specificity.

The above uncontrollable factors of N, ω, σ, and κ indicate a preference for obscure and vague yet flexible standards, while the remaining factor, λ, warrants adopting highly specific and detailed yet inflexible rules. Parisi and Fon's work discuss the value in writing legislation as specific or vague in a general sense, where it is the aggregate of the five factors that informs drafting efforts. To determine this aggregated value, however, each individual factor must be investigated as it exists within a law. Beginning with the level of difficulty in harmonizing and integrating (λ) the *STAR Act* into existing legal frameworks, the draft bill has been written so it may operate congruently with the other laws and further reduce costs related to λ. Where inconsistencies were presented between the current *AA, CAR,* and *ATR,* the *STAR Act* was specifically written to address these issues and comply with the other legislation.

Next, the more expensive long-term costs imposed by laws that are rarely applied (N), with inherently limited lifespans and whose continued applicability is limited by external factors (ω & κ), and the risk it is improperly adjudicated (σ), must be minimized. The *STAR Act* has been developed by avoiding overly extensive research efforts that would create law much too specific and more restrictive than necessary. Next, the *STAR Act* has been written so it is vague enough to be amended at future dates and keep pace with its constantly changing market environment, specifically evident in its section 53, and enable the judiciary to exercise a valuable amount of

discretion during adjudication to better reflect the subject matter's evolution. For example, section 55 of the *STAR Act* enables the Transport Minister create regulations to expand on the *Act's* core tenets and abstract nature with no need to change anything within the *Act* itself. The existence of this opportunity to tailor the law, along with the overall strategy used to write the *STAR Act* with weaker specificity, reduces the expenses incurred by the government and stakeholders in the short-term, while improves the future benefit delivered by the *Act* and maximizes its ratio of benefits over costs.

4: The Product of Law Reform: Proposing the *Space Transportation Authorization and Registration Act*

4.1: The *STAR Act* presented as a Draft Bill

Preamble

> WHEREAS Canada acknowledges that the exploration and use of outer space shall be the province of all humankind and asserts its intention to partake in the exploration and use of outer space while respecting the national sovereignty of countries on Earth and, where appropriate, will conduct its space activities in cooperation with other States and their nationals;
>
> And whereas Canada acknowledges that the safety of astronauts and spaceflight participants is of the utmost importance during space operations, regards astronauts as envoys of humankind and tasks Canadian astronauts with furthering Canadian national objectives and those of humanity in general;
>
> And whereas Canada acknowledges its responsibility not to hinder other states and their nationals in the peaceful exploration and use of outer space;
>
> And whereas Canada acknowledges that outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means, and commits to upholding these principles;
>
> Be it therefore enacted as follows:

Part I: Preliminary

1. This Act may be cited as the *Space Transportation Authorization and Registration Act*, or as the *STAR Act*.
2. The purpose of this Act is to further the Canadian space economy, particularly the Canadian orbital launch industry, and with preference given to Canadian launch providers and Canadians offering all launch-related services and products, in a safe, secure, environmentally responsible, and sustainable manner that upholds Canada's obligations at international space law and is in accordance with international law including the Charter of the United Nations.
3. Definitions in this Act:
    (a) "absolute liability" means an offence for which a party is liable once it is proven that the prohibited act was committed regardless of the existence of any fault, including negligence;
    (b) "aircraft carrier" means a machine capable of flight and of sufficient power to transport an orbital rocket in the air and horizontally deploy that rocket;
    (c) "astronaut" means an individual who has been trained to operate a spacecraft and who has been trained to travel in space;
    (d) "civil space activity" means any non-military activity in space, including those portions of launch activities occurring on Earth and in airspace;
    (e) "commercial space activity" means any profit-driven non-governmental activity in space, including those portions of launch activities occurring on Earth and in airspace;
    (f) "costly incident" means a mishap that results in:
        i. a fatality or injury to an astronaut;
        ii. a fatality or serious injury to any person other than an astronaut;
        iii. any damage to property that is estimated to exceed $30,000 and that is not associated with the launch and not located at the launch site or designated re-entry and recovery area; or
        iv. environmental damage.

(g) “dual-use space activity” means any activity in space, including those portions of launch activities occurring on Earth and in airspace, that may fit into at least two of the categories of civil, commercial, private, or government;

(h) “fault liability” means an offence for which a party is liable once it is proven that the prohibited act was committed intentionally or negligently;

(i) “government space activity” means any governmental and militarized activity in space, including those portions of launch activities occurring on Earth and in airspace;

(j) “irremediable” means impossible to cure or put right;

(k) “launch phase” means a period of time when an orbital rocket launches or attempts to launch vertically from a spaceport or ocean platform or deploys or attempts to deploy from an aircraft carrier in flight then travels through the atmosphere and into outer space, and begins when the launch sequence becomes irreversible and ends either when the payload separates from the rocket or, if the mission fails, at the point when the last fragment of the rocket lands on Earth, the Moon, or other celestial body, and any fragments in space complete at least one full orbit around Earth, the Moon, or other celestial body;

(l) “launch license” means the application required by Transport Canada to authorize providers to legally engage in launching activities and may include an additional application requesting permission to engage in re-entry activities of the rocket and/or spacecraft;

(m) “launching authority” means a State or an international intergovernmental organization which launches or procures the launching of a space object, either vertically from a spaceport or ocean platform or deployed from an aircraft carrier, and includes all launching States;

(n) “launching State” means:

i. a State which launches or procures the launching of a space object, either vertically from a spaceport or ocean platform or deployed from an aircraft carrier; or

ii. a State from whose territory or facility a space object is launched, either vertically from a spaceport or ocean platform or deployed from an aicrcaft carrier;

(o) "limitation periods" means those time periods listed in the United Nations' *Liability Convention*, including that States have one year, upon learning of the space-related incident, to make a claim for compensation;

(p) "nationals" means any Canadian citizen or corporation that is incorporated or continued under the laws of Canada or a province and that is engaged in launching activities, regardless of whether those activities occur in Canada or elsewhere;

(q) "outer space" means the area beyond the Earth's atmosphere and includes the Moon and other celestial bodies, and begins at the altitude above Earth where an aircraft can no longer utilize lift to fly and the minimum at which a satellite may still maintain an orbit around Earth without falling back to the surface;

(r) "payload" means the profit-generating hardware, product, or other goods, such as satellites, stowed on a rocket and meant to be launched into outer space and placed into orbit;

(s) "private space activity" means any non-governmental activity including launching and/or that involves space objects or humans in space;

(t) "protocol" means an emergency plan and strategy developed for application during a disaster;

(u) "re-entry activity" means a space object returning to Earth, and begins when the space object leaves outer space and re-enters the Earth's atmosphere, and ends when the space object either lands on Earth or the last of its fragments disintegrate in Earth's airspace;

(v) "responsibility" means having a duty to supervise or to have control over someone or something;

(w) "rocket" means a self-propelled launch vehicle that weighs at least 10,000 kilograms at time of vertical launch or at least 1,000 kilograms at time of air launch and is:

i. moving toward outer space and away from Earth, the Moon, or any other celestial body and that is meant to complete at least one full orbit around Earth, the Moon, or the celestial body it was launched from, and excludes suborbital rockets; or

ii. traveling or stationary in outer space.

(x) "space economy" means profit-driven space-related activities occurring in outer space, such as satellite operations, or on Earth's surface, international waters, or airspace, such as launch activities;

(y) "space object" means any artificial object launched or attempted to be launched into orbit from Earth, the Moon, or other celestial body, or that is traveling to or through outer space, and includes rockets, satellites, and spacecraft;

(z) "space object operation" means the time when an operator has, or ought to have, control over a space object, and begins when the launch phase ends and continues indefinitely or until the space object begins to de-orbit and re-enter the Earth's atmosphere;

(aa) "spacecraft" means a type of crewed space object with an artificial atmosphere;

(bb) "spaceflight participant" means any individual who is not an astronaut onboard a spacecraft;

(cc) "spaceport" means the infrastructure used to safely and securely launch a rocket, including sites located on land or on water, and includes re-entry sites;

(dd) "space-related incident" means any event causing damage either financially, in terms of human injury or fatality, or environmental, and may occur in outer space or on Earth's surface, international waters, or airspace, and includes but is not limited to:

i. rocket(s) launched from a State's sovereign territory, including from an aircraft flying in the airspace above or on any properly State-authorized ship or platform in any body of water;

ii. space object(s) damaging other space objects(s) during launch or when in outer space;

iii. space objects(s) damaging a rocket during launch;

iv. rocket damaging space object(s) during launch;

v. engineering or technical malfunction causing a rocket(s) to collide with another rocket(s); and

vi. any collision between any space object and any aircraft or spacecraft;

(ee) "scientific space activity" means any activity sending objects or humans into outer space for the purposes of systematically studying questions, principles, and methods related to the physical and natural world and the universe through observation and experiment.

Part II: Space Activity Responsibilities

4. Canada will conduct its space-based activity through operating a well-functioning authorization and licensing scheme governing orbital launch activity and space object operations performed by any Canadian entity or by any foreign entity in Canada.
5. Canada will guide its space strategy and space policy with the ultimate goals of developing a safe, secure, accessible, well-functioning, and sustainable commercialized space economy, strengthening its space-related education, research, innovation, and technological development, investing the economic benefits attained from the growth of the industry back into communities across the country to promote Canadians' access to space-related research, services, applications, and benefits, and increasing the wealth, improving standards of living and quality of life, and ensuring the safety and security of all Canadians, particularly those living nearby launch sites, launch facilities, and launch business operations and who are regularly and directly impacted by launching activities, and giving particular consideration to:

(a) facilitating growth in the national private and commercial orbital launch sector;

(b) easing bureaucratic and regulatory obstacles for investors and business leaders;

(c) developing a transparent and comprehensive licensing and authorization scheme complete with adequate insurance requirements for orbital launches;

(d) ensuring Transport Canada's expertise is readily available and accessible to stakeholders;

(e) properly studying, managing, and mitigating environmental impacts of orbital launch activity; and

(f) upholding national security, the safety of Canadians, and protection of private and public property.

6. Canada, and its nationals, will not place nuclear weapons or weapons of mass destruction in outer space, including on the Moon or on celestial bodies, and will pursue peaceful operations in outer space and in accordance with Canada's international obligations, particularly including principles within the *Outer Space Treaty, Astronaut Rescue and Return Agreement, Liability Convention,* and *Registration Convention,* and other space-related treaties and agreements to which Canada is a party.
7. Canada, and its nationals, will record relevant governmental, civil, private, and commercial space object information, including for rockets, including at least the information stipulated in the *Registration Convention's* Article IV(1), in a National Registry and will ensure this information, so long as it does not compromise national security or any other national interest, is electronically and publicly available.
8. Canada, and its nationals, shall retain jurisdiction and control over the space objects, including rockets, discussed in section 7, and over any personnel thereof, while in outer space, on the Moon, or any other celestial body.
9. Canada, and its nationals, shall inform the United Nations Secretary General, as well as the public and the international scientific community, so long as national security will not be compromised, of the nature, conduct, locations, and results of the space objects listed in section 7, and of any other space activities.
10. Canada will regularly and in a timely manner transmit the information recorded in section 7 to the United Nations Secretary General.
11. Canada will grant the appropriate applications, pursuant to this Act and other Acts of Canada, to supervise and authorize all space object activities, including launches, occurring from Canadian sovereign territory, its airspace, or territorial waters, regardless of nationality, thereby acting as launching State, and subject to any agreed upon apportionment of liability with other launching authority(ies), if any, of space object(s) onboard the rocket.
12. Canada will grant the appropriate applications, pursuant to this Act and other Acts of Canada, to supervise and authorize all space object activities, excluding launches, occurring from outside Canadian sovereign territory, its airspace, or territorial waters, by

its nationals, thereby acting as launching State, and subject to any agreed upon apportionment of liability with the other launching authority(ies) involved in the launch.

