Pontifícia Universidade Católica de Minas Gerais

Instituto de Ciências Sociais

Programa de Pós-Graduação em Relações Internacionais

Gustavo Fornari Dall'Agnol

Defense, Decision-making and Political Economy:

Large-scale projects and the decision-making process in United States' defense politics

Belo Horizonte, March, 2022

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2022

FICHA CATALOGRÁFICA
Elaborada pela Biblioteca da Pontifícia Universidade Católica de Minas Gerais

Dall'Agnol, Gustavo Fornari
D144d Defense, decision-making and political economy: large-scale projects and the decision-making process in United States' defense politics / Gustavo Fornari Dall'Agnol. Belo Horizonte, 2022.
247 f. : il.

Orientador: Eugenio Pacelli Lazzarotti Diniz Costa
Tese (Doutorado) – Pontifícia Universidade Católica de Minas Gerais. Programa de Pós-Graduação em Relações Internacionais

1. Segurança internacional. 2. Economia - Aspectos políticos. 3. Processo decisório. 4. Desenvolvimento Tecnológico. 5. Ataque e defesa (Ciência militar). 6. Defesa nacional. 7. Inovação tecnológica. 8. Política externa. I. Costa, Eugenio Pacelli Lazzarotti Diniz. II. Pontifícia Universidade Católica de Minas Gerais. Programa de Pós-Graduação em Relações Internacionais. III. Título.

CDU: 327.37
Ficha catalográfica elaborada por Elizângela Ribeiro de Azevedo - CRB 6/3393

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Belo Horizonte, April 25th, 2022

To my parents, Ledamir Fornari and Darlei Dall'Agnol, who gave me the gift of life, not one, but several times.

ACKNOWLEDGMENTS

In the first place, I would like to thank the agency CAPES (Higher Educational Personnel) for the financial support, without with this research would not be possible[1]. I wish to extend my special thanks for my supervisor, Professor Eugenio Diniz, who not only guided me through the writing of this dissertation, making precise observations, but also for providing me, in his classes, solid academic background and the main ideas that gave birth to this research.

I wish to acknowledge the outstanding staff, both technical and faculty members, of the graduate program of International Relations at the Pontifícia Universidade Católica de Minas Gerais (PUC-MG). Their contribution was pivotal for my development as a researcher, especially by providing me with the theoretical and methodological instruments necessary to conduct this dissertation. In this sense, I would like to thank Professors Letícia Carvalho de Souza Andrade, Otávio Dulce and Maria de Fátima Junho Anastasia. At PUC-MG I worked with Professor Jorge Lasmar as a teaching trainee in his International Relations Theory class, which enhanced my knowledge of the field. Furthermore, I was granted the opportunity to work at PUC-MG as an Assistant Professor, teaching the disciplines of Methodology, International Relations Theory and Decision-Making, an experience that proved crucial to this dissertation. For that, I am thankful for Daniela Secches, Director of the undergrad program, for trusting me with this opportunity. I express my gratitude for my students, which taught me so much. At PUC-MG, working with Professor Eugenio Diniz, I met other of his advised students: Andrea Resende, Aimara de Aguiar, Eduardo Kraemer, Pedro Diniz, Eduardo Maia and Bruno Maciel Santos. For them I am thankful for the debates and insights provided, alongside with their friendship.

I would like to thank my cousin, friend and collegue, Augusto César Dall'Agnol, for his direct contributions for this dissertation, with who I developed a solid work partnership. I extend my gratitude to the fellow researchers at ISAPE (Instituto Sul-Americano de Política e Estratégia), institution that provides a good space for research and debate. My father, Darlei Dall'Agnol, also contributed thoroughly to my doctorate, through debates and excellent suggestions. During my doctorate, I also shared research

[1] This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

ideas and important debates with Bruno Haeming, a friend and colleague, and for that, I am grateful to him.

I am thankful for Professor David R. Mares and the University of California San Diego (UCSD), for accepting me as a visiting scholar, with a project approved by the National Council for Scientific and Technological Development (CNPQ), which unfortunately, due to the pandemics, I was unable to attend personally. Nonetheless, I was invited to participate in the institution's Center for Iberian and Latin American Studies (CILAS) online seminars, an outstanding place for research exchange. The General Accountability Office (GAO), Congressional Research Service (CRS) and the Congressional Budget Office (CBO) offered valuable data and statistics, which I used in my project.

I also would like to express my gratitude to my family, especially my parents, Ledamir Fornari and Darlei Dall'Agnol for the unequivocal emotional support. For my girlfriend, Júnia Roberta de Souza Pereira, I am grateful for her caring love during the years of this research, especially during the pandemics. My friends in my home town, Florianópolis, have always been there for me, and for that, I am glad to have their support.

“National defense is one of the cardinal duties of a statesman, and that there is an obligation to perform such a duty absolutely irrespective of party politics or factional differences.”

John Adams

“The greatest teacher, failure is.”

Master Yoda

ABSTRACT:

Defense has always been a strong propeller for technological and organizational advances. Major defense innovations have altered many aspects of human life, including transportation, communication, amongst several others. At the core of defense innovation are large-scale defense projects, the main object of study of this dissertation. Mobilizing immense amounts of resources and personnel and several private and public institutions, large-scale defense projects arise innumerous issues and entail many consequences. On the one hand, when successful, beside enhancing defense and providing engagement advantages to the innovator, the results can substantially *spin-off* to diverse uses. On the other hand, if they fail, resources that could be used otherwise, including other defense priorities, are wasted. The institutions involved and the program's supporters must deal with the political and economic losses. All innovative efforts entail risk. Why are some large-scale defense projects successful and others fail? Answering this question is the main purpose of this study. In order to achieve this purpose, this work builds a theoretical framework for analyzing large-scale defense projects through the lenses of the International System, domestic politics, and economic/technological scenario. This framework generates three variables (external threat, political consensus and technological feasibility). The main hypothesis put forward in this dissertation is that political consensus (among and within Congress and the Executive) and technological feasibility are necessary conditions and conjointly they are sufficient to explain the success or failure of defense projects, while external threat is strongly and positively related to the project's success or failure. The success criteria proposed for the projects analyzed cover efficiency and effectiveness parameters. By applying the Historical-Comparative Method alongside with the *process-tracing* of the four proposed case studies (USS-Nautilus; B-2 Bomber; Future Combat Systems and the F-35), thoroughly investigated in chapters 5 through 8, the hypothesis was corroborated. The theoretical framework built from chapters 1 to 4 was applied to the project's lifecycle, highlighting the centrality of the budgetary arena. The dissertation was successful in explaining the central causal mechanisms which impact large-scale projects, providing solid results. The advances made in the construction of the model and its application, as well as central themes addressed opens opportunities for increasing the scope of the research developed.

Keywords: Defense; Innovation; Decision-Making; Internal-Balancing; United States.

RESUMO:

A defesa sempre foi um importante impulsionador para avanços organizacionais e tecnológicos. Grandes inovações na defesa alteraram muitos aspectos da vida humana, incluindo transporte, comunicação, dentre diversos outros. No centro da inovação em defesa estão os projetos de defesa de larga-escala, o objeto de estudo principal desta tese. Projetos de defesa de larga-escala mobilizam quantidades imensas de recursos e pessoal e diversas instituições, tanto públicas quanto privadas, com diversas consequências em muitos aspectos. Se o projeto for bem-sucedido, além de prover vantagens em termos de defesa e engajamento militar, os resultados podem gerar *spin-offs* para diversos usos. No caso de fracasso, recursos que poderiam ser utilizados para outros fins, incluindo outras prioridades na defesa, são desperdiçados. As instituições e os apoiadores do programa têm de lidar com perdas políticas e econômicas. Inovar é risco. Por que alguns programas de defesa de larga escala fracassam e outros obtêm êxito? Responder a esta pergunta é o objetivo principal desta tese. Para atingir tal objetivo, este estudo constrói, entre os capítulos 1 a 4, um modelo teórico-analítico para analisar projetos de defesa de larga-escala à luz do Sistema Internacional, política doméstica e o cenário econômico/tecnológico. Esse modelo gera três variáveis (ameaça externa, consenso político e viabilidade tecnológica). A hipótese principal desta tese é a de que o consenso político (no Congresso e no Executivo) e a viabilidade tecnológica são condições necessárias que conjuntamente são suficientes para explicar o sucesso ou fracasso de projetos de defesa, enquanto a ameaça externa está positiva e altamente correlacionada com o sucesso ou fracasso do projeto. Os critérios de sucesso propostos para os projetos analisados cobrem tanto parâmetros de eficiência quanto de eficácia. Utilizando-se do Método-Histórico Comparativo conjuntamente com o *process-tracing* dos estudos de caso propostos (USS-Nautilus; B-2 Bomber; Future Combat Systems e o F-35), assiduamente investigados nos capítulos 5 ao 8, a hipótese foi corroborada. Esta tese foi bem-sucedida ao explicar os mecanismos causais centrais que impactam projetos de larga-escala. Os resultados da pesquisa foram sólidos e os avanços feitos na construção do modelo e sua aplicação, bem como temas centrais abordados geram oportunidades para futuras pesquisas aumentando o escopo investigativo do trabalho desenvolvido aqui.

Palavras-chave: Defesa; Inovação; Tomada de Decisão; Balanceamento Interno; Estados Unidos.

LIST OF TABLES AND FIGURES

LIST OF ABREVIATIONS

A2/D2- Anti-Access/Area-Denial

AAN- Army After Next

ACAT- DoD Acquisition Categories

ACF- Advocacy Coalition Framework

AEC- Atomic Energy Commission

ALCM- Air Launched Cruise Missile

ALIS- Autonomic Logistics Information System

APUC- Average Procurement Unit Cost

BCT- Brigade Combat Team

BES- Budget Estimate Submission

BP- Bureaucratic Politics

BUR- Bottom-Up Review

CAIG- Cost Analysis Improvement Group

CBO- Congressional Budget Office

CIA- Central Intelligence Agency

Circular A-11- Preparation, Submission and Execution of the Budget

CNO- Chief of Naval Operations

COCOM- Combatant Command

CPA- Chairman-s Program Assessment

CPR- Chairman's Program Recommendation

CR- Continuing Resolutions

CSF- Critical Success Factors

CTD- Concept and Technology Demonstration

CTOL- Conventional Take-Off and Landing

D(PA&E)- Director of Program Analysis and Evaluation

DARPA- Defense Advanced Research Projects Agency

DIB- Defense Industrial Base

DoD- Department of Defense

DODIG- Department of Defense Inspector General

DoE- Department of Energy

EBR-1- Experimental Breeder Reactor

FCS- Future Combat Systems

FOC- Full Operational Capability

FPDM- Foreign Policy Decision-Making

FRP- Full-rate Production

FY- Fiscal Year

FYDP- Future-Years Defense Program

GAO- General Accountability Office

GDP- Gross Domestic Product

GE- General Electric

HAC- House Appropriation Committee

HASC- House Armed Forces Committee

HBC- House Budget Committee

HCM- Historical-Comparative Method

HMDS- (Helmet Mounted Display System

IAF- Israeli Air Force

IO&E- Initial Operational Test Evaluation

IOC- Initial Operating Capability

IP- Intellectual Property

IPL- Integrated Priority List

IR- International Relations

IRS- Infra-Red Signature

IS- International System

JAST- Joint Advanced Strike Technology

JCIDS - Joint Capabilities Integration and Development System

JCS- Joint Chief of Staff

JPG- Joint Programming Guidance

JSF- Joint Strike Fighter

LO- Low Observable

LRIP- Low Rate Initial Production

LSI- Lead Systems Integrator

MADL- Multifunctional Data Link

MIT- Massachusetts Institute of Technology

MITI- Ministry of International Trade and Industry (Japan)

MTR- Material Testing Reactor

NASA- National Aeronautics and Space Administration

NATO- North Atlantic Treaty Organization

NDAA- National Defense Appropriation Act

NRL- Naval Research Laboratory

NRO- Navy Reconnaissance Office

NSC- National Security Council

NSC-68- National Security Council 68

NSI- National System of Innovation

O&M- Operation and Maintenance

O&M- Operations and Maintenance

OCLL- Chief, Legislative Liaison

OMB- Office of Management and Budget

OSD- Office of the Secretary of Defense

PAUC- Procurement Acquisition Unit Cost

POM- Program Objective Memorandum

PPBE- Programming, Budgeting and Execution

PPBS- Planning, Programming and Budgeting System

PWR- Pressurized Water Reactor

QDR- Quadrennial Defense Review

R&D- Research and Development

RCS- Radar Cross Section

RD&E- Research, Development and Execution

RMA- Revolution in Military Affairs

SAC- Senate Appropriation Committee

SALT- Strategic Arms Limitation Talk

SAR- Selected Acquisition Report

SASC- Senate Armed Forces Committee

SBC- Senate Budget Committee

SC- Success Criteria

SDD (System Design and Development)

SDI- Strategic Defense Initiative

SIR- Submarine Intermediate Reactor

SLBM- Submarine Launched Ballistic Missiles

SOPs- Standard Operation Procedures

SPG- Strategic Planning Guidance

SRAM- Short Range Attack Missile

STOVL- Short Take-Off and Vertical Landing

TINA- Truth in Negotiations Act

TRIPS- Trade-Related Aspects of Intellectual Property Rights

UAV- Unmanned Aerial Vehicles

USSR- Soviet Union

US- United States

USAF- United States Air Force

USD (AT&L)- Secretary of Defense for Acquisition, Technology and Logistics

USD (C)- DoD Comptroller

USD (P)- Under Secretary of Defense for Policy

USMC- United States Marine Corps

VTOL- Vertical Take-Off and Landing

WIPO- World Intellectual Property Organization

CONTENTS

INRODUCTION

Throughout history, collectivities have organized themselves in the pursuit of power and wealth. In contemporary times, this dispute is leaded by states. Defense has always been in the mind and life of humans, acting as a strong motivator in several aspects. Defense has had a central place in the development of our transport systems, logistics, geographical organization, communication systems, among many other countless examples. Most importantly, defense fosters one of the most human endeavors: the transformation of nature for its service. By transforming nature, innovation is put in motion. Therefore, there is an umbilical relationship between defense and innovation.

Neither defense nor innovation, however has ever been an easy task. In present day societies, as is the case with the United States, which is here investigated, defense involves a complex variety of actors, interests and disputes. Thus, decision-makers face great responsibilities. Options regarding defense decision-making and innovation endeavors have massive economic, political and security implications. Congressman are worried about their districts, the military has to be prepared for engagement, the President will be held accountable for major failures. Firms pursue big contracts, universities and other research institutions play a strong role in the R&D (Research and Development) necessary to innovate. Resources are being continually disputed among different bureaus and other actors.

States are faced with ongoing pressure to innovate militarily. In the case of a leading state such as the United States, if they are not successful innovating, they face serious risks of losing their position. Foremost important, human lives are at stake. Nonetheless, innovating is far from a simple cause and effect result of international pressure.

Innovation, even when not regarding defense, is *per se* systemic and complex. Different variables reinforce themselves and are interrelated, challenging the analyst and the decision-maker to isolate the most important factors. In the case of defense, the importance of the matter and the quantity of resources and people involved makes it even more complex. One has to be aware of the moves taken by key-actors and their interests, the never ending nuances of the procurement and budgeting process, the technology involved, possible trade-offs and especially, if the innovation will fulfill its purpose.

This study focuses mainly on technological innovation, although a state can innovate in organizational and doctrinal spheres as well. Technology can affect both organization and doctrine and even, in some cases, constrain them towards having to adapt to new scenarios. At the center of technological military innovation are large-scale defense projects. Disruptive technologies can be decisive or, at least, provide a margin of advantage among competitors. It is a constant task; as potential adversaries will try to achieve victory in the competition as well. This mechanism structures a never ending race to seek new solutions while incrementing the existing technologies as well.

Large-scale defense projects have impacts on several levels. Large advances can substantially modify the relation between humans and their environment and have a direct impact on international politics and economics. While they mobilize thousands of people, universities, governmental institutions and large firms, if successful, they can create a synergetic innovative breakthrough. Large-scale defense projects have unraveled from the structure of the atom towards space travel and exploration. Furthermore, efforts in innovation in the defense industry can generate technology that have a dual use, benefiting the civil private sector through positive externalities or "spin offs", especially through investments in a knowledge based economy, with engineering and basic science developments (MOWERY, 2010; MCDONOUTH, 2017). Such outcome has many examples, which the most evident include the internet, nuclear energy, jet turbines, GPS and developments in microelectronics (DIAMOND, 2006). The reverse is also true. Called *spin-ins,* civil sector innovations have increasingly been applied to military use. Dual use and systemic innovative development are at the core of military technology.

Historically, as argued by Mowery (2010), albeit the main pillars have been developed since the midst 19th century, a solid structure of Research and Development (R&D) for military means has its origins in the Manhattan Project. The last mobilized civil and military agencies which jointly put efforts and contracted universities, firms and other institutions generating an innovative capacity in the private sector through public demand. The Apollo program, for example, in 1966, made "National Aeronautics and Space Administration (NASA) responsible for 20.8% of all R&D expenditure and employed ninety-two thousand scientists and engineers with an annual cost of $billions" (ZEGYELD; ENZIG, 1987, p. 29).

The problem is that a project is not always successful in achieving its initial goals and this has consequences. First and foremost, the project has to credibly justify itself and

the resources it will request. Budget politics, therefore, lies at the heart of the issue. Competition for resources is a never ending process. A failed project will entail losses for other governmental priorities, other projects, bureaus, and so forth. A failed project will have sunk costs. Its non-accomplishment means the money could have been used for something more efficient and effective, including in matters of interstate rivalry. Major stakeholders, such as leading contractors, will have to deal with financial consequences since these projects are of an immense magnitude. Others, such as key proponents of the project and supporters will have to admit their loss in the political arena. Jobs and subcontractors are affected. Local politics is affected.

Innovation is, by nature, risk. Developing disruptive, state of the art innovations is highly risky. The higher the stakes the larger the bet. Given this problematic, the main question of this dissertation is: *what makes a large-scale innovative defense project successful or a failure?* In other words: Why are some large-scale projects successful and others not? What drives the initial effort to give genesis to them and what makes them to be cancelled or be driven forward? Explaining this is what drives the purpose of this study. To explain this complex process this dissertation proposes a theoretical framework within a critical dialogue with other models and theories, which aims at explaining the success or failure of large-scale projects. It is argued that the framework built can be expanded for other countries and historical moments. Furthermore, the model can be readapted, holding to core prepositions and the centrality of budget and main actors, to develop more complete frameworks which could address other themes and issues of foreign policy and defense. By engaging the issue by three different angles: domestic, structural and economic/technological, this study builds its theoretical framework and applies it to explain the success or failure of large-scale defense projects through a comparative study of four cases, which vary in the parameters defined by the variables and hypotheses developed through the different angles. The present dissertation encompasses large-scale defense projects. Geographically and institutionally, the scope of the research is limited to the United States. In terms of historical delimitation, four specific case studies are investigated: The Nuclear Propelled Submarine (Nautilus); the B-2 bomber; the Joint Strike Fighter and; the Future Combat System (FCS). The choice of cases is explained later in this Introduction.

To engage in this research, there are, of course, many underlying other questions, such as: What are the main actors, processes and structural conditions that impact

significantly the development of such a project? However, one must first investigate: What makes a project considered successful? With what parameters can one assess its degree of success or failure? The degree of success or failure of large-scale defense projects is the dependent variable (y) of this study.

A) Dependent Variable

This dissertation aims at explaining the success and failure of high-cost, long-term, defense projects. These projects fit DoD's category of Major Acquisition Programs, as defined in US Code § 2430 and is expected to exceed 1,8$ billion in 1990 dollars (LII, 2022). Furthermore, the focus is on military innovative projects, defined by Steven Rosen as "*a change in the concepts of operation of that combat arm, which is the ideas governing the ways it uses its forces to win a campaign*" (ROSEN, 1991, p. 7). Innovation mostly starts with speculation of how some segment of military operations could be implemented to guide development and procurement. Thus, changes in hardware and software, tactics and organization, is expected to lead to the reconfiguration of some segment of military operations.

The projects explained here are high-tech projects. They are usually based primarily on new and non-existent technologies at the moment they are conceptualized. Some technologies are still being developed and others have to be developed during the project life-cycle (ROUSSEL, 1991). As a consequence, this entails great risk and certainly makes it more difficult to evaluate progress during the project and therefore, a possible prediction of success or failure. Most likely high risk projects are undertaken by governments which are willing to take risks due to the external environment and the need for security or other objectives.

The most intuitive way to measure success (the dependent variable of this dissertation) is to compare the initial objectives of the project with the project's results, checking if the objectives have been met (WIT, 1988). Nonetheless, the task is more complicated than that. The project objectives vary through its life-cycle, the hierarchy of objectives depends on the involved stakeholders, and so forth. According to Wit (1988), no project is an absolute success or failure, since that depends on timing and different positions among stakeholders. The author claims that to objectively measure the success of a project is an illusion. A project's success measurement also varies according to the project type. Rodríguez-Segura *et al.* (2016) argue that the Critical Success Factors (CSF)

and the Success Criteria (SC) of a project are not universal and depend on the type of project, highlighting that there are few studies which focus on defense projects. Wit (1988, p. 168) states that certain CSF's are most appropriate to access the performance of public-sector projects were "politics dominate and perceived success is more important than real success". Commercial projects tend to focus more on economic outcomes and government projects on performance and need. Since this study focuses on defense projects, this debate will be further assessed below. At this point, however, it behooves this study to point out some insights provided by the literature dedicated to project success.

Over the first decades of the SC debate, projects were evaluated if they achieved budget, time and an acceptable level of performance goals. These analyses were dedicated to evaluating efficiency, or maximizing output for a given level of input. Success was, thus, objectively described and identified in absolute terms: either success or failure. Over the evolution of the debate, effectiveness and a more holistic and multidimensional approach became relevant since efficiency started to be considered a poor framework for assessment of the whole project (JUGDEV, MULLER, 2005; BELOUT, 1998; KERZNER, 1994; COOKE-DAVIES, 2002). Customer satisfaction, stakeholder gains, organizational learning and future benefits became to be incorporated as SC's over the years (WATERIDGE, 1998, p. 62). Diverse studies tested and researched a large list of CSF's over the years. Success indicators started to include both efficiency and effectiveness measures over the project's life cycle and its results and future impacts. These include managerial variables, customer satisfaction, team cohesion, among others. The CSF's of this dissertation are embedded in the three variables and angles of analysis proposed as Independent Variables. The amount of variables indicated by the literature are not all considered necessary for explaining the project's outcome. As stated by Jugvev and Muller (2005, p. 29): "the indictors identified should be assessed/measured using simple and appropriate measures. It is better to use a few measures and measure them well than to have a laundry list and not address them properly".

Project management literature is important to this dissertation especially because of the conceptual evolution of evaluating success. Beyond efficiency, effectiveness has to be incorporated in this study of high-scale defense projects. Furthermore, product life-cycle and the type of project have to be taken into consideration. Specifically related to defense, Segura *et al.* (2016), analyzing aerospace defense projects, concluded that

impact in costumer and preparing for the future are necessary conditions for success. Their study also suggests that project management and satisfaction of the costumer and end user, are necessary for success. The study of defense projects in Israel (TISHLER, DVIR, SHENHAR, & LIPOVETSKY, 1996; LIPOVETSKY, TISHLER, DVIR, & SHENHAR, 1997) reveals the factors that lead to success in this type of projects: benefits to the customer are the most important factor for success, with achieving the design goals in second place. Dvir *et al.* (2006), utilizing neural network analysis and linear regression analysis concludes that the main factor for evaluating success is the essential and urgent operational need, according to both methodologies. This finding is consistent with the works of Sherwin and Isenson (1967) and Tshler *et al.* (1996).

Studies in the area of project management widened the possibilities of criteria for evaluating success. It is argued here that efficiency (schedule, cost, performance) has to be taken into consideration in evaluating the success or failure of large-scale defense projects. This analysis is important because these indicators are target of scrutinizing and affects key stakeholders during the project's lifecycle and its aftermath. Nonetheless, it has to be complemented with two other proposed factors, namely: the need of the product and its tactical success as evaluated by the key stakeholders. These SC are proposed in this dissertation as a way of appropriately measuring success in alignment with the above mentioned research findings. The main buyer and user of large-scale defense projects is the government. The government's stands (including congressman, auditing agencies, the executive, armed forces, and the defense acquisition community in general) is a key demonstrator of the need and evaluation of the project's success. Managerial effectiveness, interrelationships, customer satisfaction, among others, are not treated in this study since they are already encompassed in the political bureaucratic process.

Two other points need to be made. As literature indicates, there is no objective way of evaluating success or failure in absolute terms. Nonetheless, if a program is cancelled without meeting any criteria of success, it will be considered a failed project. If a project is completed satisfying all criteria, it will be considered successful. In between that, projects will be classified in the "failure spectrum" if they do not meet minimum success criteria, and projects will be classified in the "success spectrum" if they meet most success criteria. More importantly, however, is that effectiveness is considered more important than efficiency. This dissertation starts from this premise because it considers

that defense development needs subordinate economic calculations in the face of urgent military needs.

Thus, the success criteria to be used here are the following:

- Cost overruns (initial estimate compared to final cost in %).
- Schedule overruns (initial estimate compared to cancellation/ deployment)
- Performance: Meeting Design goals (tests, deployment)
- Stakeholder's need (Government)
- Operational Success (Satisfaction with operations utilizing the innovation).

The concept and parameters outlined in this section are indispensable to achieve the dissertation's objectives:

B) Main Objective

Explain why high-cost and long-term defense projects, in the United States, are successful or not providing predictive and nomothetic elements beyond the historical understanding of these events.

In order to achieve the main objective, however, specific objectives are indispensable:

a) Explain which actors, processes and structural conditions impact large-scale defense projects building a theoretical framework to explain such projects.
b) Derive causality mechanisms between the main variables in the development of such projects.

c) Explain the specific characteristics of these projects, which are embedded in institutional aspects of United States' history, highlighting the budgetary process.

d) Investigate, thoroughly, the proposed case studies.