13. Pursuant to section 7, Canada will include the following information in the National Registry:
    (a) name of launching State(s) or authorities;
    (b) appropriate designator of the space object or its registration number;
    (c) date and territory or location of launch;
    (d) basic orbital parameters, including:
        i. nodal period;
        ii. inclination;
        iii. apogee; and
        iv. perigee;
    (e) designation of the spacecraft as uncrewed or crewed; and
    (f) general functions of the space object.
14. Canada will study the effects that rocket launching fuels and propellants have on the atmosphere and environment, including the impacts on natural resources, including fish and wildlife, on natural, scenic, and recreational assets, on water and air quality, and on ecosystems, human health, and other factors affecting the environment, with particular focus on the largely unknown impacts of certain fuels, including the effects of byproducts of black carbon and alumina from liquid rocket fuels.
15. Canada will, based on the findings in section 14, govern its rocketry industry in a way that adequately mitigates against degradation of the atmosphere and environment.

Part III: Astronauts

16. Transport Canada is tasked with creating protocols for Canada to follow when:
    (a) astronauts and spaceflight participants of any nationality are in distress outside Canada's sovereign territory but within another State's sovereign territory with consideration for:
        i. the Canadian and/or Canadian entity responsible for coordinating rescue operations;

ii. general strategy to follow when engaging in rescue operations and when working to diligently return the astronauts to their launching authority and home State; and

iii. immediately notifying and appropriately updating the launching authority and home State on relevant information; or

(b) astronauts and spaceflight participants of any nationality are in distress in Canada's sovereign territory, with regard paid to the considerations in subsections 16(a)(i) to (iii);

(c) astronauts and spaceflight participants of any nationality are in distress in a location outside any State's sovereign territory, with regard paid to the considerations in subsections 16(a)(i) to (iii); or

(d) Canadian astronauts and spaceflight participants in distress regardless of location with regard paid to subsections 16(a)(i) to (iii).

17. Canada will collaborate as appropriate with other launching authorities and States throughout rescue operations pursuant to section 16.
18. Canada will inform the appropriate launching authority, home State, and the United Nations Secretary General immediately upon learning of any astronaut(s) or space flight participant(s) in distress.
19. Canada will pursue reimbursement from foreign States and foreign launching authorities after having spent time and other resources rescuing foreign astronaut(s) or space flight participant(s) in distress.

Part IV: Liability and Insurance

20. Canada will assume absolute liability for space-related incidents caused by its authorized crewed and/or uncrewed space object(s) on Earth or in airspace and will seek exoneration from absolute liability where the damage resulted wholly or partially from gross negligence or from an act or omission done with intent to cause damage by the claimant authorizing authority.
21. Canada will assume fault liability for space-related incidents caused by its authorized crewed and/or uncrewed space object(s) in outer space.

22. In the event a Canadian national's unauthorized crewed or uncrewed space object(s) caused damage, Canada shall, in compliance with Article VI of the *Outer Space Treaty*, bear international responsibility for the damage in the form of absolute liability for incidents occurring on Earth or in airspace and fault liability for incidents occurring in outer space, and will pursue all remedial options available to it pursuant to Article V(2) and (3) of the *Liability Convention*.
23. Canada will not assume any liability when it suffers a space-related incident on Earth or in airspace, which was wholly caused by a foreign space object(s), regardless of the other launching authority(ies') intent or degree of negligence.
24. Canada will not assume any liability when it suffers a space-related incident in outer space, which was wholly caused by a foreign space object(s) as a result of the other launching authority(ies') intent or gross negligence.
25. As part of the launch licensing procedure, launch providers shall acquire minimum levels of liability insurance based on maximum probable loss calculations made by Transport Canada, depending on all of the following factors:
    (a) numbers of estimated casualties and the costs of the estimated casualties;
    (b) costs of property damage; and
    (c) whether a rocket is uncrewed or crewed, wherein:
        i. uncrewed rocket launches shall acquire additional insurance based on the weight of its payload deliverable to low-Earth orbit, and not on its gross weight, and this shall be calculated on a linear scale; or
        ii. crewed rocket launches shall acquire additional insurance based on the weight of its payload deliverable to low-Earth orbit, and not on its gross weight, and on the number of astronauts and space-flight participants onboard, each of which values shall be calculated on a linear scale.
26. Canada will present a claim for compensation and pursue all avenues of indemnification from foreign launching authorities if harmed by that authority's space object(s).
27. Canada will recognize and abide by limitation periods stipulated in the *Liability Convention*.
28. Canada agrees to support its nationals, so long as its nationals' claims have adequate merit, in international disputes through the use of diplomatic channels and, if such

negotiations fail, at the Claims Commission, recognizing such decisions as binding, and pursuant to *Liability Convention* Articles XIV to XX.

Part V: Licensing of Launch Activities and Space Objects

29. Launch and re-entry licenses issued by Transport Canada on behalf of Canada to a prospective entity constitute Canada's authorization of that entity to launch and/or includes re-entry of the rocket and/or spacecraft.
30. Launch and re-entry licenses are required for all launches and/or re-entries regardless of whether governmental, military, civil, private, commercial, or scientific in nature, and regardless of a vertical launch from land or ocean platform, or when deployed from an aircraft carrier in flight.
31. Fees to submit a launch and/or re-entry license application will be established by the Minister of Transport.
32. Launch and/or re-entry licenses will be adjudicated by a committee of three or more qualified and impartial individuals as arranged by Transport Canada, including:
    (a) one lawyer, possessing:
        i. his/her call to the bar and license to practice in at least one Canadian province;
        ii. familiarity with the *National Security Act* and the *Canadian Constitution*, particularly the *Charter of Rights and Freedoms*;
        iii. familiarity of aeronautics, astronautics, and space-related:
            1. domestic laws, including at least the *Remote Sensing Space Systems Act, Aeronautics Act, Canadian Aviation Regulations, Canada Transportation Act,* and *Air Transportation Regulations*; and
            2. international laws and treaties, including at least the *Outer Space Treaty, Astronaut Rescue and Return Agreement, Liability Convention, Registration Convention, Moon Agreement,* and *Chicago Convention*;
    (b) one engineer, possessing:

i. the designation of Professional Engineer as granted by the relevant provincial regulatory body;

ii. extensive expertise and experience in:

1. astronautical and aeronautical engineering, with an emphasis on the safety of launch vehicles, both vertical and from an aircraft carrier in flight, as well as on spacecraft, and other space objects and equipment;
2. hardware onboard launch vehicles, satellites, and other space objects;
3. infrastructure required for a safe and successful launch, such as a spaceport, and logistical coordination of delivering space objects to spaceports;
4. rocket fuels, including their chemical properties, and transportation of those rocket fuels; and

(c) one policy analyst, possessing:

i. expertise and experience in:

1. Canada's current space policy and strategic framework;
2. Local, regional, interprovincial, and international government and diplomatic relations;
3. the current state of the orbital launch industry in North America and overseas;
4. the public perception of the launch industry both locally, nationally, and internationally; and
5. foreign approaches to conducting launch activities and operations of space objects.

33. Transport Canada is the governing department tasked with assessing launch or re-entry license applications and may:

(a) inspect any proposed rocket(s);

(b) inspect any proposed launch facilities, including spaceports and aircraft carriers;

(c) inspect any proposed payload integration;

(d) inspect any space object(s); and

(e) seek indemnification from any rocket launching entity or space object operator responsible for a space-related incident.

34. The Minister of Transport shall consider the following factors when evaluating a launch and/or re-entry license application:

(a) promoting the stable, controlled, and well-monitored development of all launching activity in Canada with a particular focus on promoting the sustainable development of private and commercial launching and operation of space objects;

(b) maintaining and upholding Canadian national security, the defence of Canada, and safety of Canadian armed forces;

(c) furthering Canadian foreign policy interests;

(d) furthering standards of living and quality of life for Canadians, particularly those living nearby launch sites, facilities, and rocketry business operations;

(e) honouring international obligations;

(f) respecting other Canadian domestic law;

(g) non-aviation related health and safety of humans, plants, animals, the environment on Earth including its land, oceans, and atmosphere, and the preservation of the outer space environment;

(h) protection of property;

(i) aviation related health and safety, including proper coordination with relevant Canadian and foreign air traffic control authorities;

(j) moral, financial, and professional guarantees of the launch provider or space object operator;

(k) moral, financial, and professional guarantees of relevant shareholders;

(l) ability of licensee to indemnify Canada if a costly incident occurs during the launch phase or re-entry activity or space object operation and may include amounts of liability insurance up to $500,000,000, a maximum of what is available on the world market, or access to levels of highly-liquid financial reserves up to $500,000,000;

(m) technical capabilities of proposed rocket or space object(s);

(n) disposal plans of space objects, including rockets, not meant to return to Earth;

(o) location of the proposed launch, including staging, payload integration, and ignition, giving consideration to surrounding population centres, infrastructure, and the environment;

(p) non-binding and informational public hearings and other consultations to gather valuable and honest stakeholder opinion from those living and working nearby proposed or existing launch sites and facilities, but with respect only to environmental protection- and human safety-related concerns and comments;

(q) class of launch or re-entry license applied for, including:

i. uncrewed vertical launch license (single-use or renewable), with rocket launched from land, ocean platform, or other spaceport, at a safe location from humans, communities, flora, fauna, and the environment in general;

ii. uncrewed horizontal air launch license (single-use or renewable), with rocket launched from aircraft carrier in flight, allowing for rocket integration with the aircraft carrier at a safe location that offers access to suitable logistics and requiring rocket deployment from an appropriate distance from any community, extensive infrastructure, or National Park;

iii. crewed vertical launch license (single-use or renewable), with rocket launched from land or ocean platform, shall require higher safety standards and more stringent testing than uncrewed launches, including:

1. proper physical, emotional, and technical training for astronauts and space-flight participants;
2. adequate artificial atmosphere, life support, medical supplies, communications equipment, and other safety and security procedures and equipment onboard; and
3. ejection system to evacuate astronauts and spaceflight participants onboard a rocket in the event of imminent launch failure.

35. Launch license applications will govern the launching of orbital rockets, while re-entry license applications will govern the re-entry of orbital rockets and/or spacecraft into the Earth's atmosphere, and each shall include the following:

(a) legal entity's name, organizational form, address, account number, contact person, and contact information;

(b) type of rocket being launched, name and contact information of rocket manufacturer, proposed launch dates and times, proposed place of launch, proposed number of similar launches with identical rockets, proposed trajectory into orbit, proposed altitude of orbit, whether the mission is uncrewed or crewed, and any other information the Minister of Transport deems necessary;

(c) whether the rocket will be uncrewed or crewed, with relevant details of astronauts and spaceflight participants provided for crewed launches;

(d) description of payload to be transported by rocket including weight and emergency plans, as necessary;

(e) guarantee by the applicant that information pertaining to all foreign satellite equipment and domestic satellite equipment launched into space by its rocket(s) will be provided to Canada for inclusion in the National Registry and subsequently transmitted to the United Nations Secretary General;

(f) documentation concerning adequate environmental, ecological, public, and astronaut and spaceflight participant health and safety of the proposed rocket launch including the rocket fuel used as propellant;

(g) description of how the rocket, including its spent stages and boosters and all other component parts, will be properly and responsibly disposed of once in outer space at the end of its useful lifespan, assuming it is not to return to Earth intact, including plans to move the rocket into a designated graveyard orbit, intentionally disintegrating the rocket upon planned re-entry into the Earth's atmosphere, or other;

(h) documentation concerning the reliability of the launching rocket;

(i) emergency protocol in case of space-related incident as prescribed by section 16 and local contact information for fire department, law enforcement, hospital services and, if necessary, national defence;

(j) documentation concerning the repeat use of rockets if the applicant is applying for a repeat rocket launch license pursuant to section 36;

(k) distance of launching rocket from nearest field, public viewing area, road, building, community, and other pertinent areas of infrastructure and interest;

(l) declaration that Canadian State secrets shall be maintained;

(m) documentation pertaining to the amount, coverage, and other details of liability insurance acquired, or documentation pertaining to the possession of adequate amounts of highly-liquid financial reserves, to indemnify Canada of costs incurred for a space-related incident(s);

(n) documentation pertaining to proposed re-entry of rocket or spacecraft, if necessary;

(o) documentation pertaining to additional safety features and extra testing conducted for crewed launches; and

(p) signed declaration confirming all information and documentation provided is accurate and has been submitted in good faith.

36. Launch and re-entry license renewal applications must include any material updates to information previously submitted under section 35.

37. Launch and re-entry renewal applications will be assessed on the factors listed in section 34, as well as the following:

(a) reference to the original application package submitted;

(b) reference to the original license granted and authorization certificate;

(c) confirmation that the rocket proposed for launch, including its disposal plan, is nearly identical to the rocket in the original application package, with differences noted;

(d) description of the proposed payload on the rocket, with differences noted between the proposed and original payload;

(e) documentation pertaining to the amount and details of new liability insurance acquired for the proposed launch, or possession of adequate highly-liquid financial reserves, to indemnify Canada of costs incurred for a space-related incident(s);

(f) signed declaration stating all information contained in the original launch application continues to be correct, other than differences notes in this renewal application; and

(g) signed declaration confirming all information and documentation provided in this renewal application is accurate and has been submitted in good faith.

38. Transport Canada has the right to investigate anything and anyone in the application and related to the application, including the rocket technology itself, the launch facilities including the spaceport or aircraft carrier, integration of payload into the rocket, and astronauts and spaceflight participants.
39. Transport Canada has the right to suspend launch and re-entry sites from operating, if the site's continued operations may compromise Canadians' safety, Canadians' public or private property, the environment, Canada's foreign policy interests, or Canada's national security interests.
40. If the Transport Minister finds that a launch will have a significant adverse effect on the environmental and ecological factors listed in section 14, the Minister may still approve the launch license application and authorize the launch only if, after a complete and publicly-accessible review of all relevant factors, including the gathering of stakeholder input pursuant to section 34(p), the Minister makes a written finding that all reasonable steps have been taken to minimize the adverse effect and the associated benefits outweigh the associated costs.
41. The Royal Canadian Mounted Police are responsible for monitoring the activities conducted on and around spaceport infrastructure.
42. Launch and/or re-entry license applications must be submitted at least 12 months prior to prospective launch date.
43. Upon receipt of the launch and/or re-entry license application:
    (a) Transport Canada has 120 days to assess the application and either grant the license or reject the application; and
    (b) if rejecting the application, provide the reasons for the rejection to the applicant and inform them of their right to request an adjudication of the original decision, which shall be conducted by the Transport Minister or his/her delegate.
44. Upon receipt of the adjudication request referred to in 43(b):
    (a) The Transport Minister has 60 days to reassess the application and either confirm or overrule the original decision; and
    (b) Provide the reasons for his/her decision and inform the applicant of their right to request a judicial review of the case at the relevant Provincial or Territorial Superior Court.

45. Launch and/or re-entry licenses, once granted, shall specify a particular period of time within which the launch or re-entry shall occur, with consideration given to potential delays in fueling the rocket, integrating payloads, and/or changes in the weather.
46. Launch and/or re-entry licenses' expiration dates shall not exceed 24 months from the date of license approval but may be extended through the license renewal process.
47. Launch and/or re-entry licenses that have been granted may subsequently be amended, suspended, revoked, and/or subject to fines pursuant to section 50, by the Transport Minister, after consideration of public safety, protection of property, environmental protection, and national security, and only if:
    (a) a licensee fails to comply with instructions and orders of State entities;
    (b) false information is found within application documents;
    (c) a licensee violates any condition(s) of a license agreement;
    (d) a licensee proves to operate and function incompetently; or
    (e) a licensee's rocket is found to be faulty or unsafe for launch.
48. Launch and re-entry licenses are not transferable and cannot be sold.
49. Launch and re-entry licenses are specific to their terms.
50. Transport Canada may impose monetary fines of up to $5,000,000 if an individual or entity is found to be carrying out unlicensed rocket launches or re-entries or other types of space activities, acting in any illegal manner or in contravention of this Act, and this fine is in addition to penalties prescribed under the *Criminal Code of Canada*.
51. Transport Canada ensures that appropriate investigations are conducted into all suspected cases of fraud in application documents, including information on all rocketry equipment, spaceport infrastructure, and payload integration, and shall investigate all space-related incidents and near-misses.
52. Transport Canada will create plans to prevent instances of application fraud, technical shortcomings, and failed launches, all of which may be undertaken by Transport Canada through collaboration with other government departments and/or non-government entities, both nationally and internationally.

Part VI: Transport Minister's *STAR Act* Amendment and Regulatory Authority

53. Transport Minister shall update the financial and numerical values in sections 3(f), 3(w), 31, 34(l), 42, 43, 44, and 50 as necessary.
54. Transport Minister has all final interpretative powers over this *Act*.
55. Transport Minister may create new regulations or amend existing regulations pertaining to this *Act*.

END OF LEGISLATION

4.2: Discussion of the *STAR Act*

4.2.1: Parts I through IV:

The Preamble of the *STAR Act* honours *OST* Article I's tenet that "The exploration and use of outer space … shall be the province of all mankind." *STAR Act's* section 2 of Part I clearly describes the guiding purpose of the *STAR Act* with an explicit preference for supporting Canadian launch providers and Canadians offering supporting services and products, in much the same way as the USA included a preference for American persons, businesses, and other entities involved in remote sensing satellite operations and applications[578] in that country's recently revised regulations in 15 CFR 960[579] and the *Land Remote Sensing Policy Act of 1992.*[580] Terms specific to the *STAR Act* are defined in section 3 and were influenced by the UN space law treaties, various domestic and foreign legal sources, dictionaries providing ordinary and usual meanings, and space-related legal scholarly and academic writings. In general, the *STAR Act* has been tailored to the particular importance of air-launched orbital rockets in the Canadian context. As noted in this thesis' chapter 1's section 1.1, rockets may be launched vertically from the land or an ocean platform, or deployed from an aircraft carrier during flight. The majority of rockets continue to be launched vertically, with only two orbital rockets having ever repeatedly launched

[578] "Licensing of Private Remote Sensing Space Systems" (20 May 2020), Department of Commerce, online: <https://www.govinfo.gov/content/pkg/FR-2020-05-20/pdf/2020-10703.pdf> at 30793 (8 May 2022).
[579] *Part 960 Licensing of Private Remote Sensing Space Systems, Title 15 of the Code of Federal Regulations*, Legal Information Institute at Cornell Law School, online: <https://www.ecfr.gov/current/title-15/subtitle-B/chapter-IX/subchapter-D/part-960> (8 May 2022); *Ibid*, at 30806 to 30815.
[580] *Land Remote Sensing Policy Act of 1992*, Pub L No 102-555, 106 Stat 4163 (10/28/1992).

from below an aircraft in flight,[581] although air-launches-to-orbit are well-suited to Canadian geography, particularly key infrastructure in the south and vast uninhabited lands in the north, and lengthy coastlines abound.

Recall that chapter 1's section 1.1 discussed the advantages and disadvantages of both vertical and air launches. Applying the two methods to the domestic context indicates that air launches are a more appropriate and affordable means for launching orbital rockets from Canadian territory for geographic and other reasons. First, integrating an aircraft into the launch procedure means most of the infrastructure required for the orbital launch amounts to the approximately $9 million construction of a 2,000-meter runway to accommodate a Boeing 747-400, rather than the $200 million cost for a spaceport for a vertical launch.[582] This cost reduction addresses the difficulty in accessing adequate levels of capital, that is experienced within the industry. Second, the maneuverability provided by an aircraft leverages Canada's sparsely inhabited land and lengthy coastlines to facilitate launches far from major population centers, thus greatly reducing the risk to human health and safety and of damaging valuable infrastructure. An aircraft and rocket could be integrated and staged near a populated centre by leveraging access to infrastructure and logistics, but then deploy the rocket many hundreds of kilometers away. Although there are disadvantages to air launches, namely that aircraft are limited to carrying relatively smaller rockets that are more likely to offer lower profit margins compared to larger rockets, the benefits outweigh these costs and present an incredible opportunity. The government may wish to consider passing legislation that encourages smaller launch providers to operate in Canada through bonus depreciation, similar to the USA's *American Space Commerce Act of 2021* in Table 4.1.

Part II of the *STAR Act* discusses Canada's responsibilities when conducting space- and launch-related activities, with attention given to the UN's space law treaties. Part II's sections 11 and 12

---

[581] Horizontal Launches, *supra* note 18.

[582] For airports: "Eight Steps to Building a New Airport" Florida Department of Transportation, online: <https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/aviation/pdfs/8-steps-to-building-a-new-airport.pdf?sfvrsn=1b4c83a5_2#:~:text=Typically%2C%20it%20requires%20more%20than,a%20simple%20general%20aviation%20airport.> (11 September 2021); for spaceports: B Browder & D Newman, "How to Build a Spaceport: Analyzing Spaceport Feasibility Via Financial Analysis" (2019) *ResearchGate* at 1, online: (https://www.researchgate.net/publication/338719791_How_to_Build_a_Spaceport_Analyzing_Spaceport_Feasibility_via_Financial_Analysis> (11 September 2021).

stipulate Canada will supervise and authorize all space-related activities undertaken by itself or its nationals, including endeavors originating on the surface of the Earth and occurring in the airspace above. Canada's commitment to studying the effects of rocket fuels and propellants, particularly of black carbon and alumina, on the environment and ecosystems, human health, and numerous other specified considerations, is written in section 14, and to mitigate for these harmful effects is in section 15. The *STAR Act's* sections 14, 34(p), and 40 were all drafted and influenced by the text in *Title 51 USC* section 51104's (a) and (b). None of the Chinese, Russian, or French legislative schemes reviewed in this thesis discussed the environment as extensively as the USA's framework: China's *Permit Measures* considers the environment, directly at least, only once, in its Article 6(b) by requiring launch license applicants submit documentation proving the proposed launch conforms to the laws and regulations of the Chinese government on "environmental protection"; Russia's *SLSO* considers the environmental impacts of a proposed launch in its section 5(h) which requires launch license applicants submit documentation confirming the "ecological" safety of space operations and the reliability of space equipment, and while France's *FSOA* notes the importance of environmental protection throughout its text, it does not offer any definition of, or elaborate on, what considerations of the "environment" entail.

The *STAR Act's* Part III implements *ARRA's* imposed obligations into domestic law by ensuring Canada develops well-informed strategies and plans to rescue astronauts and spaceflight participants in distress and return these astronauts and spaceflight participants to their launching State. Part III also ensures Canada will appropriately collaborate with other States and the United Nations during rescue and return operations and will seek indemnification from other States as necessary. Part IV of the *STAR Act* honours various parts of both the *Liability Convention* and *Registration Convention*. Part V creates an all-encompassing legal framework to sufficiently govern Canada's and its nationals' launch-related activities, and throughout the entirety of the *STAR Act*, the legislation honours obligations imposed on Canada at international space law:

Table 5.1: The *STAR Act's* Implementation of International Obligations from UN Treaties

STAR Part	*STAR* Section	*Treaty* and Article (content) Compliance			
		Outer Space Treaty	*Astronaut Rescue and Return Agreement*	*Registration Convention*	*Liability Convention*
Preamble	-	I (exploration and use of outer space shall be the province of all mankind; international cooperation)	-	-	-
		II (without national appropriation by claim of sovereignty)	-	-	-
		V (astronauts as envoys of mankind)	-	-	-
		X & XII (opportunity for other nations to observe and visit space activities and objects)	-	-	-
I – Preliminary	2	III (compliance with international law)	-	-	-
II – Space Activity Responsibilities	6	IV (nuclear prohibition; peaceful operations)	-	-	-
	7 & 10	-	-	II (national registry and inform UNSG)	-
	4, 11, & 12	VI (government authorization of nationals' space activities)	-	-	-
	7 & 13	-	-	IV (information in registry)	-
	8	VIII (retain jurisdiction and control of space objects)	12 (retain jurisdiction of personnel and	-	-

			space objects on the Moon)		
	14 & 40	IX (environmental protection)	-	-	-
	9	XI (inform of the nature, conduct, locations, and results of space activities)	-	-	-
III – Astronauts	16	-	1, 2, 3, 4 (rescuing and returning astronauts)	-	-
	17	-	5(2), 5(3), 5(4) (international collaboration)	-	-
	18	-	5(1) (inform UN and launching State)	-	-
	19	-	5(5) (pursue reimbursement from launching States)	-	-
IV – Liability and Insurance	20, 22	VII (internationally liable for damage to others caused by space object)	-	-	II (absolute liability on Earth or airspace)
	21, 22		-	-	III (fault liability in outer space)
	23 & 24	-	-	-	VI (exoneration from liability)
	25(c)ii	-	-	-	VIII (claim for compensation)
	27	-	-	-	X (limitation period)
	28	-	-	-	VIII to XX (diplomatic negotiations and Claims Commission)

4.2.2: Parts V and VI:

The *STAR Act's* section 30 states the scope of the Act includes all launch activities no matter who conducts or procures the launch, a concept that is perhaps well-established amongst those knowledgeable of the field of space law but worth noting to provide clearer guidance to all stakeholders. Additionally, section 30 includes rocket and spacecraft re-entry activities within the launch licensing and authorization scheme, thereby enabling the possibility of future Canadian crewed missions.