C) General Hypothesis and Model Construction

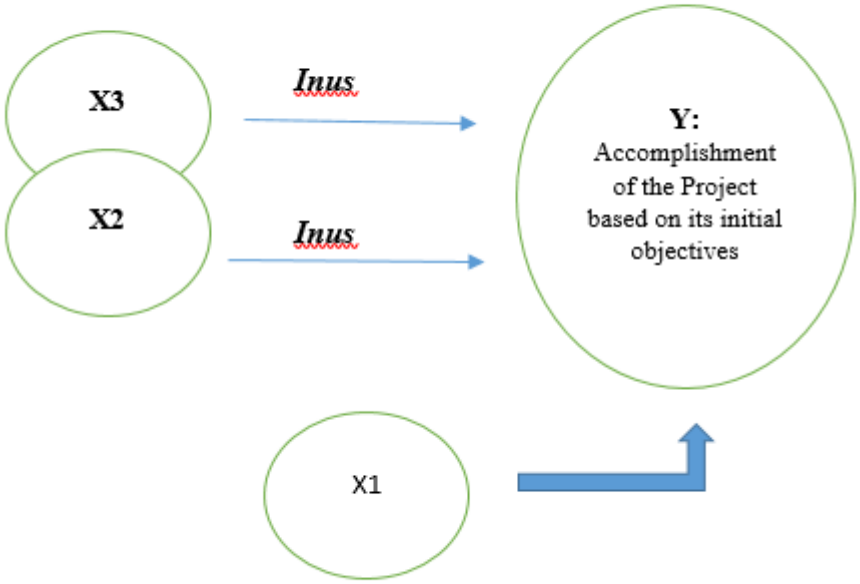
This study adopts three angles of analysis (structural, domestic and economic/technological), which will generate three main hypotheses and independent variables. Alongside with propositions and conclusions regarding these angles, the independent variables will build the theoretical framework and proposed model to investigate the case-studies, and, therefore, explain the dependent variable (Y). The structural independent variable, X1, correlates external threat level with innovation, utilizing balancing theories, especially the internal-balancing aspect of the international

dynamics. It is argued that the greater the threat, the most probable the innovative effort will be successful. X2 is developed utilizing some premises drawn from literature, especially Bureaucratic Politics (BP). It works with the qualitative evaluation of the level of consensus within and among the Executive and Congress. The greater the level of consensus, the most probable the project will be successful. Finally, economic and material conditions are necessary for the project's success, and independent variable X3 is a *proxy variable* developed to address technological feasibility, based on the variations of demand of the project and actor's stand on the subject. Greater elasticity of demand and doubts surrounding decision makers signalizes technological challenges. The independent variables will be qualitatively addressed through *process-tracing* of the case-studies within the parameters established in the three subsequent chapters.

The hypothesis put forward by this dissertation is represented in Figure 1. What is proposed is a Venn Diagram in order to explain Y. *Inus* is an insufficient, but necessary part to explain Y. However, several *Inus conditions,* taken conjointly, can result in a sufficient set that explains Y. If X1, X2 and X3 are analyzed separately, they are not sufficient to explain Y. A set of *Inus* conditions, for example, X1+X2+X3 can reveal to be a sufficient to explain Y (MAYONEY, KIMBALL, KOIVU, 2009).

In this dissertation, it is argued that variables X2 and X3 are necessary conditions which conjointly is sufficient to explain Y. The variation in X2 and X3 can explain the success or failure of large-scale defense projects. Since they are necessary, if a project is not technologically feasible or loses the necessary level of political support, it will fail. As for X1 (threat level), it is strongly and positively related to Y, but this dissertation does not consider it necessary, although it is extremely important, to explain Y.

Figure 1- Venn Diagram (Construction of the Model)



Source: The Author.

D) Methodology and Research Techniques

Parissinotto and Codato (2015) argue that the word 'methodology' usually has two meanings. The first refers to the logic which the study is encompassed, the general research strategy. The latter are the actual techniques utilized in the selection, validation and processing of data. Relating to this dissertation, both meanings are now presented. The Historical-Comparative Method (HCM) is the general methodology in which the case studies are investigated within the parameters and hypotheses of the theoretical framework. The main research technique which is utilized is qualitative, namely, *process-tracing.*

Epistemologically, the study works primarily with Middle Range Theories. This dissertation does not have the pretention of universalizing in a nomothetic manner its conclusions. Middle Range Theories do not aim at universalizing general models, but to explain more specific empirical phenomena. However, even though sometimes they may seem as idiosyncratic explanations, Middle Rage Theories aim at inferring causality between phenomena. These causal links can occur since Middle-Range Theories are

concerned with the sophistication of models which unravel causal mechanisms and to link them to the research results (JACKSON, NEXON, 2013; SIL, KATZENSTEIN, 2010).

The comparative method aims at establishing these causal empirical relations between two or more variables while others are kept constant. In this way, it utilizes a *ceteris paribus* condition (LIPJART, 1971). Usually, the comparative method engages in a limited number of cases (*small-n),* that is, it is recommended as an intermediate strategy between case-studies and *large-n* quantitative studies. The present research, through theoretical dialogue, lies also in the *theory-confirming*, *theory infirming and theory building* spectrum, depending on the result of the comparative case analysis. According to Lipjart:

> "*Theory-confirming* and *Theory infirming* are implicitly comparative analysis. They focus on a particular case in order to build towards an analysis of a relatively larger number of cases. This set of cases are analyzed through their empirical context utilizing a specific theoretical angle" (LIPJART, 1971, p. 693).

Bennet and Elman (2008), for example, argue that the comparative method is well suited for theoretical development, individual case-studies and more generalized conclusions about causal mechanisms. They aim neither at nomothetic or idiographic explanations. Hence, they are complementary with Middle-Range Theories' epistemology (BENNETT, 2010; BENNETT, ELMAN, 2008; MAHONEY, RUESHEMEYER, 2003). Skocpol (1979) argues that comparison represents, hence, a valuable tool for theoretical speculation.

The main technique used in this dissertation, *process-tracing,* comes from a response made by researchers, who defend qualitative methodologies in the advent of increasing utilization of statistical regressions to define parameters of analysis. According to Mahoney and Rushmeyer (2003), *small-n* studies contribute to advanced theoretical insights. *Process-tracing* can generate ideas and insights regarding causality and provide auxiliary traits to a specific theory (MAHONEY, 2010). Collier (2011) defines *process-tracing* as an analytical tool to make descriptive and causal inferences through the study of the sequence of events, which constitute the study object. *Process-tracing* aims at connecting hypothetical X variables to a Y dependent variable through the identification of the absence or presence of causal interactions among relations between the parts that interact (SILVA, CUNHA, 2010).

The choice of cases in this dissertation comes from the ideas put forward by Theda Skocpol (1979). The author bases her analysis on John Stuart Mill's ideas in order to proceed in a Historical-Comparative Analysis. In the first place, Mill identifies what he calls the *Method of Agreement*, in which an author analyzes various cases within a common phenomenon in which they can demonstrated a common set of causal variables, even though they can vary in other factors or manners which can also appear casually significant (SKOCPOL, 1979). Secondly, Mills develops the *Method of Difference*, in which the author contrasts the cases with others that the phenomenon and hypothetical causes are absent, however, that are in other ways similar to the positive cases. With the proper choice of negative cases (where the causes and the result are not present), the *Method of Difference* becomes extremely useful for comparative analysis.

According to Skocpol (1979, p. 37), the combination of the two logics is highly useful. In her research the author chooses positive cases of social revolutions (China, Russia and France) and contrasts them with the adequate negative cases. In this same sense, this dissertation chooses two positive cases (successful high-scale defense projects) and two negative cases (unsuccessful projects), aiming at inferring the significant variables.

E) Relevance

The main theme of the present dissertation is both socially and theoretically relevant. Decisions regarding the defense budget can cost lives: types of radar and sonar choices and armored vehicles, for example, affect directly military engagement and its main characteristics and, by consequence, soldiers. High-cost and long-term projects can change in a decisive manner the relative advantage of a country in a competitive international arena. Decisions of spending, as well, rise important trade-offs between expenditures in social welfare, for example, and large amounts of resource to defense. Economically, these decisions affect tax payers, inflation, and debt, for example. When one works with budgeting, relevant political aspects appear:

> "The victories and defeats, the compromises and the bargains, the realms of agreement and the spheres of conflict in regard to the role of national government in our society all appear in the budget. In the most integral sense, the budget lies at the heart of the political process" (WILDAVSKY, 1964. p. 5).

Explaining large-scale defense projects, can also provide more tangibility and predictability regarding future decisions of the United States' defense policy. Socially, in

the case of Brazil, one can infer important lessons in relation to the decision-making process of large-scale defense projects. This is especially true since Brazil also aims at these kinds of projects, for example, the nuclear propelled submarine.

Theoretically, the present study presents an important investigation examining external threat, technology and decision-making, advancing in this field of study by establishing a critical dialogue with the main perspectives of the area. Secondly, if one disregards the contingencies of the case-studies (large-scale defense projects) the model can be further developed to be extended in its geographical and historical scope, encompassing other important areas of decision-making in defense and foreign policy as well. Lastly, the choice of variance in time and services among the Armed Forces, which makes the projects embedded in different international structural conditions, domestic institutional and political aspects and material basis, can provide causality and theory-building.

F) Structure of the Dissertation

In order to achieve the objectives of this dissertation, the structure is organized in two main parts. The part that follows this Introduction – Structure, Actors, Processes and Issues –develops the theoretical framework and hypotheses to be tested in the comparative case analysis. Chapters 1,2 and 3 engage in a theoretical discussion about the structure, actors and defense economics. Each of these chapters, as further explained below, addresses an angle of analysis. Chapter 1 is aimed at debating the International System (IS) and its impact on large-scale defense projects. Chapter 2 engages in a discussion about the key-decision makers that impacts the outcomes of US' domestic politics. Chapter 3 discusses the economics in defense decision-making. Hypotheses are proposed from the results of this theoretical construction. Each of the three angles of analysis sets an independent variable to explain the success and failure of large-scale defense projects. Chapter 4 is an empirical chapter aimed at explaining the U.S defense budget system, it focuses on the process that a large-scale defense project will be encompassed through its lifecycle. The second main part of this study –High stakes and high risk: An Analysis of large-scale, high-cost and long term defense projects. – investigates thoroughly the four cases proposed by this dissertation. By reconstructing the timeline of the events, highlighting the three angles of analysis, the hypotheses and theoretical framework are confronted with the outcomes of the cases. The conclusion resumes the main findings in this study and discusses its results.

To specify further the contents: Chapter 1 discusses the impact of the IS on military innovation, more specifically, on technological innovation. In order to do so, the chapter engages with balancing theories from the realist tradition and the impact of external threat in the internal organization of states. Its objective is to propose a correlation between external threat and large-scale defense projects. Subsequently, Chapter 23 debates the domestic structure of politics, especially U.S politics, by critically reviewing the main theories of policy making. The role of bureaucracies is highlighted, and critics of bureaucratic theory discussed. The decision-making structure and its main actors are analyzed engaging with several theoretical backgrounds from political science and public policy. The chapter's objective is to isolate the most important domestic variable in defense decision-making regarding large-scale defense projects and to identify the main "rules of the game" in U.S' domestic arena. Chapter 3 focuses on defense economics and innovation. Mobilizing resources within a specific market structure is the theme of the chapter. Identifying the main issues of defense economics and innovation, the chapter places large-scale defense projects in this structure. Along with the important inferences outlined in the chapter, innovation is a condition by technological development, hence, a hypothesis is proposed correlating technological feasibility and large-scale defense projects. The budget is central to the success or failure of any government policy. The rules, actors and phases of defense acquisition lies the table in which the cards are played. Chapter 4 is dedicated to explaining the defense budgetary process.

With the theoretical framework constructed and the hypotheses outlined, chapters 5 through 8 test them in accordance to the methodology proposed. Hence, the four cases outcomes are explained. Chapter 5 investigates the U.S Nautilus, the first nuclear propelled submarine in the world. The U.S had come victorious of the Second World War to encounter the Cold War. Furthermore, the results of the Manhattan Project and the possibilities involving nuclear energy seemed limitless. As it will be seen, the project was successful. Chapter 6 investigates the B-2 bomber. The B-2 was conceived to strengthen the manned bomb leg of the strategic triad, perceived as becoming obsolete by B-2's proponents. The project was highly ambitious and its outcome is considered here in the failed spectrum of large-scale defense projects. Chapter 7 analyzes the Future Combat Systems (FCS), an Army project for future wars, which was centered around full situational awareness and time advantage, with the promise to "lift the fog of war". As it

will be demonstrated, the FCS failed. The last case which is examined is the F-35 fighter, in chapter 8. Its origins are traced to the idea to build a fighter which would contemplate the future needs of the Air Force, Navy and the Marines, since their fighters were aging. The chapter analyzes the development and outcomes of the F-35 up until the present moment, arguing it to be in the successful spectrum of large-scale defense projects.

The conclusion ends this dissertation. The cases and their results are reviewed in the light of the general model and success criteria presented in this Introduction and the impact of the independent variables is further scrutinized. The limits of the present study are presented and proposals of necessary future research to further explain the phenomena studied suggested. Furthermore, possible relations amongst the variables are proposed and future application and development of the model are addressed.

PART I- STRUCTURE, ACTORS, PROCESSES AND ISSUES

"I must study politics and war that my sons may have liberty to study mathematics and philosophy. My sons ought to study mathematics and philosophy, geography, natural history, naval architecture, navigation, commerce, and agriculture, in order to give their children a right to study painting, poetry, music, architecture, statuary, tapestry, and porcelain."

John Adams

"Although our prospect is peace, our policy and purpose are to provide for defense by all those means to which our resources are competent."

Thomas Jefferson

CHAPTER 1- THREAT, RESPONSE AND TECHNOLOGY

But what else does balance mean and entail beyond alliance making? In the short run, some states may have the good fortune of generous friends and fortuitous external circumstances (fortuna), but in the long run their viability can only be assured by their own efforts and the strength of their internal organization (virtù).

(RESENDE-SANTOS, JOÃO, 2007, p. 65).

It is theory which decides what we can observe.

Albert Einstein.