Pursuant to the current *CAR* section 602.43, the Minister of Transport guides his or her application assessment by considering whether the proposed orbital rocket launch is in the "public interest" and "not likely to affect aviation safety". The *STAR Act's* section 34 provides more extensive direction to the Transport Minister during evaluation processes and this addition to the law will reduce the reliance on Ministerial discretion by employing a less arbitrary framework and improve the predictability of pending approvals or rejections of applications, thereby bringing greater clarity and certainty to investors and business leaders in the industry. As well, section 35 of the *STAR Act* explicitly lists the documents and information required when submitting a launch license application to Transport Canada. For example, subsections 35(c) and 35(o) of the *STAR Act* mandate prospective launch providers indicate in the application package whether the rocket will launch an uncrewed or crewed mission and requires additional documentation and information mainly for more stringent health and safety standards for crewed launches.

Sections 42, 43, and 45 impose deadlines on application submissions and application assessment outcomes, and lists expiration dates of approved licenses and options for renewal. Sections 39 and 47 enable the Transport Minister to temporarily suspend or permanently revoke spaceport and launch licenses, mostly due to safety concerns, as inspired by the SCC's interpretation of the licensing scheme within the *Fisheries Act* in *Comeau's*.[583] Section 50 addresses fine(s) of up to $5,000,000 that shall be issued to any Canadian persons or entity engaging in unauthorized launch activity regardless of location or by foreign persons or entities engaging in unauthorized

[583] *Comeau's, supra* note 363 at para 36.

launch activity within Canada. Section 51 grants Transport Canada the right and responsibility to investigate suspected fraud in submitted application documents and all information therein, including the rocket technology, launch facilities, payload integration procedures, persons involved, and requires investigations into failed launches and near misses, while section 52 requires Transport Canada develop plans to prevent cases of fraud and launch incidents from occurring in the first place.

The final three provisions of the *STAR Act*, sections 53, 54, and 55 are included in its Part VI. These sections grant the Transport Minister specific powers including the authority to update certain financial figures and numerical values throughout the *Act*, to exercise final interpretive powers of the *Act*, and develop and enact additional regulations to accompany the *Act* as the industry changes.

4.3: Rationale for Reform

As discussed in chapter 1, "sufficient" was defined as "meeting the minimum requirements", "to be acceptable", and "to be reasonable", but possibly more depending on the resources available to law reform efforts.[584] How "sufficient" is the proposed *STAR Act*? Does it govern the Canadian launch market at the optimal level of specificity? Laws that are too obscure will produce similar problems experienced by the Canadian launch provider market. The current legal scheme does not provide enough certainty with respect to the likelihood of launch applications being approved or rejected by Transport Canada and how strict of a standard the Transport Minister will employ when assessing launch license applications. Alternatively, regulation that is too detailed and restrictive and that offers no flexibility will produce new problems including the need for burdensome efforts by providers to comply with excessive bureaucracy and "red-tape" and a resulting stifling of business activity, innovation, and financial investment. The *STAR Act* aims to govern at the sufficient level, namely at the minimum point of specificity where the intermediary and ultimate objectives can still be reached, but without creating any excessive administrative, bureaucratic, or "red-tape" obstacles.

[584] See discussion in subsection 2.1 in chapter 1.

Particularly in the cases of ensuring health and safety standards are maintained, including the technical capabilities of proposed orbital launchers, it is better to over-regulate than under-regulate. David Monk's article published in the Journal of Air Law and Commerce, titled "The Lessons of Airline Regulation and Deregulation: Will We Make the Same Mistakes in Space," discusses how lawmakers may learn from the historical worsening health and safety of the airline industry following excessive deregulation in the 1960s and 1970s.[585] By imposing at least minimally adequate safety requirements on the Canadian launch industry, the market will avoid jeopardizing the health and safety of Canadians. Additionally, the *STAR Act* represents the government's warranted intervention in the launch market because the Act addresses negative externalities affecting human health and safety and quality of life, real and personal property, the environment, and national security concerns, by properly allocating inequitably imposed costs on third parties onto the first and second parties having caused those costs.

This thesis is timely and valuable for those within government and private industry. Canada, without a detailed and comprehensive rocket launch-governing legislation, is in a unique position to create effective and smart legal and regulatory decisions from the start. The previously mentioned article by Monk aptly states:

> Because the area of space law is so new, especially regarding space transport, the industry is starting with a more perfect world than that found in the pure aviation environment. As a result, opportunities exist to make the right choices from the start.[586]

The American government recognized the important role that the airline industry would play in terms of nation-building in the mid-1950s, specifically including the growth and development of the country.[587] The aviation sector has grown into an important industry benefiting national economies around the world both financially and socially.

The *STAR Act* imposes new requirements on launch providers because "… the government should seek to achieve an equitable balance between market efficiency and public policy objectives."[588] According to the OECD, "Legal certainty, predictability and businesses' trust in

---

[585] Learning from Airline Deregulation, *supra* note 170 at 723.
[586] *Ibid* at 718.
[587] *Ibid* at 719.
[588] *Ibid* at 728.

justice systems help positive investment decisions and promote competition."[589] Upholding the rule of law and enacting clearer, more transparent, and more comprehensive legislation and regulation will produce the optimal mix of predictable governance, improved safety and security for Canadians, and increased levels of investment.

Finally, launch providers and investors will directly benefit from the increased sufficiency of the *STAR Act* with improved accuracy of business and industry forecasting efforts. With the greater specificity of this new *Act* over the obscurity of the relevant sections in the *AA* and *CAR*, launch providers may better account for additional unknown variables involved in risk forecasting and this greater certainty will offer more time for business leaders and investors to strategize and plan accordingly. Launch providers will also benefit from Canada's commitment to supporting and representing its nationals during dispute resolutions through diplomatic channels, and if necessary, through the Claims Commission. Knowing the Claims Commission may be an option, albeit of last resort, to resolve disputes with international entities offers the opportunity to significantly reduce dispute resolution costs and presents the possibility for more satisfactory and more timely outcomes. It is important that investors and business leaders in this industry know the Canadian government is committed to supporting them in their endeavors and has the resources to follow through on these commitments.

5: Conclusion

Following research and comparative analysis, this thesis has proposed the implementation of updated and new legislation governing orbital rocket launches in Canada, as evident in the *STAR Act*. This legislation has been developed with a view to attracting rocketry investors, launch providers and operators, and business leaders to the nascent Canadian orbital launch industry. Specifically, the writing of the *STAR Act* was guided through the lens of legal instrumentalism and the application of the techniques in "Economics of Lawmaking", to offer the optimal balance between legislative specificity and simplicity. The *STAR Act* clarifies uncertainties in the industry, yet minimizes unnecessary bureaucratic delay by limiting the amount of "red-tape" in licensing, registration, and insurance schemes, applications, and procedures. As such, the *STAR*

[589] "Access to Justice" (2019), OECD, online: <https://www.oecd.org/gov/access-to-justice.htm> (1 December 2019).

Act may be used as model legislation to produce economic, financial, and social benefits, such as improved employment opportunities, for Canadians and communities nearby launch sites, facilities, and operations.

The Canadian launch sector must sustainably develop in a manner that pursues the intermediary policy objectives of honouring obligations at international law, maintaining the health and safety of Canadians, protecting real and personal property of Canadians, upholding national security interests, conserving local nature, flora, and fauna, protecting the Earth's environment, and improving the transparency of the government's legislative decision-making process and associated outcomes. A developing launch sector will only offer meaningful benefits if its expansion is carefully managed.

Ultimately, the goal of this thesis' law reform is to improve the lives of Canadians by facilitating and sustaining Canadian space-related industry and commercial growth to improve Canadian launch competitiveness, strengthen innovation and technological development both in industry, academia, and at other research institutions, ensure the safety and security of Canadians and the environment, and improve opportunities for Canadians to pursue employment, research, and studies in space-related disciplines including natural sciences and engineering, but also law, psychology, medicine, and more. Furthermore, investing the economic benefits attained from the growth of the industry back into communities across Canada will allow the government to further promote and improve accessibility to the use and application of space technologies. Lastly, the *STAR Act* is meant to increase the wealth and improve standards of living and quality of life for the most impacted Canadians – namely those living near launch sites, facilities, and other operations – by enhancing social and healthcare programs, maintaining low levels of noise and chemical pollution, and preserving the pace of life and comfort that locals have come to enjoy.

APPENDIX A: HISTORICAL TRANSPORT CANADA LAUNCH LICENSE APPLICATION

The following form was used by the now-defunct Canadian Launch Safety Office as part of Transport Canada's launch licensing process. Although the CLSO existed in the 1990s, it was eventually disbanded in the early 2000s.[590]

Transport Canada / Transports Canada

APPLICATION FOR AUTHORIZATION TO LAUNCH
HIGH POWER AND ADVANCED HIGH POWER ROCKET(S)

All rocket activities and participants must comply with the applicable safety codes, launch standards & procedures as developed, published and maintained by a rocketry association accepted by the Minister including all applicable Canadian Aviation Regulations (602.43) and standards as well as other federal, provincial and municipal laws.

A - EVENT INFORMATION

Proposed Launch Date(s) (YYYY-MM-DD)	Proposed Times	Proposed Number of Rocket Launches

Maximum altitude requested ASL (Above Sea Level)	Rocket Association sponsoring this event

B - APPLICANT OR SPONSOR INFORMATION

Name	Residence Telephone	Business Telephone	Facsimile

Address	Email	Membership Number (if applicable)	Certification(s)	Telephone Number for contact during Launch Operations

C - RANGE SAFETY OFFICER

Name	Residence Telephone	Business Telephone

Address	Club	Certification(s)

Description of Experience

D - SAFETY INFORMATION

Rocket Association Sanctioned and Insured	Emergency Plan/Accident Contigency Telephone Numbers Available	Fire Department	Local Police
Liability Insurance / Coverage	☐ Yes ☐ No	Hospital	Fire Extinguisher

E - SITE INFORMATION

Site Layout (Provide a site description and a drawing or map depicting site boundaries; including proximity to buildings, public transportation routes, residential areas and airports/aerodromes or navigational aids)

Launch and Recovery - Dimensions of Area	Distance of Launcher from Nearest Road
Site Approvals (where applicable)	Distance of Launcher from Public Viewing Area
☐ Approval of public or private proerty owner (attached)	Distance of Launcher from Nearest Building
☐ Approval of Neighbouring property owners (attached)	Location
☐ Approval of airport/aerodrome operator (attached)	Latitude / Longitude

F - DECLARATION

All high power and advanced high power rockets as well as related launch activities described in this application will be in accordance with the launch standards, procedures, safety codes and technical recommendations as developed, published and maintained by the rocket association named in this application.

Signature / Date (YYYY-MM-DD)

26-0659 (0312-02)

Canada

[590] Transport Canada, "Response – ATIP," (personal communication, 13 July 2020) [email].

BIBLIOGRAPHY

Legislation: Canada

Aeronautics Act, RSC 1985, c A-2.

Air Transportation Regulations, SOR/88-58.

Broadcasting Act, SC 1991, c 11.

Canada Evidence Act, RSC 1985, c C-5.

Canada Transportation Act, SC 1996, c 10.

Canadian Aviation Regulations, SOR/96-433.

Canadian Radio-television Telecommunications Commission Act, RSC 1985, c C-22.

Fisheries Act, RSC 1985, c F-14.

Interpretation Act, RSC 1985, c I-21.

Radiocommunication Act, RSC 1985, c R-2.

Radiocommunication Regulations, SOR/96-484.

Remote Sensing Space Systems Act, SC 2005, c 45.

Remote Sensing Space Systems Regulations, SOR/2007-66.

Telecommunications Act, S.C. 1993, c. 38.

Transportation Accident Investigation and Safety Board Act, SC 1989 c 3.