Human beings are creative. Throughout history, humans have interpreted and transformed nature for countless purposes. Survival is the *sine qua non* condition for all of their aspirations. Humanity has organized itself in political units where the individual transfers his right to freedom of action in exchange for security. These units are embedded in an anarchic environment, where competition thrives and the lack of a sovereign to secure their safety impels them to seek survival counting only on themselves[2]. Modern states are the most common type of political units on our contemporary world. When threat increases, how does a state respond? States have to mobilize their material and human resources in order to answer threatening situations. They can also seek friends to shield them from external aggressions. States have to be prepared for war. This means that they have to organize themselves militarily, draw a fighting strategy, and enhance their material capabilities. In this sense, some large-scale innovative projects are crucial, albeit their failure can result in an enormous resource lost. How does one explain the success or failure of high-scale military technological projects in the light of the level of threat? This chapter's aim is to address this question from a theoretical point of view. It will treat the systemic level as an independent condition and generate hypotheses regarding state behavior before international environment's constrains. This study, while investigating the international realm's effects on innovation behavior, will put forward an analytical framework building upon Neorealist insights.

In order to address such issues, this chapter will be organized in four sections. The first is intended to lay out some key Neorealist concepts regarding the international system. Subsequently, the second section draws out a discussion regarding a typology of

[2] The contractualist philosophical tradition referred to in this paragraph can be traced to Thomas Hobbes (2009). A more recent development can be found in the work of Mearsheimer (2018).

states' possible military behavior facing systemic constraints and the different dimensions of possible state action in this situation. The third section aims at giving a conceptual treatment of threat and innovation. Finally, the theoretical discussion in this chapter will be reviewed in order to generated hypotheses relating systemic incentive and the success or failure of large-scale defense projects. Auxiliary hypotheses which relate to the discussion presented here will be also be raised.

1.1- Anarchy and Unit Behavior

Who and what shapes foreign policy? Over the discipline's history, International Relations (IR) scholars have debated extensively about the nature of the International System (IS)[3]. States are embedded and shaped by it. It is intuitive to assume that the IS influences state behavior. Nevertheless, the questions of *how* and *to what extent* are states affected by the IS is a matter of great controversy in IR literature. In order to address these issues one has to identify the nature of: a) the international system; b) states; c) state's behavior. The field of IR offers a variety of theories in order to explain these topics of inquiry, most of them built on solid intellectual traditions[4]. This dissertation investigates the IS building on a Neorealist foundation. Since the goal of this study is not to engage in metatheoretical, ontological or epistemological debates, it deliberately leaves out the competitive paradigms.

What allows one to speak of a Realist "tradition" despite its several different "schools of thought"[5] is a common denominator of its main assumptions -- the IS as anarchic, states as its main actors and the centrality of power in international relations. Since this chapter is dedicated *exclusively* to the international sources of state's behavior, it is adequate to focus on the Neorealist Theory, as it offers the most systematic and theoretically solid approach to the subject.

Neorealism has its origins with Kenneth Waltz's seminal work *"Theory of International Politics"* published in 1979. After criticizing what he calls "reductionist

[3] A well-developed conceptual analysis of "International System" can be found at: (BUZAN, JOHNES, 2000). Authors of the called English School separate "International System" from "International Society", with an emphasis given to balance of power in the former and rules and order in the latter (BULL, 2012; BUZAN, 2014).

[4] Wight (1994) argues that are three traditions in International Relations: Realism, Liberalism and a middle-ground perspective, the English School, which he identifies himself.

[5] Realism can be found in different authors with different perspectives, albeit there are some shared assumptions which allows us to identify it as a school of thought.

theories[6]", that is, theories which attempt to explain systemic outcomes through the unit's properties, Waltz proposes a structural theory of the international political system[7]. Adopting a structural perspective aims at explaining the "backbone" of a system and outcomes that occur independent from actor's intentions. The structure constrains the units. A political structure is understood by Waltz as a system's organizing principle, its unit functional differentiation and the distribution of capabilities across units (WALTZ, 1979).

The structural characteristics of the IS, according to Waltz (1979), are anarchy, the functional equivalency of the units, and the power distribution among states. The absence of government in the IS, as opposed to the domestic level, results in a system which the states are the main actors and are responsible for carrying out a set of basic functions, which results in the similarity of behavior among them. Insofar as states are sovereign, according to Waltz (1979), what distinguishes them is their relative power towards each other, the distribution of capabilities in the system. As a consequence, the only form of possible structural change, as long as anarchy prevails, is a transformation of the distribution of capabilities between units. Albeit there can be conflicts in the sub-national level, the ordering principle of the domestic realm is hierarchy. Hierarchical structures are *per se* distribution of functions between internal actors.

The immediate consequence that the structure imposes on states is their responsibility of self-help: they have to take care of themselves. In order to accomplish any of their possible objectives, states must survive. Survival is their highest and overriding goal[8]. As Waltz's logical deduction follows, from anarchy derives the competitive nature of the system and the insecurity and uncertainty that pervade the life of states[9]. At the root of the logic that underlines competition lies the *security-dilemma*[10]. In order to survive states are impelled to enhance their capabilities, as they are suspicious

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[7] According to Waltz, economic or other issues, in a self-help environment, are subordinated to political considerations. (WALTZ, 1979, p. 145-155).

[8] Mearsheimer (2014), in a different perspective, argues that beyond survival, conquering the best position in the International System is a constant goal for states.

[9] Keneth Waltz was the target of several analysis and criticism by different authors. See, for example: (KEOHANE, 1986).

[10] John Herz (1950) famously argued that, in order to survive, states will look at their adversaries and attempt to surpass them. The response by the other state will be the same and this will generate a dilemma were the main consequence is an arms-race among contenders.

of the other states' intensions. The other states react in the same way, creating a spiral logic. The most obvious way of enhancing capabilities is through military means, since physical survival is a precondition for any other form of competition. We should expect a military build-up among states. Structural competition does not mean that states will act necessarily according to its survival imperative. Nevertheless, according to the theory, if a state fails to respond to the system's imperatives, it will be "punished", as firms are punished by the market if they fail to adjust to its demands. At the limit, a State can cease to exist.

As a structural theory of the IS, Neorealism aims, primarily, at explaining the international outcomes. So does it effectively help explaining state behavior? Since the publication of *Theory of International Politics,* there has been successive attempts to amend the theory in order to explain foreign policy[11]. Waltz's construction makes few predictions about state behavior as his concepts are aimed at explaining general tendencies, which are reviewed below. Waltz argues that his study is not theoretically constructed to explain the separate realms of the domestic and international level:

> "The theory explains why states similarly placed behave similarly despite their internal differences. The explanation of states' behavior is found at the international, and not at the national, level. That is why the theory is called a theory of international politics. In contrast, a theory of foreign policy would explain why states similarly placed in a system behave in different way (…) Market theory does not deal with characteristics of firms. International political theory does not include factors at the level of states" (WALTZ, 1996, p. 55-56).

It is rather intuitive that state behavior depends upon both domestic and international factors. As Waltz (1996, p 57) argues: "neither realists nor anyone else believe that unit-level factors can be excluded from foreign-policy analysis". The present study does not have the ambition of explaining state behavior by constructing a theory that unifies both domestic and international variables. This is the reason why this chapter is dedicated exclusively to a systemic theoretical approach towards state behavior and it is analytically separate from the subsequent chapter, which is focused on a domestic level elaboration. The dissertation's aim is not to unify both level explanations[12], albeit both are exposed. The study simply offers two *perspectives* to approach the empirical

[11] Some examples include: Elman (1996) and Neoclassical Realism (which is further explored in the subsequent chapter).

[12] Putnam (1988) argues that there is a solid interconnection between the International Arena and the Domestic Arena. From this starting point, the author develops a theory of "two-level games".

phenomena, treating them as independent sources of explanation[13], as this dissertation agrees with Waltz that, for explaining foreign policy:

> "(…) the most satisfying way would be to provide a single theory capable of explaining the behavior of states, their interactions, and international outcomes. Unfortunately, no one has even suggested how such a grand theory can be constructed, let alone developed one (…) Economists get along quite well with separate theories of firms and markets. Students of international politics will do well to concentrate on, and make use of, separate theories of internal and external politics until someone figures out a way to unite them" (WALTZ, 1996, p. 57).

Nevertheless, it is argued here that there are powerful theoretical tools derived from Neorealism to explain state behavior, and, specifically, large-scale defense projects. Military build-ups can be seen, without pushing the boundaries of the theory, as responses to the international system, specially through balance-of-power propositions. As Posen (1984, p. 35) puts it, theorizing about military doctrines: "balance-of-power theory should be able to explain the behavior of sovereign political units in any unregulated environment". Balance-of-power is a notion embedded in most realist studies[14]. In the Neorealist approach, in order to survive, states are compelled to adopt a balancing behavior towards other states, in order to respond to the incentives of the anarchic environment. Waltz develops his theory of balance-of-power in the following way:

> "A balance-of-power theory, properly stated, begins with assumptions about states: They are unitary actors who, at a minimum, seek their own preservation and, at a maximum, drive for universal domination. States, or those who act for them, try in more or less sensible ways to use the means available in order to achieve the ends in view. Those means fall into two categories: internal efforts (moves to increase economic capability, to increase military strength, to develop clever strategies) and external efforts (moves to strengthen and enlarge one's own alliance or to weaken and shrink an opposing one) "(WALTZ, 1979, p. 118).

These two kinds of responses (external and internal) result in two different forms of state behavior: external-balancing and internal-balancing. External-balancing has been well developed by IR literature[15]. As for internal-balancing, Resende-Santos (2007) and Collin Elman (1999) present solid theoretical developments on the topic, which will be addressed in the subsequent section. In order to develop a framework to analyze military build-up from the Neorealist perspective, a more detailed discussion about balancing, specifically internal-balancing, will be provided in the next section.

[13] By doing such, this dissertation generates different sets of hypothesis by analyzing both levels separately.
[14] Waltz (1979) and Posen (1984) review some of the main authors which work within this perspective.
[15] See, for example: (SNYDER, 1984; WALT, 1987).

1.2- Internal Balancing and the Second-Image Reversed

From a Neorealist perspective, state behavior can be explained through structural incentives and constraints imposed by the IS. States that fail to respond to structural imperatives are punished by the system. Due to self-help and the competitive environment of the IS, states are expected to balance. Simply put, states will be impelled to enhance their power either by increasing their material capabilities and better their strategies or by forming alliances in order to balance another state or group of states. Externally, they can also engage in buck-passing or *bandwagoning* (free-ride).

Table 1.1 – Simplified Balancing Strategies

External	Free Riding Buck-Passing	Formal Alliance	
Internal	Countermeasuring	Innovation	Emulation
	Balancing Strategies		

Source: (RESENDE-SANTOS, 2007, p. 69)

Internal-balancing can be done either by emulation, innovation or counter-measuring (RESENDE-SANTOS, 2007).[16] A particular state may choose to keep its current strategy as well. Counter-measuring can be understood as fundamentally quantitative (increasing one's capabilities). Innovation and emulation have qualitative aspects (for example, the ability to better mobilize and use resources). These strategies of internal-balancing can be juxtaposed by a state, for example, combining emulation and innovation.

A theory of emulation is latent in Waltz's formulation (RESENDE-SANTOS, 2007). Waltz argues that states tend to emulate the most successful practices of one another, specifically, military weapons and practices. This sort of behavior will lead to a diffusion of the best practices, generating isomorphism in the IS[17]. Albeit Waltz conceptualizes this sort of state behavior he does not systematically develop it (POSEN, 1993). According to Resende-Santos (2007), Waltz's theory cannot predict in which way, when and under what conditions a state will balance.

[16] For a detailed analysis, see: (ELMAN, 1999; RESENDE-SANTOS, 2007).
[17] According to Waltz (1979), the forces which lead to isomorphism among unites are Socialization and Competition.

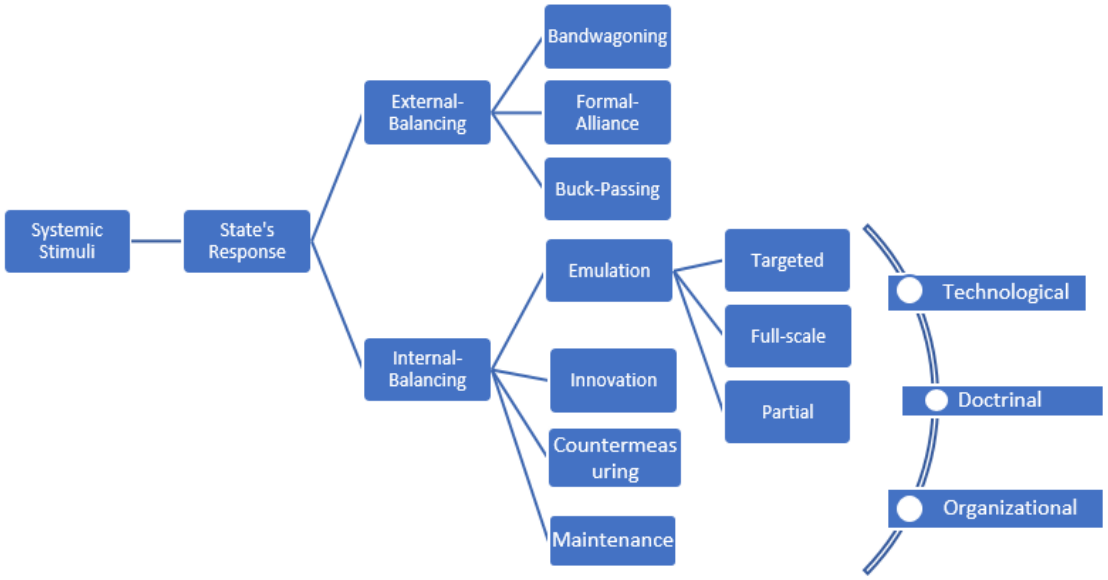
States responses to structural demands can be long enduring large-scale processes as it is the case with the military organizational and technological full-scale emulations studied by Resende-Santos (2007) or the military responses to external constraints analyzed by Elman's (1999). Balancing behavior can also be targeted at specific dimensions of military response, as brilliantly unraveled by Posen's seminal work on the sources of military doctrine[18]. Although this study's only aspect of internal-balancing discussed is military balancing, states can balance other assets of one another, as for example, economic development strategies. States are not the only actors to engage in balancing behavior: firms also emulate and innovate. Even if, this dissertation, as it analyses the IS, restricts itself to discussing the *state's* balancing strategies, it is important to point out that there are several internal mobilization strategies, which involve quantitative and qualitative mustering of the state's human, material, organizational and technological resources (RESENDE-SANTOS, 2007, p. 67).