Transportation Appeal Tribunal of Canada Act, SC 2001, c 29.

Legislation: USA

Title 14 of the Code of Federal Regulations, Aeronautics and Space.

Title 51 USC, National and Commercial Space Programs.

Commercial Space Launch Act, 1984. Pub L No 98-575, 98 Stat 3055 (10/30/1984).

Commercial Space Launch Amendments Act of 1988. Pub L No 100-657, 102 Stat 3900 (11/15/1988).

Commercial Space Launch Amendments Act of 2004. Pub L No 108-492, 118 Stat 3974 (12/23/2004).

Land Remote Sensing Policy Act of 1992. Pub L No 102-555, 106 Stat 4163 (10/28/1992).

One Small Step to Protect Human Heritage in Space Act. Pub L No 116-275, 134 Stat 3358 (12/31/2020).

US, Bill S 1260, *US Innovation and Competition Act of 2021*, 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/117/bills/s1260/BILLS-117s1260es.pdf>.

US, Bill HR 1304. *American Innovation and R&D Competitiveness Act.* 117 Cong (2021-2022).

US, Bill HR 1369. *American Space Commerce Act of 2021*. 117 Cong. (2020-2021).

US, Bill HR 2262. *Commercial Space Launch Competitiveness Act*. 114 Congress, 2015.

US, Bill HR 2262. *Spurring Private Aerospace Competitiveness and Entrepreneurship.* 114 Cong, 2015.

US, Bill HR 3752. *Commercial Space Launch Amendments Act of 2004.* 108 Cong, 2004.

US, Bill HR 4792, *Countering Communist China Act*, 117 Cong (2021-2022), congress.gov, online: <https://www.congress.gov/117/bills/hr4792/BILLS-117hr4792ih.pdf>.

US, Bill S 1549. *To require a review of the National Aeronautics and Space Administration preference for domestic suppliers.* 117 Cong (2021-2022).

US, Bill S 360. *21st Century Space Grant Modernization Act of 2021*. 117 Cong (2021-2022).

US, Bill S 4827. *Space Preservation and Conjunction Emergency Act of 2020* (*SPACE Act*). 116 Cong (2019-2020).

Legislation: Chinese

Circular of SASTIND Central Military Commission Equipment Development Department on Promoting the Standardised and Orderly Development of Commercial Launch Vehicles, 2021 (*CCR Measures*). Laws of the People's Republic of China.

Constitution of the People's Republic of China, 1982. National People's Congress.

Interim Measures on the Administration of Permits for Civil Space Launch Projects (*Permit Measures*). Order No 12 of the Commission of Science, Technology, and Industry for National Defense and the People's Republic of China, 21 November 2002.

Measures for the Administration of Registration of Objects Launched into Outer Space (*Registration Measures*). Order No 6 of the Commission of Science, Technology, and Industry for the National Defense and the Ministry of Foreign Affairs of the People's Republic of China, 8 February 2001.

Legislation: Russian

Statute on Licensing Space Operations. Resolution No 104 of the Russian Federation Government, 2 February 1996.

Legislation: French

Loi n 92-597 du 1 July 1992 de Code de la propriete intellectuelle, *Journal Officiel*, 1 July 1992, Intellectual Property Code.

Loi n 2008-518 du 3 juin 2008 relative aux operations spatiales, Journal Officiel, 3 June 2008, *French Space Operations Act.*

Loi n 2019-1479 du 28 decembre 2019 de finances pour 2020, Journal Officiel, 28 December 2019, 2020 Finance Law.

International Treaties

Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982. 28 July 1994, 1836 UNTS 3, (entered into force 16 November 1994). United Nations General Assembly.

Astronaut Rescue and Return Agreement, 22 April 1968, 672 UNTS 119 (entered into force 3 December 1968).

Liability Convention. 29 March 1972, 961 UNTS 187 (entered into force 1 September 1972). United Nations Office of Outer Space Affairs.

Moon Agreement. 18 December 1979, 1363 UNTS 3 (entered into force 11 July 1984). United Nations Office of Outer Space Affairs.

Outer Space Treaty. 27 October 1967, 610 UNTS 205 (entered into force 10 October 1967). United Nations Office of Outer Space Affairs.

Registration Convention. 14 January 1975, 1023 UNTS 15, (entered into force 15 September 1976). United Nations Office of Outer Space Affairs.

United Nations Convention on the Law of the Sea. 10 December 1982, 1833 UNTS 3 (entered into force 16 November 1994). United Nations Treaty Collection.

Jurisprudence

Canada (Attorney General) v Khawaja, 2007 CAF 342.

Comeau's Sea Foods Ltd v Canada (Minister of Fisheries and Oceans), [1997] 1 SCR 12.

Mavrommatis Palestine Concessions (*Greece v UK*), 1924 PCIJ (ser B) No 3 (Aug 30).

Montreal City v 2952-1366 Quebec Inc, 2005 SCC 62.

North Sea Continental Shelf Cases (Germany v Denmark; Germany v Netherlands), ICJ Reports 1969.

R v Ahmad, 2011 SCC 6.

Re Harkat, 2014 SCC 37.

Rizzo & Rizzo Shoes Ltd (Re), [1998] 1 SCR 27.

Tataryn v Tataryn Estate, [1994] 2 SCR 807.

Secondary Sources

"2019 Financial Statements." Energia. Online: <https://www.energia.ru/en/corporation/consdocs/rpt_2019-2018.pdf>.

"2022 Budget Highlights." US Department of Transportation. Online: <https://www.transportation.gov/sites/dot.gov/files/2021-05/Budget-Highlights2022_052721_FINAL.PDF>.

"51 U.S. Code CHAPTER 509 – COMMERCIAL SPACE LAUNCH ACTIVITIES." Legal Information Institute at Cornell Law School. Online: <https://www.law.cornell.edu/uscode/text/51/subtitle-V/chapter-509>.

"747-400 Airplane Characteristics for Airport Planning." (December 2002), Boeing. Online: <http://large.stanford.edu/courses/2017/ph240/kau2/docs/d6-58326-1.pdf>.

"About International Telecommunication Union (ITU)." (2022), ITU. Online: <https://www.itu.int/en/about/Pages/default.aspx>.

"About Us: Our Shareholders." ArianeGroup. Online: <https://www.ariane.group/en/about-us/our-shareholders>.

"Access to Justice." (2019). OECD. Online: <https://www.oecd.org/gov/access-to-justice.htm>.

"aeronautics." Merriam-Webster.com. Online: <https://www.merriam-webster.com/dictionary/aeronautics>.

Alamalhodaei, Aria. "Rocktet Lab's Electron booster splashes down in the Pacific Ocean." (17 November 2021), TechCrunch+. Online: <https://techcrunch.com/2021/11/17/rocket-labs-electron-booster-splashes-down-in-the-pacific-ocean/#:~:text=Rocket%20Lab%20has%20successfully%20recovered,the%20destruction%20of%20the%20payload.>.

Alexander C & A Ansari. "Making regulation a competitive advantage." (2019), Deloitte. Online: <https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/finance/ca-en-making-regulation-comp-advantage-pov-aoda-v2.pdf?location=top>.

Amos, Jonathan. "Success for SpaecX 'reusable rocket'." (30 March 2017), BBC News. Online: <https://www.bbc.com/news/science-environment-39451401>.

Arianespace. Online: <https://www.arianespace.com/>.

Bartolotta, Paul, et al. "Horizontal Launch: A Versatile Concept for Assured Space Success." (December 2011), NASA-DARPA. Online: <https://ntrs.nasa.gov/api/citations/20120000791/downloads/20120000791.pdf>.

Beldavs, Vidvuds, "Simply fix the Moon Treaty," (15 January 2018), *The Space Review*. Online: <https://www.thespacereview.com/article/3408/1>.

"Benefits of ADR." (28 June 2021), Government of Canada – Canadian Intellectual Property Office. Online: <https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr04443.html>.

Benson, Tom. "Four Forces on a Rocket." (13 May 2021), NASA. Online: <https://www.grc.nasa.gov/www/k-12/rocket/rktfor.html#:~:text=While%20most%20airplanes%20have%20a,dramatically%20during%20a%20typical%20flight.>.

Berger, Miriam. "Israel's relations in the Middle East, explained." (15 August 2020), The Washington Post. Online: <https://www.washingtonpost.com/world/2020/08/15/israels-relations-middle-east-explained/>.

Betz, Eric. "The Karman Line: Where does space begin?" (5 March 2021), Astronomy Magazine. Online: <https://astronomy.com/news/2021/03/the-krmn-line-where-does-space-begin>.

Black's Law Dictionary. (10th Edition, 2014).

Bothos, J & S Thomopoulos. “Factors influencing crime rates: an economic analysis approach.” (17 May 2016) 9842 *Signal Processing, Sensor/Information Fusion, and Target Recognition XXV*. Online: <https//doi.org/10.1117/12.2223395>.

Boucher, Marc. “Canada Decides it Wants To Be a Launching State.” (29 October 2021), SpaceQ Media. Online: <https://spaceq.ca/canada-decides-it-wants-to-be-a-launching-state/>.

Boyko, Cynthia. “Sounding Rockets.” (20 August 1996), Friends of CRC. Online: <https://www.friendsofcrc.ca/Projects/Sounding%20Rockets/rocket.html>

Browder, Becca & Dava Newman. “How to Build a Spaceport: Analyzing Spaceport Feasibility Via Financial Analysis” (2019) ResearchGate. Online: <https://www.researchgate.net/publication/338719791_How_to_Build_a_Spaceport_Analyzing_Spaceport_Feasibility_via_Financial_Analysis>.

Cabbage, Michael. “Russia’s Rockets Still do the Job.” (29 October 2000), Orlando Sentinel. Online: <https://www.orlandosentinel.com/news/os-xpm-2000-10-29-0010290137-story.html>.

Caiazzo, Ilaria, Gallagher, Sarah, and Heyl, Jeremy. *A Vision for Canadian Space Exploration.* (Vancouver: University of British Columbia Library, 2017). doi: <10.14288/1.0352001>. Online: <http://hdl.handle.net/2429/62531>.

Canadian Space Agency, *The Canadian Space Program: A New Era for Canada in Space,* (Government of Canada: July 1999)

Canadian Space Agency, *The Canadian Space Program: A New Horizon,* (Government of Canada: 1994).

“Canadian Space Milestones.” (21 June 2018), Canadian Space Agency. online: <https://www.asc-csa.gc.ca/eng/about/milestones.asp>.

“CCAR – Quick Search.” Government of Canada. Online: <https://wwwapps.tc.gc.ca/Saf-Sec-Sur/2/CCARCS-RIACC/RchSimp.aspx>.

“Centre for Space Policy and Strategy.” (2021). The Aerospace Corporation. Online: at 453-470 <https://aerospace.org/sites/default/files/policy_archives/French%20Space%20Ops%20Act%20008%20unofficial%20translation.pdf> 453-470.

Center on Budget and Policy Priorities. Online: <https://www.cbpp.org/>.

Chabot, Alain. “Tsyklon-4M (Cyclone-4M) prepares a move to Canada.” (16 March 2017), Russian Space Web. Online: <http://www.russianspaceweb.com/tsyklon4m.html>.

Chapman, John et al. *Upper Atmosphere and Space Programs in Canada.* Science Secretariat of Canada, 1967. Online: <http://www.spaceq.ca/wp-content/uploads/2018/02/1967ChapmanReport.pdf>.

"Chinese rocket firm Galactic Energy successfully puts satellite into orbit, 1st private launch since COVID-19." (7 November 2020), Global Times. Online: <https://www.globaltimes.cn/content/1206011.shtml#:~:text=Chinese%20private%20rocket%20firm%20Galactic,of%20the%20COVID%2D19%20epidemic>.

"Circular of SASTIND Central Military Commission Equipment Development Department on Promoting the Standardised and Orderly Development of Commercial Launch Vehicles. (2021), BHO Legal. Online: <https://www.bho-legal.com/wp-content/uploads/2021/02/2019-Development-of-Commercial-Launch-Vehicles-CN-EN-courtesy-translation.pdf>.

Clark, Matthew. "Celebrating the *Radio Regulations*." (May 2016), ITU News Magazine. Online: <https://www.itu.int/en/itunews/Documents/2016-05/2016_ITUNews05-en.pdf>.

Clark, Stephen. "Rocket Lab briefly catches booster in mid-air after successful launch." (3 May 2022), Spaceflight Now. Online: <https://spaceflightnow.com/2022/05/03/rocket-lab-briefly-catches-booster-in-mid-air-after-successful-launch/#:~:text=Rocket%20Lab%20used%20a%20helicopter,rocket%20recovery%20and%20reuse%20program.>.

"Chapter 2: Definitions and Industrial Classifications." (2012), OECD Handbook on Measuring the Space Economy. Online: <https://read.oecd-ilibrary.org/economics/oecd-handbook-on-measuring-the-space-economy_9789264169166-en#page21>.

Chung, Emily. "Canadian space flight dreams live on." (12 November 2010), CBC. Online: <https://www.cbc.ca/news/science/canadian-space-flight-dreams-live-on-1.895322>.

Cobb, Wendy. "How SpaceX lowered costs and reduced barriers to space." (1 March 2019), The Conversation. Online: <https://theconversation.com/how-spacex-lowered-costs-and-reduced-barriers-to-space-112586#:~:text=When%20the%20space%20shuttle%20was,is%20just%20%242%2C720%20per%20kilogram>.

"Commercial Space Launch Insurance – FAA Needs to Fully Address Mandated Requirements." (January 2018), United States Government Accountability Office. Online: <https://www.gao.gov/products/gao-18-57>.

"Commercial Space Launch Insurance – Weakness in FAA's Insurance Calculation May Expose the Federal Government to Excess Risk." (March 2017), United States Government Accountability Office. Online: <https://www.gao.gov/assets/gao-17-366.pdf>.

"Commercial Space Transportation Activities." (19 June 2020), Federal Aviation Administration. Online: <https://www.faa.gov/newsroom/commercial-space-transportation-activities?newsId=19074>.

"Company Profile." (7 January 2021), Arianespace. Online: <https://www.arianespace.com/company-profile/>.

"Contracts." (2 May 2018), NASA. Online: <https://www.nasa.gov/centers/johnson/news/contracts/index.html>.

"Contribution of Space Law and Policy to Space Governance and Space Security in the 21st Century." (8 September 2016), United Nations Office for Outer Space Affairs. Online: <https://www.unoosa.org/pdf/SLW2016/Other/2016_SLW_conclusions_and_recommendations.pdf>.

"Cyclone-4M SLS Abbreviated User's Guide." (15 May 2019), Maritime Launch Services. Online: <https://www.maritimelaunch.com/sites/default/files/2019-08/UG_C4M%20abbreviated.pdf>.

Daines, Gary. "Earth Missions List." (3 August 2017), NASA. Online: <https://www.nasa.gov/content/earth-missions-list>.

Daines, Gary. "Humans in Space." (3 August 2017), NASA. Online: < https://www.nasa.gov/content/human-missions-list>.

Daines, Gary. "Solar System Missions." (3 August 2021), NASA. Online: <https://www.nasa.gov/content/solar-missions-list >.

Dallas, JA, et al. "The environmental impact of emissions from space launches: A comprehensive review," (20 January 2020) 255 *Journal of Cleaner Production*. Online: <https://doi.org/10.1016/j.jclepro.2020.120209>.

De Selding, Peter. "France giving up Arianespace Ownership, but not Oversight." 19 June 2015. Space News. Online: <https://spacenews.com/france-giving-up-arianespace-ownership-but-not-oversight/>.

Deffree, Suzanne. "China launches 1st Shenzhou spacecraft." (November 19, 1999), EDN Network. Online: <https://www.edn.com/china-launches-1st-shenzhou-spacecraft-november-19-1999/>.

DeNyse, Gavin. "How Can We Get There?" (2000), MIT. Online: <http://web.mit.edu/10.391J/www/proceedings/Sustainability&Markets_DeNyse2000.pdf>.

Doucette, Keith. "Nova Scotia grants 18-month extension for work to begin on commercial spaceport." (17 March 2021), Atlantic CTV News. Online: <https://atlantic.ctvnews.ca/nova-scotia-grants-18-month-extension-for-work-to-begin-on-commercial-spaceport-1.5350643>.

"Draft conclusions on identification of customary international law." (2018), United Nations. Online: <https://legal.un.org/ilc/texts/instruments/english/draft_articles/1_13_2018.pdf>.

"Draft Launch Propulsion Systems Roadmap." (November 2010), National Aeronautics and Space Administration. Online: <https://www.nasa.gov/pdf/500393main_TA01-LaunchPropulsion-DRAFT-Nov2010-A.pdf>.

Dunbar, Brian. "The Future – Human Spaceflight." NASA. Online: <https://www.nasa.gov/specials/60counting/future.html>.

"Eight Steps to Building a New Airport." Florida Department of Transportation. Online: <https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/aviation/pdfs/8-steps-to-building-a-new-airport.pdf?sfvrsn=1b4c83a5_2#:~:text=Typically%2C%20it%20requires%20more%20than,a%20simple%20general%20aviation%20airport.>.

"External List of 747-8 Destination Airports with Regulatory Approval Status." (30 July 2021), Boeing. Online: <https://www.boeing.com/resources/boeingdotcom/commercial/airports/misc/Current-List-of-Approved-7478-Airports.pdf>.

"Externalities – The Economic Lowdown Podcast Series." Federal Reserve Bank of St. Louis. Online: <https://www.stlouisfed.org/education/economic-lowdown-podcast-series/episode-11-externalities>.

Faculty of International Law of China University of Political Science and Law. "Chinese Law: Registration, Launching and Licensing Space Objects." (2007), 33(2) *Journal of Space Law* 437-456. Online: <https://airandspace.confit.dev/pdfs/jsl-33-2.pdf>.

"Falcon 9: Overview." SpaceX. Online: <https://www.spacex.com/vehicles/falcon-9/>.

"Falcon 9." SpaceX. Online: <https://www.spacex.com/vehicles/falcon-9/>.

Fahey, Mark "When a rocket blows up, space insurers pay for it," *CNBC* (1 Sept 2016), online: <https://www.cnbc.com/2016/09/01/when-a-rocket-blows-up-space-insurers-pay-for-it.html>.

"Ford and the automotive revolution." Britannica. Online: <https://www.britannica.com/technology/automobile/Ford-and-the-automotive-revolution>.

Fortson, R. "Three Roles for a Theory of Behavior in a Theory of Law. A Commentary on a talk by Lewis Kornhauser." (1999) 1 *Stanford Journal of Legal Studies* 30-34.

Foust, Jeff. “A trillion-dollar space industry will require new markets.” (5 July 2018), Space News. Online: <https://spacenews.com/a-trillion-dollar-space-industry-will-require-new-markets/>.

Frick, Warren. “Payload User’s Guide.” (September 2020), Pegasus. online: <https://www.northropgrumman.com/wp-content/uploads/Pegasus-User-Guide-1.pdf>.

Friedman, Milton. “The Social Responsibility of Business is to Increase its Profits.” (13 September 1970), The New York Times Magazine. Online: <http://umich.edu/~thecore/doc/Friedman.pdf>.

Fuller, Lon. *The Morality of Law.* (New Haven: Yale University Press, 1969).

Garcia, Mark. “Commercial Resupply Services Overview.” (9 April 2019), NASA. Online: <https://www.nasa.gov/mission_pages/station/structure/launch/overview.html>.

Gebhardt, Chirs. “Starhopper conducts Raptor Static Fire test.” (3 April 2019), NASA Spaceflight. Online: <https://web.archive.org/web/20190404103545/https://www.nasaspaceflight.com/2019/04/starhopper-first-flight-starship-superheavy-updates/>.

Gibbs, Graham & W Mac Evans. *Part 5: A History of the Canadian Space Program – Policies & Lessons Learned Coping with Modest Budgets.* (16 April 2017), The Commercial Space Blog. Online: <http://acuriousguy.blogspot.com/2017/04/part-5-history-of-canadian-space.html>.

Global Affairs Canada. CTS 2000 No 14 (Government of Canada: 3 March 2014). Online: <https://www.treaty-accord.gc.ca/text-texte.aspx?id=103522>.

“Global Orbital Rocket Launch Statistics.” (2021), RocketLaunch Live. Online: <https://www.rocketlaunch.live/stats/2021>.

Godefroy, Andrew. *The Canadian Space Program: From Black Brant to the International Space Station*. (Springer: 2017). Online: doi: <https://dx.doi/org/10.1007/978-3-319-40105-8>.

Griffin, Nancy. “Americans and the Moon Treaty.” (1981) 46:3 *Journal of Air Law and Commerce* 751.

Grush, Loren. “SpaceX’s last Falcon 9 upgrade could finally make reusable rockets cost-Effective.” (9 May 2018), The Verge. Online: <https://www.theverge.com/2018/5/9/17254384/spacex-falcon-9-block-5-upgrade-rocket-reusability-savings>.

Grush, Loren. “The Defense Department picks three companies to develop rockets for national security launches.” (10 October 2018), The Verge. Online:

<https://www.theverge.com/2018/10/10/17961832/defense-department-launch-service-agreement-ula-blue-origin-northrop-grumman>.

Grush, Loren. “Why it’s time to study how rocket emissions change the atmosphere.” (31 May 2018), The Verge. Online: <https://www.theverge.com/2018/5/31/17287062/rocket-emissions-black-carbon-alumina-particles-ozone-layer-stratosphere>.

Guiry, Sandra. “Canadians’ Support and Enthusiasm for Development in the Space Sector is Taking Off.” (20 September 2018), Ipsos Public Affairs. Online: <https://www.ipsos.com/en-ca/news-polls/space-sector-taking-off>.

Hanlon, Michelle. “What is the Moon Treaty and is it still useful?” (17 January 2020), Filling Space. Online: <https://filling-space.com/2020/01/17/what-is-the-moon-treaty-and-is-it-still-useful/#:~:text=Many%20consider%20the%20Moon%20Agreement,China%2C%20Japan%2C%20and%20Germany.>.

Harding, Luke. “The space race is back on – but who will win? (16 July 2021). The Guardian. Online: <https://www.theguardian.com/science/2021/jul/16/the-space-race-is-back-on-but-who-will-win>.

Hart, HLA. *The Concept of Law.* (Oxford: Oxford University Press, 1961).

Himma, Kenneth. “Natural Law.” n.d. *Internet Encyclopedia of Philosophy.* Online: at s 4 <https://iep.utm.edu/natlaw/>.

“Horizontal Proposition.” (2021), Air International. Online: <https://www.airinternational.com/article/horizontal-proposition>.

Horsley, Jamie. “Party Leadership and Rule of Law in the Xi Jinping Era.” (September 2019), Global China. Online: <https://law.yale.edu/sites/default/files/area/center/china/document/horsley_china_party-_legal_development.pdf>.

“How to bring a rocket back from space.” Rocket Lab. Online: <https://www.rocketlabusa.com/about-us/updates/how-to-bring-a-rocket-back-from-space/>.

Howell, Elizabeth. “Europe’s ArianeWorks Aims for Reusable Rockets (with a Very SpaceX Look).” (10 September 2019), SPACE.com. Online: <https://www.space.com/arianeworks-reusable-rockets-themis-callisto-video.html>.

Huang, Echo. “A private Chinese space firm successfully launched a rocket into orbit.” (24 July 2019), Quarts. Online: <https://qz.com/1674426/ispace-to-attempt-chinas-third-private-rocket-launch/>.

Innovation, Science and Economic Development Canada. *Exploration, Imagination, Innovation: A New Space Strategy for Canada.* (Government of Canada: 2019).

"Internet Growth Statistics." (3 July 2021), Internet World Stats. Online: <https://www.internetworldstats.com/emarketing.htm>.

"ITU Radio Regulatory Framework for Space Services." n.d., International Telecommunication Union. Online: <https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf >.

Jakhu, R. *Chapter 5 – Regulation of Space Activities in Canada*. (2010) 81-107. In Jakhu, R. *National Regulation of Space Activities.* Montreal: Springer, 2010.

Jakhu, Ram & Kerkonian, Aram. *Independent Review of the Remote Sensing Space Systems Act.* (2017), Institute of Air and Space Law. Online: <https://www.mcgill.ca/iasl/files/iasl/2017_review_of_canadas_remote_sensing_space_systems_act_en.pdf>.