According to Resende-Santos (2007, p. 23), "unit-level factors, such as regime insecurity and domestic politics, cannot provide satisfactory explanations for why states emulate and whom they emulate". Political battles and organizational behavior are some of the main unit-level explanations about internal-balancing behavior developed by the literature on the subject[19]. Nonetheless, as it has already been said, the purpose of this chapter is not to engage in an extensive intratheoretical debate. This chapter's aim is to develop hypotheses from a systemic level explanatory framework, that is, explain why states make security decisions before the IS's constrains and incentives.

Figure 1 presents a synthesis of literature's development of balancing behavior. States will protect their survival and goals by seeking external friends or mobilizing its internal resources (human and material) to prepare for any possible competitive outcomes, including wars. Figure one shows the possible balancing strategies presented by the literature discussed. Three dimensions encompass military internal-balancing behavior: organizational, doctrinal and technological. States can emulate, countermeasure or innovate targeted practices of each of these dimensions, juxtapose them in a combination, or choose to partially or fully emulate the one that is most successful.

Figure 1.1- Simplified Military Balancing Options

[18] See: (POSEN, 1984).
[19] The next Chapter brings some of the main perspectives on the subject.



Source: The Author.

Since this dissertation discusses pioneering defense projects that are the structural foundations of large military rearrangements, innovation will be given priority of analysis in relation to the other balancing strategies. Military innovation occurs mainly within great powers. To assume the risks of innovating, one has to have resources to spare, as the innovation may fail to be feasible or prove to be unsuccessful when implemented. Resende-Santos (2007) correctly points out to the fact that Waltz does not develop the basis for explaining innovation. The theoretical insights of Neorealism give the path for understanding innovation, because it can be logically derived that in a system of uncertainty and competition, states will innovate. Nonetheless, explaining the nuances of the process and predicting when a state will innovate as opposed to engaging in other strategies is a gap in the literature that has to be more solidly engaged with. Resende-Santos also deliberately takes out of the analysis the explanation for the success or failure of internal balancing: “the question of why some emulators are more prodigious is historically and theoretically interesting, but lies outside this study” (RESENDE-SANTOS, 2007, p. 11). Neorealist literature presents some interesting insights regarding innovation. Anyway, these hypotheses will be introduced in the next section of the present chapter, as they relate to an important variable to be introduced: level of external threat.

1.21- Second Image Reversed

Albeit Waltz intended in his theory only to develop a few general predictions about state behavior, other authors have argued that it is possible to go further in

explaining the domestic consequences of systemic pressures (GOUREVITCH, 1978; ELMAN, 1996). In his seminal work *"The second image reversed: the international sources of domestic politics"*, Gourevitch (1978, p. 883) states that "political development is shaped by war and trade". The second image reversed approach is a key theoretical path towards explaining the object of study in this dissertation since the approach claims that the IS has casual weight in conditioning the behavior of states. This study will analyze this conditioning process through the conceptual lenses of internal-balancing, since as stated by Resende-Santos (2007, p. 15) "internal balancing is the avenue through which the system works its organizational effects on states".

The anarchic environment compels states to organize themselves to meet the challenges of competition, be their goal survival or world domination. It is important to highlight that some qualitative features inherent to specific states' position in the IS will affect their behavior. Geography is the most obvious example. To illustrate, England developed a strong navy as opposed to an army since the English Chanel lessened the threat of invasion. To give one more examples: Prussia, surrounded by land competitors, had to stay in constant vigilance. For these reasons, Gourevitch (1979) states that these conditions substantially affected the development of these countries' domestic institutional arrangements. In the same line of thought, Posen (1984) argues that these geographical imperatives were responsible for the choice of a defensive doctrine by England and an offensive doctrine by Germany. In this sense, Jervis (1978, p. 194) states that "technology and geography are the two main factors that determine whether the offense or the defense has the advantage"[20].

There is substantial literature to back the second image reversed perspective. Otto Hintz, for example, argues that "all state organization was originally military organization, organization for war" (HINTZE, 1975, p. 178). Perry Anderson (1974) explains the emergence of absolutism in eastern Europe from an international lens. Faced by the pressure of more powerful western states and Turkish invasions from the east, eastern European states had to adapt or sink. Skocpol (1979) also gives causal weight to systemic pressures in explaining the French, Chinese and Russian revolutions (DALL'AGNOL, 2019). Finally, as summarized by Gourevitch:

> "The international system is not only a consequence of domestic politics and structures but a cause of them. Economic relations and military pressures

[20] Mearsheimer (2014) gives special emphasis to "large bodies of water" which further hampers balancing.

> constrain an entire range of domestic behaviors, from policy decisions to political forms. International relations and domestic politics are therefore so interrelated that they should be analyzed simultaneously, as a whole" (GOUREVITCH, 1978, p. 911).

This dissertation adopts Gourevitch's perspective that both domestic factors and international incentives shape state behavior. Nevertheless, as it has already been stated, in this stage of the dissertation, the focus is on explanations that treat systemic factors as the independent variable. Historical sociology offers important insights that are confluent with the second image reversed perspective. The authors which work from this perspective analyze the features of the international environment that are on the root of state-building.

Charles Tilly (1990) argued that the capacity of a state's response to the international competition depends on its resource base and the ability of its organizational core. Charles Tilly, among other historical sociologists, maintains that the political-organizational form of the states (or other political sovereign units) is determined by both internal and external requirements. States makes the war and war makes the state. In Tilly's conception, the primarily function of the state is war and war-preparedness. War requires a deep mobilization of the state's organizational, extractive and material capacities. As a dynamic process, external imperatives will directly affect the state's modernization requirements. Resende-Santos argues that "competitive effectiveness is structurally determined. It is not a quality of the individual units, but a product of their competition (…) the anarchic structure alone determines the minimum requirements of viability in the system" (RESENDE-SANTOS, 2007, p. 64-65).

Norbert Elias, in his work "*The Civilizing Process"*, studies the *sociogenesis* of modern states in western Europe. The author highlights that competition among smaller unites operated as an impelling force in the formation of the modern monopolization of the use of force. According to Elias (1993), peaceful times would shake the internal power structures of political unites, making power fragmented, and, as a consequence, the authority of the leader, contested. The centralizing power of the leader, in times of military competition, according to Elias, is high. Expansionism is, by these means, stimulated. Political actors are impelled to expand in order to survive. Elias's historical sociology derives from the external competitive environment the expansionist behavior of political units:

> "The soul preservation in social existence requires, in free competition, a permanent expansion. Who doesn't rise, falls. Victory, therefore, means, primarily-- be that or not the intention--, domination over the competitors and their reduction to a state of dependency. In this case the gain one is necessarily the loss of the other, be that in terms of land, military capability, Money, or any other form of concrete manifestation of social power. But beyond this fact, victory will mean, sooner or later, the confrontation and conflict with a rival whose strength is threatening to yours, and once again, this situation impels the expansion of one and the absorption, subjugation, humiliation and destruction of the other" (ELIAS, 1993, p. 134).

Beyond the zero-sum reasoning of Elias, it is easily identified in his writings a thesis of structural constraint, which political units face having to expand in order to survive. The system leads, thus, inevitably, to conflict. A similar line of argument can be found in John Mearsheimer's Neorealist theory of great power competition. Mearsheimer (2014, p. 2) argues that "the desire for more power does not go away, unless a state achieves the ultimate goal of hegemony. Since no state is likely to achieve global hegemony, however, the world is condemned to perpetual great-power competition". Since the pursuit for power by great powers is inherit to the system, Mearsheimer's theory has been called Offensive Neorealism in opposed to Waltz's Defensive Neorealism. The differentiation of both theories lies in the fact that in Waltz's theory, survival is the ultimate and natural goal and in Mearsheimer's construction, expansionism is also ontologically tied to the system. Mearsheimer (2014, p. 3), categorically states that: "simply put, great powers are primed for offense. But not only does a great power seek to gain power at the expense of other states, it also tries to thwart rivals bent on gaining power at its expense".

Literature, thus, has an interdisciplinary tradition of deriving from the system, specifically the competitive nature of the international order, the behavior and internal construction of states. This topic has showed that beyond Waltz's general predictions about states' behavior before the system constraints, it is possible to explain more specific traits of the states' actions before the structure and the consequences of the second image reversed logic. Since this dissertation studies the military behavior of states and specifically, in this chapter, the military responses toward the system, some concepts regarding state strategic behavior might be helpful at this moment.

1.22- States' Military Responses

Up to this point, in this study, Neorealist theory was introduced with its main concepts regarding states' behavior in the international system. Furthermore, internal-balancing theoretical developments were introduced alongside with second image

reversed perspectives and state-building insights. It was argued that military internal-balancing consists of three dimensions: doctrinal, technological and organizational. This study focuses more in the technological dimension, since it analyzes specific defense projects. Moreover, it focuses mainly in innovation and innovative-capable states, as it attempts to explain the United States' cutting-edge defense transformations. At this moment, it benefits the dissertation's logical development to introduce some key concepts regarding military actions.

Clausewitz's concept of war is relational; that is to say, it is political. For the author, war is a collective duel. It is political because it involves the will of the actors involved. "War is thus an act of force to compel our enemy to do our will" (CLAUSEWITZ, 2007, p. 13). War is confrontation to accomplish a political objective. War is, therefore, an instrument of politics, the mean to pursue a goal: "war is merely the continuation of policy by other means (…) the political object is the goal, war is the means of reaching it, and means can never be considered in isolation from their purpose" (CLAUSEWITZ, 2007, p. 28-29). Clausewitz classical study of war gives us important challenges to study military action. Because it is human and political, the study of war is not a simple derivative of material functions. Clausewitz (2007, p. 20), makes this clear when states that "the political object cannot, however, in itself provide the standard of measurement". Confrontation between parties involves human interests and creativity- "force, to counter opposing force, equips itself with the inventions of art and science" (CLAUSEWITZ, 2007, p. 13). The present study is not embedded in the field of Strategic Studies, nevertheless, Clausewitz's theoretical insights has important consequences to the study of innovation and technology.

Competition demands military response. According to balancing theory, there are three dimensions of such action: organizational, doctrinal and technological. These can be considered elements of strategy. The concept of strategy is somewhat, in a sense, confusing in literature, since the word is used extensively, surpassing different issues, without a precise meaning. IR scholars, have, for example, developed a wider concept-grand strategy. According to Robert Art:

> "(…) a grand strategy tells a nation's leaders what goals they should aim for and how best they can use their country's military power to attain these goals. (…) To define a nation's foreign policy is to lay out the full range of goals that a state should seek in the world and then determine how all of the instruments of statecraft—political power, military power, economic power, ideological power—should be integrated and employed with one another to achieve those

> goals. Grand strategy, too, deals with the full range of goals that a state should seek, but it concentrates primarily on how the military instrument should be employed to achieve them. It prescribes how a nation should wield its military instrument to realize its foreign policy goals" (ART, 2003, p. 1-2).

Posen (1984, p. 13) states that "grand strategy is a political-military, means-ends chain, a state's theory about how it can best cause security for itself". Grand strategy can be somewhat confusing. Hence Art argues that grand strategy deals with the full range of goals of a specific country, a whole range of dimensions of power are part of the concept, even though the author makes it clear that this holistic view focuses on the military means, as an instrument, in accordance with Clausewitz idea. Posen presents a similar, although apparently more restricted concept. Clausewitz defines strategy as "the use of an engagement for the purpose of war" (2007, p. 133). It is a more precise, and, thus, it can be argued, a more rigorous concept, more closely with accordance to scientific patterns as opposed to political rhetoric.

The use of a strategy concept entails some consequences for the political analyst. The perspective of grand strategy provides to the student a more holistic view. Nevertheless, the analysis will be necessarily more descriptive and difficult to translate into theoretical guide for research. It is useful to trace the process of decision-making and to identify the arguments put forward by the many different actors in the bargaining theatre. The concept of grand strategy will be always present, as an *en passant* description in an empirical analysis such as the one of this dissertation.

Waltz restricts his analysis to the political dimension; Clausewitz argues that war is an instrument for political purposes. Clausewitz's concept of strategy can be more fruitful for this study as opposed to the grand strategy notion. The engagement for the purpose of war restricts the decision-making actors to the chain of political-military command responsible for engagement for war decisions. Breaking down the concept into the dimensions of doctrine (Posen, 1984), organization and technology, rises the risk of theoretical distortion. Nonetheless, this breakdown is useful for developing an analytical framework.