JAXA. Online: <https://global.jaxa.jp/>.

Jones, Harry. "The Recent Large Reduction in Space Launch Cost." (8 July 2018), *48th International Conference on Environmental Systems*. Online: <https://ntrs.nasa.gov/citations/20200001093>.

Kagan, Julia. "Bonus Depreciation." (20 April 2021), Investopedia. Online: <https://www.investopedia.com/terms/b/bonusdepreciation.asp>.

Kenton, Will. "Externality." (26 October 2020), Investopedia. Online <https://www.investopedia.com/terms/e/externality.asp>.

Kerkonian, Aram Daniel. *New Law for New Space: The Case for a Comprehensive Canadian Space Law.* (Montreal: McGill Institute of Air and Space Law, 2020).

Koh, Harold. "Why Do Nations Obey International Law?" (1997) *Yale Law School Legal Scholarship Repository* 2655.

Kyle, Ed. "Worldwide Orbital Launch Summary by Year." (31 December 2021), Space Launch Report. Online: <https://www.spacelaunchreport.com/logyear.html>.

Lal Bhavya & Emily Nightingale. "Where is Space? And Why does that Matter?" (2014) *Space Traffic Management Conference.*

Laudicina, P & E Peterson, "Entering the Storm: anticipating risk in an uncertain world – The 2020 Foreign Direct Investment Confidence Index." (March 2020), Kearney. Online: <https://www.kearney.com/documents/20152/17744880/The+2020+Kearney+Foreign+Direct+Investment+Confidence+Index.pdf/18e45f29-867f-2cad-1899-8294b94e89d5?t=1608470571000>.

Laudicina, P & E Peterson. “On Shaky Ground: The 2021 FDI Confidence Index.” (24 March 2021), Kearney. Online: <https://www.kearney.com/documents/3677458/88299256/On+shaky+ground%E2%80%932021+FDI+confidence+index.pdf/4f8fd544-ce57-d498-96e3 dfb5fd81f77e?t=1616536746000>.

“Launch History – Per Year,” online: Spacexstats.com <https://www.spacexstats.xyz/#launchhistory-per-year>.

“Launch History.” (2022), RocketLaunch.live. Online: <https://www.rocketlaunch.live/?pastOnly=1>.

“Launch Log,” (24 July 2020), online: Spaceflight Now <https://spaceflightnow.com/launch-log/>.

“Launch Services.” (2022), Maritime Launch Services, Inc. Online: <https://www.maritimelaunch.com/launch-services>.

“Launch Vehicles.” Krunichev State Research and Production Space Center, Online: <http://www.khrunichev.ru/main.php?id=23>.

“Launcher One Service Guide.” (August 2020), Virgin Orbit. Online: <https://virginorbit.com/wp-content/uploads/2020/09/LauncherOne-Service-Guide-August-2020.pdf>.

Lawrence, Susan and Martin, Michael. “Understanding China’s Political System.” (20 March 2013), Congressional Research Service. Online: <https://sgp.fas.org/crs/row/R41007.pdf>.

“Legal Realism.” Cornell Law School Legal Information Institute. Online: <https://www.law.cornell.edu/wex/legal_realism>.

“Licensing of Private Remote Sensing Space Systems.” (20 May 2020), Department of Commerce. Online: <https://www.govinfo.gov/content/pkg/FR-2020-05-20/pdf/2020-10703.pdf>.

“List of ITU Member States.” (2022), ITU. Online: <https://www.itu.int/en/ITU-R/terrestrial/fmd/Pages/administrations_members.aspx>.

Liu, Jingjing. “Overview of the Chinese Legal System.” (January-March 2013) 1:1 *Environmental Law Reporter.* Online: <https://elr.info/sites/default/files/chinaupdate1.1.pdf>.

Liu, Joan. “UPDATE: Finding Chinese Law on the Internet.” (October 2021), GlobaLex. Online: <https://www.nyulawglobal.org/globalex/China1.html >.

Llewellyn. “Some Realism About Realism – Responding to Dean Pound.” (1931) 44 *Harvard Law Review* 1222.

Lyall, Francis, Larsen, Paul, *Space Law: A Treatise*, 2d ed (New York: Routledge, 2018) 142.

"Maritime Launch." (2021), Maritime Launch Services, Inc. Online: <https://www.maritimelaunch.com/>.

McClintock, Bruce. "The Russian Space Sector: Adaptation, Retrenchment, and Stagnation" (2017) 10:1, *Space & Defence Journal of the United States Air Force Academy*. Online: <https://www.rand.org/content/dam/rand/pubs/external_publications/EP60000/EP67235/RAND_EP67235.pdf>.

Mehta, Ivan. "Private Chinese space company aims to rival SpaceX with a reusable rocket by 2021." (23 October 2019), The Next Web. Online: <https://thenextweb.com/space/2019/10/23/private-chinese-space-company-aims-to-rival-spacex-with-a-reusable-rocket-by-2021/>.

"Military-Civil Fusion and the People's Republic of China." US Department of State. Online: <https://www.state.gov/wp-content/uploads/2020/05/What-is-MCF-One-Pager.pdf>.

Ministry of State for Science and Technology. *Background Paper: The Canadian Space Program Plan for 1981/82 – 1983/84.* (Government of Canada: April 1981).

Ministry of State for Science and Technology. *Interim Space Plan 1985-1986.* (Government of Canada, March 1985).

Ministry of State for Science and Technology. *The Canadian Space Program: New Initiatives.* (Government of Canada, May 1986).

Mitchell, Rebecca. "A Conceptual Analysis of Spacecraft Air Launch Methods." (20 December 2012), *Department of Aerospace Engineering Sciences, University of Colorado, Boulder*. Online: <https://www.colorado.edu/faculty/kantha/sites/default/files/attached-files/42797-36621_-_rebecca_mitchell_-_dec_20_2012_710_am_-_final_project_mitchell.pdf>.

"MHI Launch Services: Launch Vehicles." Mitsubishi Heavy Industries. Online: <https://www.mhi.com/products/space/launch_srv_lineup.html>.

Mohney, Doug. "The Coming U.S. Small Launch Crash, Thanks to SpaceX Rideshare." (3 February 2021), Space IT Bridge. Online: <https://www.spaceitbridge.com/the-coming-u-s-small-launch-crash-thanks-to-spacex-rideshare.htm#:~:text=Leveraging%20the%20reusability%20of%20the,slightly%20less%20at%20%2424%2C000%2Fkg>.

Monk, David. "The Lessons of Airline Regulation and Deregulation: Will We Make the Same Mistakes in Space*"* (1992) 57:3 *Journal of Air Law & Commerce* 715-753.

Monteith, Wayne R. “Office of Space Transportation – update letter.” (3 April 2020), FAA. Online: <https://www.faa.gov/about/office_org/headquarters_offices/ast/media/AST_Update_Letter_April_2020.pdf>.

Morozova, Elina & Alena Laurenava. “International Liability for Commercial Space Activities and Related Issues of Debris.” (23 February 2021), *Oxford Research Encyclopedia of Planetary Science.* Online: <https://doi.org/10.1093/acrefore/9780190647926.013.63>.

“NASA Awards Environmental Test, Integration Services Contract.” (19 June 2019), NASA. Online: <https://www.nasa.gov/press-release/nasa-awards-environmental-test-integration-services-contract>.

Norris, Guy. “Design Space.” (2015) 177:2 *Aviation Week and Space Technology* 58.

“OAO Rocket and Space Corporation Energia after S.P. Korolev.” *Energia.* Online: <https://www.energia.ru/english/energia/history/oao.html>.

“Operator Licenses & Permits,” (26 January 2020), online: Federal Aviation Administration <https://www.faa.gov/space/licenses/operator_licenses_permits/>.

“Origins of the Commercial Space Industry.” Federal Aviation Administration. Online: <https://www.faa.gov/about/history/milestones/media/commercial_space_industry.pdf>.

“Our Faculty.” Yale Law School. online: <https://law.yale.edu/harold-hongju-koh>.

Parisi, Francisco & Vincy Fon. *The Economics of Lawmaking* (New York: Oxford University Press, 2009).

“Pegasus.” (2021), Northrop Grumman. Online: <https://www.northropgrumman.com/space/pegasus-rocket/>.

Pettinger, Tejvan. “Benefits of economic growth.” (14 December 2019), Economics Help. Online: <https://www.economicshelp.org/macroeconomics/economic-growth/benefits-growth/>.

Pettit, Don. “The Tyranny of the Rocket Equation.” (1 May 2012), NASA. Online: <https://www.nasa.gov/mission_pages/station/expeditions/expedition30/tryanny.html>.

“Policy Archives,” online: The Aerospace Corporation <https://aerospace.org/sites/default/files/policy_archives/French%20Space%20Ops%20Act%202008%20unofficial%20translation.pdf>.

Price, Edward. “Rocket: jet-propulsion device and vehicle.” (14 May 2010), Britannica. Online: <https://www.britannica.com/technology/rocket-jet-propulsion-device-and-vehicle>.

"Railroads in the Late 19th Century." Library of Congress. Online: <https://www.loc.gov/classroom-materials/united-states-history-primary-source-timeline/rise-of-industrial-america-1876-1900/railroads-in-late-19th-century/>.

Rao, Rahul. "Virgin Orbit clears FAA hurdle for small satellite launches from Guam." (2 September 2021), SPACE.com. Online: <https://www.space.com/virgin-orbit-guam-launches-faa-environmental-review>.

"Repartition of Arianespace capital." (7 January 2021), Arianespace. Online: <https://www.arianespace.com/company-profile/>.

"Requirements for Launching High Power Rockets in Canada." (4 January 2000), Transport Canada. Online: <http://www.canadianrocketry.org/files/tc_hpr_reqs_jan00.pdf>.

"Responsibilities and Regulatory Obligations." (1 June 2020), CRTC. Online: <https://crtc.gc.ca/eng/comm/telecom/resp.htm>.

Rincon, Paul. "NASA SpaceX launch: What is the Crew Dragon?" (31 May 2020), BBC. online: <https://www.bbc.com/news/science-environment-52840482>.

"RKK Energiya im. S.P. Koroleva PAO." Financial Times. Online: <https://markets.ft.com/data/equities/tearsheet/summary?s=RKKE:MCX>.

Robert, F, et al, "Achieving Australian Leadership in Space." (2018), AT Kearney. Online: <https://www.kearney.com/documents/1722225/1730674/Achieving+Australian+Leadership+in+Space.pdf/f930cacf-5c83-603f-0f0d-699b3e2be5fe?t=1542530548000>.

Roberts, Thomas. "Space Launch to Low Earth Orbit: How Much Does it Cost?" (2 September 2020), Center for Strategic and International Studies. Online: <https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost/>.

"Rocket Lab Successfully Launches U.S. Space Force Mission." (29 July 2021), RocketLab. Online: <https://www.rocketlabusa.com/updates/rocket-lab-successfully-launches-u-s-space-force-mission/>.

"Rocket Systems and Space Exploration." IHI Corporation. Online: <https://www.ihi.co.jp/en/products/aeroengine_space_defense/rocket_system/index.html>.

Romero, Jessie. "Interview: John Haltiwanger." (July 2013), *Federal Reserve Bank of Richmond – Econ Focus Second Quarter*. Online: <https://www.richmondfed.org/-/media/richmondfedorg/publications/research/econ_focus/2013/q2/pdf/full_issue.pdf>.

Ross, Martin & Darin Toohey. "The Coming Surge of Rocket Emissions." (24 September 2019), Eos (American Geophysical Union). Online: <https://eos.org/features/the-coming-surge-of-rocket-emissions>.

Rudolph, Christiane. “Facilitating investment.” (6 January 2019), Development and Cooperation. online: <https://www.dandc.eu/en/article/rule-law-essential-generating-employment-and-fostering-prosperity>.

Ruskin, Brett & Cassie Williams. “T-minus 1 year until rocket launch site construction starts in Nova Scotia.” (15 March 2017), CBC. Online: <https://www.cbc.ca/news/canada/nova-scotia/t-minus-1-year-until-rocket-launch-site-construction-starts-in-nova-scotia-1.4023808>.

Saini, N & M Singhania. “Determinants of FDI in developed and developing countries: a quantitative analysis using GMM.” (2018) 45:2 *Journal of Economic Studies* 348-382. Online: <https://doi.org/10.1108/JES-07-2016-0138>.