Human beings engage in the transformation of nature since the genesis of his existence. The manipulation of materiality for purposes of war can be treated as a subcomponent of strategy, since the decisions about it, obviously, affects tactics and outcomes of conflict. Despite this, Clausewitz (2007, p. 47) famously argues that "war is the realm of uncertainty; three quarters of the factors on which action in war is based are

wrapped in a fog of greater or lesser uncertainty". Technology changes war, but technology is only a subcomponent of the conflict phenomena. The temptation for the analyst to fall into technological determinism is strong since "the relations between material factors are all very simple; what is more difficult to grasp are the intellectual factors" (CLAUSEWITZ, 2007, p. 134).

Since the industrial revolution and the escalation of production and innovation, technology appears to be the sole determinant of the outcomes of war. Although, this perception is, however, challenged by two facts: a) technological advances does not mean better performance in war; b) technology does not change the nature of war. Technology, in this line of reasoning, has to be analyzed, in terms of its clear impact on tactics and logistics (DINIZ, 2002). Nonetheless, one can argue that technology, in a timeframe of causal effects, has preponderance over organization and doctrine, since it may impel strategic commanders to change the latest in consequence of the former's variation. For example, aviation changed force structure, tactics and the shape of war. A scientific breakthrough such as quantum mechanics and the subsequent development of the atomic bomb forced a substantial changed in strategy. Countless other examples can be given in this sense. Does technology have a causal preponderance in internal-balancing? How does one better analyze the impacts of technology of large size defense projects as the ones studied here? These questions can lead to fruitful paths of theoretical and empirical investigations.

Up until now, this study has presented some key concepts to analyze the behavior of states in the light of systemic characteristics. The IS is anarchic. Anarchy entails self-help and uncertainty. In order to survive, states have to be aware of the others, and the security dilemma makes them respond to the structure by balancing. They can seek allies or mobilize and enhance their material capabilities. Militarily, internal-balancing constitutes of organizational, technological and doctrinal responses. States can innovate, emulate, counter-measure, or do nothing. A second-image reversed logic explains also the reorganization of the state before international constraint. The merit of the state's response does not change this logic.

The theoretical constructions of Neorealism or even state-building literature is not deterministic. A state can do as it chooses. If they fail to answer to systemic constraints, they will be punished by the competitive logic. Military responses were also analyzed in terms of some foundational strategic studies' concepts. These concepts are useful to

analyze the decision-making process regarding strategy, and to rise some instigating research fronts regarding its subcomponents and their relation to each other, as, for example, the role that technology plays in a subjective and non-deterministic clausewitzen analysis of strategy. Nonetheless, how does one operationalize an independent systemic variable in order to present a more objective relation between the structure and state response? What differentiates states in the IS is their relative position in the distribution of power. Systemic features will materialize objectively before a state as threats. The level of threat will have casual significance in determining state behavior. But how? In the next section, this debate is presented.

1.3- Threat, Technology and Innovation

Gourevitch (1978, p. 896) states that "the anarchy of the international environment poses a threat to states within it: the threat of being conquered, occupied, annihilated or made subservient. The obverse of the threat is opportunity: power, dominion, empire, glory, 'total' security". His reasoning follows to infer the second image reverse logic: "this state of war induces states to organize themselves internally so as to meet these external challenges" (GOUREVITCH, 1978, p. 896). As it was argued, the relative position of a state in the international distribution of power can be viewed jointly with qualitative aspects of the threat imposed. The most obvious characteristic of specific states is their geographical features. A more objective way of analyzing the level of threat, nonetheless, is to derive it from the distribution of power measured in terms of relative capabilities. The position of the state in the system's distribution of power will present the objective level of threat. Specific traits like geography or perception may be useful in analyzing more deeply specific cases, but are detrimental to a more theoretical systematic framework of analysis in terms of research methodology.

A states' response to structural constraint is a response to threat. The level of threat correlates to qualitative and quantitative aspects of the state's response. This study investigates the success or failure of large defense projects, consequentially, it investigates the military response, specifically in the form of the technological dimension of innovation. This chapter is dedicated to explaining the relation between the systemic influence and state military response. The level of threat represents the systemic pressure that presents itself before states. In a second image reverse logic, the level of threat is a determinant of state behavior.

The level of threat is proposed in this study as an independent variable explaining the outcomes of the large defense projects. Nevertheless, literature does not present a precise measuring standard of the level of threat. As threat is correlated to relative distribution of power, relative capabilities will be determinants of threat. Literature presents only some rough estimates to measure capabilities (WALTZ, 1979) – usually some sum of economic resources, population, territory and military assets. Therefore, the level of threat is usually treated in a qualitative manner, and, thus, it presents a complicated obstacle to variable operationalization. Resende-Santos (2007) argues that IR lacks a theory of threat, a concept very difficult to operationalize.

Authors have attempted to operate the level of threat variable developing theoretical constructs that would incorporate other factors to make the analysis more precise. Stephen Walt (1987) develops an instigating hypothesis in his balance-of-threat theory. According to Walt, states balance to threats. The author argues that some threats are more immediate and intense than others. In this sense, threats are posed in a dynamic scenario, and states respond to the pace and qualitative characteristics of threats. States will respond to the more serious and urgent threats. Walt identifies four components of threat: aggregate power, offensive military capabilities, geographic proximity, and aggressive intentions.

Resende-Santos (2007) relies on Walt's notion to construct a parameter for analyzing the level of threat. He argues that shifts in the aggregate power balance matter, but it is not the only variable determining level of threat. Resende-Santos argues that shifts in the level of threat can be consistently incorporated into the Neorealist structural theoretical framework, beyond a relative distribution of power analysis, incorporating three variables. For the author, the level of threat is a "function of a number of geostrategic factors, important among which are the state's relative military power, its geographic assets and liabilities, the offensive capabilities of the adversary, and the availability of external balancing options" (RESENDE-SANTOS, 2007, p. 86).

It was already stated here that geography will qualitatively entail the sort of threat. For example, Posen argues that geographically surrounded states will innovate and integrate its military doctrine more often since civilian will tend to intervene in military practices more often (POSEN, 1984, p. 79). Albeit geography provides a greater descriptive accuracy to the investigation and has been argued by many as a source of explanation to states' military behavior, it is not necessary to ad it as a component of the

level of threat. As for Stephen Walt's incorporation of the aggressive intentions as a component of threat level, one can argue that intention entails perception, and they are both problematic variables. One cannot systematically set apart intentions and capabilities as components of threat[21], since usually the former is only materialized in the light of the last. In empirical analysis of large defense projects, offensive capabilities as a concept is somewhat troubling. As argued by Diniz (2002), it is not possible to distinguish offensive from defensive technologies, since full defense implies elements of attack. Therefore, intentions and offensive capabilities will be not incorporated in analyzing threat levels in this dissertation.

If a state has options such as alliance making and buck-passing to shield a threat, or geographic imperatives alter the qualitative aspects of specific threats, geography and balancing options will affect the state's response to threats (RESENDE-SANTOS, 2007). But it is argued here that these elements do not have to be included as components of the *level* of threat, since they will alter primarily the *type* of threat and the characteristics of *states' response*. The level of threat can and will be measured solely in relation to the aggregate distribution of power. Once one determines how to operationalize the level of threat variable into the analysis, one has to identify how it relates to state behavior.

At this moment, it behooves this study to point out some hypothesis regarding state behavior and its relation to threat already investigated by literature. Posen (1984) investigates changes in the military doctrine through three dependent variables: a) choice between offense-defense-deterrence; b) doctrinal integration; c) doctrinal innovation. Posen applies two theoretical frameworks to test theory explanatory power in this study: organizational theory[22] and balance of power theory (or the neorealist model). Posen (1984) proposes that theory explanatory power is correlated to the level of threat. He argues that "in times of relative international calm we should expect a high degree of organizational determinism. In times of threat we should see greater accommodation of doctrine to the international system-integration should be more pronounced, innovation more likely" (POSEN, 1984, p. 80). The greater the threat, the greater the explanatory power of the balance of power theory. Propositions of the organizational theory such as conflicting interests and views among and inside bureaucratic organizations and resistance to innovation will lose importance in the light of greater threat. One can infer

[21] See: (SNYDER, 1984).
[22] Treated in the next Chapter.

from this analysis another hypothesis: the greater the level of threat, states will behave more as the unitary actors proposed by balance of power theory as opposed to the fragmented states identified by organizational theory. Elman (1999) tests the same theories regarding military response, and reaches similar conclusions, stating that:

> "There is evidence to support the conclusion that both models have something to offer in our attempts to explain how states react to other states' military practices (…) But in the long run, especially as the threat and severity of war increase, the neo-realist model comes into its own" (ELMAN, 1999, p. 97).

Both Posen and Elman sustain their theories in a second image reversed logic, since the pressures of the international environment affect state behavior. The authors' reasoning has a causal logic as it follows: with the growth of external threat, competition tightens, consequentially, states' civil leaders are compelled to centralize decision-making in defense. As the chain of command becomes more rigid and integrated, intra and inter organizational disputes and interests are mitigated, so the civilians can adequately respond to the growing threat, by mobilizing and distributing resources the best way they find feasible. This process will result in military innovation. The outcome of threat has organizational and state-building consequences. The causal argument is, then: level of threat > civil interference > innovation.

If the works of both authors are sound, one can expect also that the second image reversed propositions about state behavior in relation to threat have theoretical and empirical validity. Consequentially, the object of analysis in this study haves a relation to the level of threat. As this dissertation investigates the success or failure of innovations, it proposes a causal relationship between the level of threat and the outcomes of this type of balancing behavior. Resende-Santos (2007) proposes a hypothesis regarding specifically the thematic of this dissertation. According to the author, and fully endorsed by this study:

> "All competitive realms have built-in incentives for innovating, since the prospective payoffs of successful innovation are great. Emulation may bring security payoffs, but the payoffs from successful innovation are likely to be greater. Given the competitive advantages that result from successful innovation, states that possess the necessary material-technical-scientific capacity will innovate, all else being equal. The rate of innovation will increase with the intensity of competition. The international system, like the market, generates ceaseless technical and organizational innovation. The system is in constant motion because of it. Neorealism expects the system to display continuous innovation as a result of the striving and jockeying among contending states – constant striving and jockeying to avoid falling behind as a result of what others have done as well as in anticipation of what they might do. In other words, when we look at how states think about and practice

> innovation, their actions display both an action-reaction dynamic as well as a prisoners' dilemma dynamic" (RESENDE-SANTOS, 2007, p. 72).

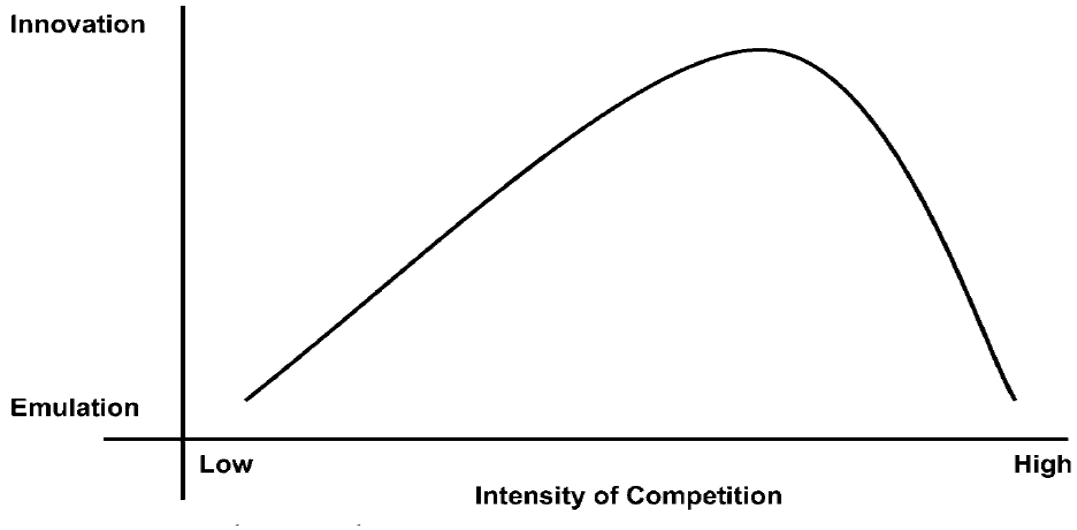
. The anarchic and competitive nature of the IS entails a security dilemma scenario and impels states to innovate continuously. The innovative balancing behavior will be greater when states are faced with threats. In this case, systemic pressure will enhance innovative pace and scale. Innovation's "timing, pace, and scale will correspond with the timing and magnitude of external threats" (RESENDE-SANTOS, 2007). Faced with danger, a state will have to successfully mobilize and extract resources in order to innovate. As it has been already held, those who fail to balance will be punished by the structures' imperatives. Nonetheless, innovation is one of the forms of balancing behavior and not all states innovate. In order to innovate, the state must have an extra margin of security and resource availability to maintain the regular military responses and assume the risk of innovating. These are innovative-capable states. One could reasonably expect that these states are, mainly, great powers. According to Resende-Santos:

> "Innovation is both expensive and risky. It is both time consuming and uncertain in results. States of primary capabilities are more likely to have not just the resource base but, more important, the extra margin of safety necessary to incur these risks. Secondary states have neither. Even the occasional secondary state that may have the resources and skills base may not have the extra margin of safety to risk innovation as competition increases" (RESENDE-SANTOS, 2007, P. 73).