Sarigul-Klijn, M & N Sarigul-Klijn, “Flight Mechanics of Manned Sub-Orbital Reusable Launch Vehicles with Recommendations for Launch and Recovery.” (9 January 2003), *41st Aerospace Sciences Meeting and Exhibit*. Online: <http://www.spacefuture.com/archive/flight_mechanics_of_manned_suborbital_reusable_launch_vehicles_with_recommendations_for_launch_and_recovery.shtml>.

Scatteia, Luigi. “Main trends and challenges in the space sector.” (June 2019), PwC Space. Online: <https://www.pwc.fr/fr/assets/files/pdf/2019/06/fr-pwc-main-trends-and-challenges-in-the-space-sector.pdf>.

Schrogl, Kai-Uwe, et al. “Space Law Symposium 2019: The Moon Agreement Revisited: The Road Ahead.” (1 April 2019), International Institute of Space Law (IISL) and European Centre for Space Law (ECSL). Online: <https://www.unoosa.org/documents/pdf/copuos/lsc/2019/LSC_2019_IISL-ECSL_Symposium_Final.pdf>.

“Search for Virtual Licence or Certificate.” Government of Canada. Online: <https://sms-sgs.ic.gc.ca/licenseSearch/searchVirtualLicense?execution=e3s1&lang=en_CA>.

Sevel, Michael & Brian Leiter. “Legal Positivism.” 5 October 2016. Oxford Bibliographies. Online: <https://www.oxfordbibliographies.com/view/document/obo-9780195396577/obo-9780195396577-0065.xml>.

Sempsrott, Daniel. “NASA’s ELaNa 20 Mission First to Fly on Virgin Orbit Launch.” (11 December 2020), NASA. Online: <https://www.nasa.gov/feature/nasa-s-elana-20-mission-first-to-fly-on-virgin-orbit-launch>.

Senger, Emily. “Is Canada’s space program slipping out of orbit? (10 December 2018), Maclean’s. Online: <https://www.macleans.ca/society/science/is-canadas-space-program-slipping-out-of-orbit/>.

Sheetz, Michael. “Bank of America expects the space industry to triple to a $1.4 trillion market within a decade.” (4 October 2020), CNBC. Online:

<https://www.cnbc.com/2020/10/02/why-the-space-industry-may-triple-to-1point4-trillion-by-2030.html>.

"Small Satellite Market Size to Reach USD 9.75 Billion by 2027." (10 May 2021), Fortune Business Insights. Online: <https://www.globenewswire.com/en/news-release/2021/05/10/2226336/0/en/Small-Satellite-Market-Size-to-Reach-USD-9-75-Billion-by-2027-Communication-and-Navigation-Satellites-High-Demand-to-Augment-Market-Growth-Says-Fortune-Business-Insights.html>.

Smith, Rich. "How Much Cheaper are SpaceX Reusable Rockets? Now We Know." (5 October 2020), The Motley Fool. Online: <https://www.fool.com/investing/2020/10/05/how-much-cheaper-are-spacex-reusable-rockets-now-w/>.

Solum, Lawrence. "Legal Theory Lexicon 068: Welfare, Well-being, and Happiness." (5 July 2020), Legal Theory Lexicon. Online: <https://lsolum.typepad.com/legal_theory_lexicon/normative_theory/>.

"South Korea tests solid-fuel space rocket, amid rising tensions." (31 March 2022), Aljazeera. Online: <https://www.aljazeera.com/news/2022/3/31/south-korea-tests-solid-fuel-space-rocket-amid-rising-tensions>.

"Space for Everyone from Everywhere." (2021), Virgin Orbit. Online: <https://virginorbit.com/vision/>.

"Space Investment Quarterly – See the Dashboard." (31 December 2021), Space Capital. Online: <https://www.spacecapital.com/quarterly>.

"Space Licensing in China." ANGELS: Australian Navigational Guide Explaining Laws for Space. Online: <https://spacelaws.com/articles/space-licensing-in-china/>.

"Space Licensing in France." ANGELS: Australian Navigational Guide Explaining Laws for Space. Online: <https://spacelaws.com/articles/space-licensing-in-france/>.

"Space policy and the Remote Sensing Space Systems Act." Government of Canada. Online: <https://www.international.gc.ca/world-monde/issues_development-enjeux_developpement/peace_security-paix_securite/space-espace.aspx?lang=eng>.

Space Strategies Consulting Ltd. "2022 Independent Review of the *Remote Sensing Space Systems Act (RSSSA)*." (March 2022), Global Affairs Canada. Online: <https://www.international.gc.ca/transparency-transparence/assets/pdfs/remote-sensing-systemes-teledetection/2022-review-rsssa-examen-lsts-en.pdf>.

"SpaceX Brownsville." Brownsville. online: <https://visitbtx.com/spacex/>.

"Status and application of the five United Nations treaties on outer space." (31 May 2021), Committee on the Peaceful Uses of Outer Space. Online:

<https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_22021crp/aac_105c_22021crp_10_0_html/AC105_C2_2021_CRP10E.pdf>.

Status of the Treaty. United Nations Office for Disarmament Affairs. Online: <http://disarmament.un.org/treaties/t/outer_space> (1 April 2020).

Stewart, Luke. "The Impact of Regulation on Innovation In the United States: A Cross-Industry Literature Review." (14 November 2011), Information Technology & Innovation Foundation. Online: <https://itif.org/publications/2011/11/14/impact-regulation-innovation-united-states-cross-industry-literature-review>.

Stone, Chad. "Economic Growth: Causes, Benefits, and Current Limits." (27 April 2017), Center on Budget and Policy Priorities. Online: <https://www.cbpp.org/sites/default/files/atoms/files/4-27-17econ-testimony.pdf>.

Stott, Mason. "Space Law: application of United Nations' treaties to new exploration and exploitation endeavors." (2018), College of Law, University of Saskatchewan.

Strategic Space Law Course, Institute of Air & Space Law, McGill, (Montreal: 15-18 October 2019).

"Stuck to the ground by red tape." (1 June 2013), The Economist. Online: <https://www.economist.com/technology-quarterly/2013/06/01/stuck-to-the-ground-by-red-tape>.

"Submission of Canada to the Office of Outer Space Affairs and the Office of Disarmament Affairs on its implementation of the report of the Group of Governmental Experts on Transparency and Confidence-Building in Outer Space Activities." (April 2017), United Nations. Online: <https://www.un.org/disarmament/wp-content/uploads/2017/04/Canada-In-extenso1.pdf>.

Sukol, Rob. "Positive Law Codification of Space Programs: The Enactment of Title 51, United States Code." (Spring 2011) 37:1: *Journal of Space Law* 1-40. Online: <https://airandspace.confit.dev/pdfs/jsl-37-1.pdf>.

Sullivan, Ruth. *Statutory Interpretation*. 2d ed. Toronto: Irwin Law, 2007.

Summers, Robert. *Het pragmatisch instrumentalisme* [*Pragmatic Instrumentalism*]. Antwerp, Belgium: Standaard Wetenschappelijke Uitgeverij [Standard Scientific Publisher], Dutch (Netherlands), 1980.

Summers, Robert. "Pragmatic Instrumentalism in Twentieth Century American Legal Thought – a Synthesis and Critique of Our Dominant General Theory About Law and its Use." (1981) 66:5 *Cornell Law Review* 861-948 at 864. Online: <http://scholarship.law.cornell.edu/clr/vol66/iss5/1>.

Takala, Rudy. “The red tape keeping private companies from getting us into space.” (5 July 2016), Washington Examiner. Online: <https://www.washingtonexaminer.com/the-red-tape-keeping-private-companies-from-getting-us-into-space>.

Tartar, Andre & Yue Qiu. “The New Rockets Racing to Make Space Affordable.” (26 July 2018), Bloomberg Business Week. Online: <https://www.bloomberg.com/graphics/2018-rocket-cost/>.

Tennant, Fraser. “The space economy: ready for lift-off.” (January 2022), Financier Worldwide. Online: <https://www.financierworldwide.com/the-space-economy-ready-for-lift-off#.YeSJ8_7MKUk>.

“The Era of Mass Air Travel Begins.” Smithsonian National Air and Space Museum. Online: <https://airandspace.si.edu/exhibitions/america-by-air/online/heyday/heyday11.cfm>.

“The Russians always launch.” (2 February 2012), Travels in Orbit. Online: <https://www.travelsinorbit.com/the-russians-always-launch/>.

Tiwari, Ashish. “Why Are Rockets Launched From Areas Near the Equator?” (19 January 2022), Science ABC. Online: <https://www.scienceabc.com/nature/universe/how-are-satellites-put-into-orbit-and-kept-up-there-for-so-long.html>.

Transport Canada, “Response – ATIP,” (personal communication, 13 July 2020) [email].

Treaty on Outer Space: Hearings before the Committee on Foreign Relations United States Senate. 90th Cong. (1967) (Statement of Secretary of State Honorable Dean Rusk). Online: <https://books.google.ca/books?id=YcdEAQAAMAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false>.

Treves, Tullio. “United Nations Convention on the Law of the Sea.” (July 2008), Audiovisual Library of International Law. Online: <https://legal.un.org/avl/ha/uncls/uncls.html>.

“UK Registry: Outer Space Objects.” (20 May 2021), UK Government. Online: <https://www.gov.uk/government/publications/uk-registry-outer-space-objects>.

“United Nations Treaties and Principles on Outer Space,” (2002), United Nations Office of Outer Space Affairs. Online: <https://www.unoosa.org/pdf/publications/STSPACE11E.pdf>.

“Upcoming Launches.” (27 November 2021), Next Spaceflight. Online: <https://nextspaceflight.com/launches/>.

Van Aeken, Koen. *Legal Instrumentalism Revisited.* (2005), 67-92. In Wintgens, Luc. *The Theory and Practice of Legislation*. Burlington: Ashgate Publishing Company, 2005.

Vidvuds, Beldavs. “Simply fix the Moon Treaty.” (15 January 2018), *The Space Review.* Online: <https://www.thespacereview.com/article/3408/1>.

Von der Dunk, Frans & Fabio Tronchetti. *Handbook of Space Law*. Gloucestershire, UK: Elgar Publishing, 2017.

Von Ihering, Rudolf. *Law as a Means to an End*. (Boston: The Boston Book Company, 1877, Eng. trans. 1914).

Wall, Mike. "SpaceX Breaks Ground on Private Spaceport in Texas." (23 September 2014), SPACE.com. Online: <https://www.space.com/27234-spacex-texas-spaceport-groundbreaking.html>.

Wall, Mike. "The Private Spaceflight Decade: How Commercial Space Truly Soared in the 2010s." (20 December 2019), SPACE.com. Online: <https://www.space.com/private-spaceflight-decade-2010s-retrospective.html>.

Wall, Mike. "Wow! SpaceX Lands Orbital Rocket Successfully in Historic First." (22 December 2015), SPACE.com. Online: <https://www.space.com/31420-spacex-rocket-landing-success.html>.

"What is Market Failure?" Corporate Finance Institute. Online: <https://corporatefinanceinstitute.com/resources/knowledge/economics/market-failure/>.

"What We Heard Report: Consultation on a framework for future space exploration activities." (30 July 2021), Canadian Space Agency. Online: <https://www.asc-csa.gc.ca/eng/astronomy/moon-exploration/what-we-heard--report-consultation-framework-future-space-exploration-activities.asp>.

Williams, David. "NASA Space Science Data Coordinated Archive." (10 February 2021), NASA. Online: <https://nssdc.gsfc.nasa.gov/nmc/spacecraft/spacecraft/query>.

Willick, Frances. "Canso spaceport partners with U.S. company to recycle rockets in space." (3 November 2019), CBC News. Online: <https://www.cbc.ca/news/canada/nova-scotia/mla-nanoracks-repurpose-cyclone-4m-rockets-1.5344086>.

"Young's Endless Frontier Act Passes the Senate." (8 June 2021), Todd Young: U.S. Senator for Indiana. Online: <https://www.young.senate.gov/newsroom/press-releases/youngs-endless-frontier-act-passes-the-senate>.

Yun, Zhao. "A Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space." (2009) 74 *Journal Air Law & Commerce* 959.