Resende-Santos argues that the correlation between threat and innovation can be understood as U form graphic (Figure 2). Albeit competition and threat will increase the rate and scale of innovation, the author argues that this holds true up to a certain level of threat. When threat reaches this hypothetical parameter, states will become more risk averse and will rely mainly on emulation. Thus, paradoxically, increasing threat is both the cause that generates innovation and dampens it, as facing greater risk any being more risk-adverse actors, states will prefer, according to Resende-Santos, to count on existing strategies:

> "In this light, the emulation behavior of great powers comes into clearer view. Even for the great powers of the system, innovation is a product of a delicate balance between potential risks and prospective gains. As competition increases, we expect all states to be more risk averse, and thus opt for the certain and immediate payoffs of emulation. Given the risks and uncertainty that attend innovation, intensifying competition will dampen innovativeness" (RESENDE-SANTOS, 2007, p. 73).

Figure 1.2- Innovation, Emulation and Threat for Resende-Santos



Source: Resende-Santos (2007, p. 74).

Resende-Santos' reasoning seems to conform to logical-deductive standards. Nevertheless, there is a problem in his argument. The author contends that states, faced with growing threat, as long as they are innovative capable states– have an extra margin of security and resources– will innovate. Indeed, self-help in a competitive environment is the very cause of innovation. Albeit it seems reasonable that states will become more risk-averse in extreme competition, the author does not present a causality between the capability of innovation and threat. So, even facing growing threats, nothing apparently dictates that states will cease to have the extra margin of safety and resources that makes them innovatively capable. That means that if states continue having innovative capabilities, the parameter of threat presented by Resende-Santos that supposedly mitigates innovation does not actually determine it. The United States (U.S) was faced by an extreme growth of threat from 1939 to 1941 when Japan and Germany showed increasingly relative advantage in the distribution of power, finally compelling Roosevelt to enter the war after Pearl Harbor. This did not mean, however, that the U.S lost his extra margin of safety and resources, since the country continued to fully mobilize and grow its preparedness for war. Growing threat did not compel the United States to stop innovating. This hypothetical turn on the author's U curve is highly subjective and cannot be sustainably operationalized in analysis.

That being said, this study sustains that in a *ceteris paribus* scenario, threat will have a directly proportional relation with innovation, as it is the very structural incentive that causes it. Innovative-capable states will increasingly innovate in the face of

increasing threat. This relation is true for all three dimensions of military innovation-technological, organizational and doctrinal. Pace and scale of innovation will also increase in relation to increasing threat. It is argued here that factors like geography, perception, intentions and external-balancing options do not affect the level of threat in absolute terms, derived from the distribution of power.

Nonetheless, some factors do affect state-behavior. Geography, for example, affects the form of response. The United States, isolated in a bi-oceanic scenario, when faced with increasing threat, can be more prawn to develop a naval strategy, but that does not change the growing systemic pressure to innovate. The choice of other balancing strategies, however, seem to have a more substantial effect on states' response. The availability of balancing options can lead the state to seek for alliances and buck-pass, for example. Anyhow, these variables do not affect the level of threat *per se* or structural incentives to balance, they alter the form of response and the type of threat. Nevertheless, the balancing option variable insides directly on the states substantial choice to opt for more or less internal balancing. Balancing option, therefore, is a variable with qualitative and quantitative effects. One can argue that if a state has balancing options the level of innovation will be affected. Regardless of this effect, in theoretical terms, one can reasonably assume that this does not change the direct positive relation between threat and innovation in general terms. But in specific historically contingent processes of innovation, the option to balance can alter innovation's main aspects: level, pace, scale and timing. Therefore, another question of inquiry presents itself: how does the prospect of balancing options impact innovation? This investigation is beyond the scope of this research, although this problem will inevitably present itself in the empirical analysis of large innovative defense projects, and can be addressed marginally.

As it has already been stated, Resende-Santos (2007) points out the fact that success or failure of internal balancing lies beyond his investigation and can be theoretically and empirically fructuous to tackle such problematic. This research will engage in this analysis, treating success or failure of large innovative defense projects as its dependent variable. As this study primarily focuses on the technological dimension of innovation, it will attempt to correlate external threat to success or failure of large-cost long-term defense projects. It is argued that these projects are the material backbone of many cases of innovative internal-balancing behavior. However, a state has to properly mobilize its resources and the innovation has to be technologically feasible in order to

succeed. The more economical and technological aspects of innovation are addressed in Chapter 3 of this study.

1.4- What to expect?

Foreign policy and defense, as other complex political phenomena, have numerous possible determinants. Consequently, their analysis may include many variables. Nevertheless, how can one, standing before such complex reality, operationalize a framework of inquiry to make these phenomena tangible? That is the role of theory. Theoretical construction is an abstract and simplified version of reality and has no ambition to describe all of its nuances. To engage in theory is, thus, assuming the risk of oversimplification. Nonetheless, when analyzing large-scale defense projects, one cannot risk to omit a variable with the potential causal weight as international threat. The purpose of this chapter was, hence, to present the theoretical grounds which constructs the conceptual relations that demonstrate international constraint to state behavior or, more specifically, international threat positive causal relation to the success or failure of high-cost long-term defense projects.

Waltz makes few predictions about state behavior. However, his theoretical construction is useful for further developments on the subject. Regardless of the state's goals, it has to survive in a self-help and competitive environment. As the security-dilemma operates, states are expected to balance against threats. States can engage in external-balancing or internal-balancing. Internal-balancing refers to the state's effort in increasing and better administrating its internal resources, both human and material. In the military realm, emulation, innovation and counter-measuring are sorts of internal-balancing, which can be juxtaposed by a state and target specific or large-scale threats through technological, doctrinal and organizational dimensions of military practice. Internal-balancing behavior is embedded in a second-image reversed logic, which states that external pressures will have organizational and material consequences in the domestic arrangement of the state. Authors, (GOUREVITCH, 1978; HINTZE, 1975; ANDERSON, 1974; TILLY, 1990; ELIAS, 1993; MEARSHEIMER, 2001), among others, endorse the second-image reversed perspective, attributing external pressure to the source of state-building or state behavior. Military behavior is a mean to achieve political goals and strategy is the engagement for the purpose of war. The concept of military strategy allows the researcher to trace decision-making in the political-military chain of command. As it was argued, threat can have different components (WALT, 1990;

RESENDE-SANTOS, 2007), albeit some of them can have qualitative or even quantitative effects on state response, as in the case of external-balancing option, it behooves analysis to consider threat level in relation to distribution of capabilities as there is no objective measurement of the variable presented by literature. Deducting from the line of reasoning and theoretical framework presented in this chapter, this study can, at this point, present the main hypothesis regarding innovation and its relation threat level. To test the relation between the systemic independent variable (level of threat) and the dependent variable (success or failure of large-scale innovative defense projects), the main hypothesis of this chapter is:

Main hypothesis: Innovative-capable states will militarily innovate in a directly proportional relation to the level of threat, measured in terms of the relative distribution of power. Hence, *ceteris paribus*, the greater the threat level, the more likely an innovation will succeed. Large-scale projects, as the technological pillars of innovation, will be more likely to succeed in the face of high level of threat.

The debate put forward by external variable causal weight in state behavior also allows this dissertation to inquire other auxiliary hypotheses regarding the empirical object:

Auxiliary hypotheses:

a) Regarding the dimensions of innovation, technology has causal linear preponderance in relation to organization and doctrine, since substantial variation in the first can compel states to adjust the latter;
b) In a second image reversed framework, increasing level of threat will cause civilian interference in military decisions, which will, by consequence, generate innovation.
c) Pace, scale and timing of innovation will be related to the level of threat. The large the threat, the innovation will assume greater speed, scale and urgency.
d) One can falsify the U form model presented by Resende-Santos since we can reasonably assume that innovative-capable states do not stop innovating when faced with threat, because threat is the sole motivator of innovation.
e) External balancing options will affect scale, pace and timing of innovation, albeit it does not alter the systemic incentive for innovation, it may mitigate a state's choice to adhere to internal-balancing, thus, causing a negative effect in the success of innovation.

The hypotheses outlined above will be investigated in the empirical chapters of the present dissertation. In the subsequent chapter, this study turns its attention to theoretical insights which look to defense and foreign policy from the domestic level perspective. In accordance to the proposal of Chapter 2, this study will treat the investigation of domestic politics as an independent variable. This exercise will allow this dissertation to elaborate hypotheses regarding success or failure of large-scale defense projects from a domestic politics perspective.

CHAPTER 2- DOMESTIC POLITICS AND DEFENSE DECISION-MAKING

"(...) decisions typically reflect considerable compromise. Compromise results from a need to gain adherence, a need to avoid harming strongly felt interests (including organizational interests), and the need to hedge against the dire predictions of other participants (...)"
(ALLISON, HALPERIN, 1972, p. 52)

"If this book has any distinctive message, it is military policy can only be understood as the responses of the government to conflicting pressures from its foreign and domestic environments (...) Military policy cannot be separated from foreign policy, fiscal policy, and domestic policy. It is part of the warp and woof of American politics"
(HUNTINGTON, 1961, p. 67)

Scholars have pointed out that the domestic and systemic levels are interrelated (KATZENSTEIN, 1976; PUTNAM, 1988) and have impact on one another. Here, this is not denied. However, while Chapter One argued, the relation between threat level and innovation, building exclusively from a systemic perspective, this Chapter develops its hypothesis and derives another independent variable from the domestic angle. It is shown that this way of theoretical framework development behooves the treatment of the dependent variable (success or failure of large-defense projects) since causation can be more clearly seen, hence, turning investigation and thus empirical hypotheses testing, more tangible.

It is maintained in this Chapter that a necessary "degree of consensus" between the Executive and Congress, taking into account its senior decision-makers, is a condition for the success of large-scale projects. This hypothesis is formalized at the end of the Chapter. However, since there are many theoretical developments and variables utilized by scholars to analyze the impacts of domestic and intragovernmental politics, this Chapter engages in debate with authors and models which address the issue. It is argued that building this theoretical framework does not entail the objective of a general model of foreign policy decision-making or defense, albeit some of the points outlined here can be further developed and applied to different issues apart from the one treated in this dissertation.

Decisions usually revolve around a structure, main actors, processes and issues. The previous chapter addressed the systemic structure. In this Chapter the main actors are analyzed. Processes and issues appear throughout the four first Chapters of this

dissertation, albeit Chapter 4 gives special attention to process and Chapter 3 to issues. From the complex and wide range of variables and actors it will be argued that the relationship and consensus needed among main actors can be operationalized within parameters for objective comparison. Similar to Chapters 1 and 3, auxiliary hypotheses will also be outlined, in the light of theoretical debate, to provide guidance to be tested in the empirical case-studies.

2.1- Presidents, Bureaucrats and Decision-Making

In a presidential republic, founded in the light of the decay of absolutism in Europe, the historical and present role of the Executive and its leader has naturally drawn the attention of scholars. Especially, since the system is guided by a "checks and balances" logic, the question of the extent of the Presidential power is indispensable for understanding US politics.

The first point made here is that one person has a physical limitation in dealing with the entire political agenda presented before him and dedicate the necessary attention to optimize- in terms of instrumental rationality[23]- all decisions (SIMON, 1972)[24]. The source of information and options presented for the Present to decide is, thus, extremely important. Another major issue is the question of who influences and mediates presidential decisions, contest them and alter their outcomes. The present section is primarily dedicated to this discussion.

Amongst the first to tackle this issue was Robert Art (1973) calls the *first wave* of Bureaucratic Politics (BP), which included the works of Neustadt (2008), Schilling (1961) and Huntington (1961). These authors argued that political power, as the ability to get someone to do something he would otherwise not do, is pulverized and dispersed in national government. In this section, the study reviews some of the arguments made by these authors and further developments and criticisms, especially drawing attention to Allison's (1969) systematization of BP.

Schilling (1961) analyzed the response of the United States' government to the explosion of a fission bomb by the SU, in 1949. In this case, possible policies and

[23] For a review on instrumental rationality, see: Martin Peterson (2009).

[24] Herbert Simon (1965) claimed that cognitive models assume that decision makers have limited information processing capabilities. Instead of objectively searching all information for the best outcome, decision makers will select an alternative that is acceptable or "good enough."

considerations were produced as the result of five months of debate and deliberation between the State Department, Office of the President, DoD, Atomic Energy Commission (AEC) and the Joint Committee on Atomic Energy of Congress. Despite the technological feasibility issues (requirement of large amount of tritium, for example), the DoD sustained a firm position of securing powerful weapons as a need to maintain deterrence. On the other hand, the State Department, the AEC and the GAC made recommendations against the developing of the H-and A bombs, through questioning its real utility in terms of effective engagement. Once the President made his decision, he distributed tasks for each of the organizations involved, albeit not endorsing a large-scale H-bomb program. According to Schilling (1961, p. 37): "the President did make choices, but a comparison of the choices that he made with those that he did not make reveals clearly the minimal character of his decision". Schilling (1961) argues that the H-Bomb is one of the many examples that reveals the dispersed power structure of decision-making in the United States, which different actors have to reach a form of "consensus" so that a given policy is implemented. The logic of the argument consequence is that a minimum acceptable decision to the players generates the outcome. According to the author (1961, p. 43):

> "The continuous winnowing and worrying of the same old issues is an inevitable consequence of a political process that depends on the voluntary cooperation of independent and competing elites for the formulation and conduct of policy. Major policy changes can, for the most part, be effected only through incremental change"[25].

Similarly, in his seminal work about presidential power, Richard Neustadt (2008) questions the extent of the decision-making power of the President. He argues that there is a sharp difference between the constitutional and legislative powers attributed to the President and the costume, or *modus operandi,* of the real political process. According to Neustadt, to share power is to limit it, and what he sees in the President is weakness (in the sense of what is expected from the President versus the guarantee of what can be done). Neustadt argues that the President is an employee, but a valuable employee, which others may depend on the future and thus have to bargain with caution. Members of the Executive, Congress, parties, international actors and the population might have to count on the President, but the other way around is also true. The President's power lies on persuading other actors that what the White House wants is also what those actors pursue.

[25] This argument is strongly associated with Incrementalism, a public policy theory which will be further explored in Chapter 4 of this dissertation.

Furthermore, bureau chiefs and specialists have a strong power to hold and influence the President's mood. According to Franklin Roosevelt (apud NEUSTADT, 2008, p. 75):

> "The Treasury is so big and open and embedded in its own practices that I think it is almost impossible to achieve the results I want– even with Hans Morgenthau there. But the Treasury does not even begin to compare with the State Department. You should pass through the experience to try to change the minds, policies or action of career diplomats and then you would know what is a problem in fact. But the Treasury and the State Department together do not even compare to the Navy. It is needed to know how to deal with Admirals, - and I should know that. To change anything in the Navy is like punching a feather blanket. You knock with the right and with the left until you are exhausted and then you realize that the blanket remains exactly the same as it was".[26]

Nonetheless, Neustadt (2008) argues that, besides from bargaining advantages with other players, professional reputation and public prestige can enhance the influence of the President. Furthermore, Neustadt (2008, p. 53) states that an effective order from the President can occur once three criteria are met: i) the order is widely spread; ii) the people who received the order had the full control needed to execute it and; iii) implementers do not question the President's authority.

Samuel Huntington (1961) argues that strategic decisions and meaningful policy require content and consensus. In confluence with Neustadt's arguments, Huntington holds that building consensus is a *sine qua non* condition in policy implementation, but has costs for all actors involved in the decision-making process. Consequently, the *initial intent* of actors is not precisely the nature of the outcome of the compromises, which can be unintended or unforeseen. According to Huntington (1961, p. 167):

> "If this book has any distinctive message, it is military policy can only be understood as the responses of the government to conflicting pressures from its foreign and domestic environments (…) Military policy cannot be separated from foreign policy, fiscal policy, and domestic policy. It is part of the warp and woof of American politics".

Hilsman (1992) lays out the role of the bureaucracies in decision-making. According to the author (1992, p. 179) "bureaucracies are centers of power". Their power relies on its specific jurisdiction and rules, which provide a specific technical competence

[26] Translated by the author from the Brazilian's version of Neustadt's book. Original: "O Tesouro é tão grande e tão aberto e está tão entranhado em suas próprias práticas, que acho quase impossível conseguir a ação e os resultados que desejo- até mesmo com Henry Morgenthau lá. Mas o tesouro nem se compara ao Departamento de Estado. Você deveria passar pela experiência de tentar obter quaisquer mudanças no pensamento, nas políticas e na ação de diplomatas de carreira e então você saberá o que de fato é um problema. Mas o Tesouro e o Departamento de Estado juntos não são nada comparados à Marinha. É preciso saber lidar com os almirantes- e eu deveria saber isso. Mudar qualquer coisa na Marinha é como dar socos em um cobertor de penas. Você bate com a direita, e você bate com a esquerda até ficar exausto, e então você constata que o maldito cobertor está do mesmo jeito que estava antes de você começar a bater.

and special training, expertise and experience. Beyond that, organizations have interests of their own and functionally act as policy makers, legislators and innovators: "Make policy, apply policy, decide implementation, interpret legislation, make some of the rules (…) thus the bureaucracies have power- lots of power (…) Some are more subservient to the president and some are more independent" (HILSMAN, 1992, p. 184). Presidents, thus, share power with bureaucracies by political appointees in the high levels of the executive to mediate the relationship between the White House and the bureaus.

Special examples of powerful bureaucracies are the Central Intelligence Agency (CIA) and the Military. The first holds the legal monopoly of espionage, secrecy and the possibility to withhold indispensable information, allowing the CIA to pursue its own policies. As for the Military, huge budgets and real physical power and close ties with industry, Congress and its constituencies, make it a threat to democracy itself (HILSMAN, 1992; HUNTINGTON, 1967)[27]. Civilian-Military relations[28] are further addressed at the end of this chapter, since they are important for consensus building and policy implementation.

2.21- The Bureaucratic Politics Model

Building upon the insights of the previously discussed authors, BP theorists Allison (1969) and (ALLISON, HALPERIN, 1972) develop what they call a "systematic statement of basic assumptions, concepts, and suggestive propositions, or, in their conception, an analytic paradigm" (ALLISON, HALPERIN, 1972, P. 44). Their work consists of building two models (Model II and III) to tackle the issues they appoint as neglected by the predominant paradigm of analysis at the time of their study (Model I). The development of these authors framework is central to this chapter as the latter discussions in decision-making after their work, at least in some sense, dialogue critically with their BP model. Beyond that, as it is the purpose of this chapter to address hypotheses from a domestic political angle, it is argued that the BP model proposes a series of

[27] According to Brooks (2019, p. 381): "On the one hand, the military is a regime and state's chief protector. A regime's military is its last line of defense against its internal opponents and must repress both civilian protesters and armed rebels when needed. It also defends the state against foreign threats and external challengers in armed conflict. On the other hand, the military is also a regime and state's chief threat and source of insecurity. A military can turn its guns on the government and remove leaders by force, or compromise the state's security by losing on the battlefield (…) States must ensure the military is both submissive to civilian authority and effective in armed conflict. Much research on civil–military relations in political science seeks to address some aspect of that central dilemma".

[28] For a good appraisal of the subject, see: (FEAVER, 1999; 2016; PION-BERLIN D, 1997; MARES, MARTÍNEZ, 2014).

propositions and concepts that generate important research issues concerning the main thematic put forward by this dissertation.

The BP model is built upon its criticism to the analysis of what Allison calls Model I, or Rational Policy Model. According to the author (ALLISON, 1969, p. 692-695), Model I assumes the State as a monolithic actor that selects actions in foreign policy by maximizing its strategic goals and objectives. From a range of options to respond to the international environment, this model, consequently, presupposes a cost and benefit, rational value-maximizing choice by the state "whose consequences rank highest in terms of his goals and objectives". The outcome, thus, is analogous with neoclassical economic theory of consumer and firm choice. The alternative proposed by Allison is composed of a Model II (organizational model) and a Model III (bureaucratic model) which he uses to "confront" empirically Model I in a "least probable case", the Cuban Missile Crisis, since it is "a crisis decision, by a small group of men in the context of ultimate threat *and thus* this is a case of rational policy model *par excellence"* (ALLISON, 1969, p. 691; italics added.

Allison argues that according to Model I the blockade was the US' only real option. Nonetheless, the author states that this was not the case, and the decision-making process needs to include organizational and bureaucratic outputs in order to proper evaluate the issue. Allison (1969, p. 695) argues that Model I has the tendency to adapting to situations in which attempting to explain a number of occurrences and a great deal of information, rational policy model uses *ad hoc* foreign policy analysis and often invokes the notion that a "mistake" was made if the model fails to explain the decision outcome. Allison and Halperin (1972, p. 707) argue that the "the leaders who sit on top of organizations are not a monolithic group". Instead, government is composed of organizations and individuals that engage in competition, bargaining through different channels and thus: "government decisions *are made* not by rational choice but by the pulling and hauling that is politics (…) The apparatus of each national government constitutes a complex arena for intra-national game" (ALLISON, HALPERIN, 1972, p. 707; italics added). In accordance with previous insights, the authors argue that power is shared, and each player has considerable discretion in a decentralized decision-making process. Policy outcomes "is sometimes the result of the triumph of one group over others. More often, however, different groups pulling in different directions yield a resultant distinct from what anyone intended" (ALLISON, HALPERIN, 1972, p. 707).

Building on this rupture with Model I[29] and alternative insights, BP engages in formulating a Model, which includes organizations as determinants of policy outcome.

The Organizational Model (Model II) states that the options presented to high level decision makers are the result of dispersed organizations, which usually operate through Standard Operation Procedures (SOPs), have different parochial priorities, perceptions and issues and that "government leaders can substantially disturb, but not substantially control, the behavior of these organizations" (ALLISON, 1969, p. 698). Organizations will usually pursue maximizing their budget, prestige and protect their parochial task (e.g., flying in the Air Force). SOPs usually result in inertia, dramatic changes occur on condition of periods of budgetary feast, periods of prolonged budgetary famine or performance failures (ALLISON, 1969, p. 701). According to the author, coordination between organizations are, therefore, difficult.

Nonetheless, Allison and Halperin (1972) argue that Model II is also insufficient, and has to be complemented in order to understand outcomes of foreign policy decisions. Model III, or the BP model, therefore, enhances their "analytic paradigm". In BP, the main unit of analysis are actions of the government, which include a number of dispersed decisions internal to the government, in which players move through decision games, to policy games and action games. In order to explain policy outcomes, thus, Allison and Halperin (1972) introduce concepts regarding who plays, what determines the player's stand and how these are aggregated to yield decisions and actions of a government.

Regarding relevant actors, Model III highlights senior players of national security policy. "This circle includes the major political figures, the heads of major national security organizations, including intelligence, the military and, for some purposes, the organization that manages budgetary allocations and the economy" (ALLISON, HALPERIN, 1972, p. 47). The authors do not neglect the importance of the President, which they state that has a range of interests and formal powers that set him apart from

[29] Model I, according to Allison and Halperin (1972, p. 42): "this simplification- like all simplifications- obscures as well as reveals. In particular, it obscures the persistently neglected fact of bureaucracy: the maker of government policy is not one calculating decision-maker, but rather a conglomerate of large organizations and political actors who differ substantially about what their government should do on any particular issue and who compete in attempting to affect both governmental decisions and the actions of their government".

other players. Around this senior player "circle" the authors highlight what they call "junior players":

> "(…) Congressional influential, members of the press, spokesmen for important interest groups, especially the "bipartisan foreign policy establishment" in and out of Congress, and surrogates for each of these groups) can enter the game in a more or less regularized fashion. Other members of the Congress, the press, interest groups, and public for concentric circles around the central arena- circles that demarcate limits within which the game is played" (ALLISON, HALPERIN, 1972, p. 47).

Junior players may deviate decisions through actions, albeit senior players dominate the decision games. As this study investigates large-scale defense projects, it is essential to trace the senior players in the respective arena, since "the mix of players will vary depending on the issue and type of game" (ALLISON, HALPERIN, 1972, p. 47). As for what determines the stand of players, the authors argue that his perceptions and preferences stem both from his individual characteristics (…) and his position. Allison and Halperin (1972, p. 48) organize players' interests in four headings: national security interests; organizational interests; domestic interests, and personal interests. Players will move through action channels to pursue their desired result. According to the authors (1972, p. 50):

> "Each player's probability of success depends upon at least three elements: bargaining advantages, skill and will in using bargaining advantages, and other players' perceptions of the first two ingredients. Bargaining advantages stem from control of implementation, control over information that enables one to define the problem and identify the available options, persuasiveness with other players (including players outside the bureaucracy) and the ability to affect other player's objectives in other games, including domestic political games".

Beyond the elements highlighted above, success depends on power *per se*: formal authority, control over resources, control over information, among others. According to the authors, constraints to actions stem from SOPs, the supply of information and "shared values within society and bureaucracy" (ALLISON, HALPERIN, 1972, p. 52). Five suggestive propositions derive from the interactions among players in the authors' work:

> "(…) i) decisions of a government seldom reflect a single coherent, consistent set of calculation about national security interests; ii) decisions (…) assign specific actions should be taken; iii) decisions typically reflect considerable compromise. Compromise results from a need to gain adherence, a need to avoid harming strongly felt interests (including organizational interests), and the need to hedge against the dire predictions of other participants; iv) decisions are rarely tailored to facilitate monitoring. As a result, senior players have great difficulty in checking on the faithful implementation of a decision, and: v) decisions that substantial changes in action typically reflect a coincidence of: a deadline for a President or senior players that focuses them on a problem and fuels the search for a solution and; the interests of junior

> players committed to a specific solution in search of a problem" (ALLISON, HALPERIN, 1972, p. 53-54).

Beyond that, and especially important for the purposes of this investigation: "Those who opposed the decision, or who oppose the action, will maneuver to delay implementation, to limit implementation to the letter but not the spirit, or even to have the decision disobeyed" (ALLISON, HALPERIN, 1972, p. 53). In large-scale defense projects, delays and budget or organizational limitations can be crucial for their success or failure.

At this point, it is necessary to affirm that albeit BP provides a powerful paradigm for the analysis of decision-making there are some elementary issues to be outlined. "Shared values and perceptions", "self-interested individuals" and "the stand of a player depends on his seat" are not necessarily contradictory. However, they difficult theoretical building, in the sense of applying methodologies drawn from a conceptual framework towards an operationalizing analysis in real life situations. The richness of process description can limit focused studies to excessively historical, idiosyncratic accounts. Nonetheless, some propositions outlined by BP are powerful and hypothesis generating, applicable to a large number of case studies, which may vary on issue, space and time. From what this study endorses in BP, alongside with the theoretical discussion proposed in this chapter will result in the main and auxiliary hypotheses to investigate large-scale defense projects. As a natural result of the provocative and insightful paradigm put forward by BP, it instigated a large number of critiques, debates and empirical studies in the decades that followed.

2.22- BP Early Criticisms and Epistemic Developments

Krasner (1972) argues that in applying its propositions, BP is misleading and has practical consequences, namely as relieving individuals of responsibilities and thus giving them excuses for failures. He (1972. p. 161) states that "what sense to vote a man out of office when his successor, regardless of his values, will be trapped in the same web of only incrementally mutable SOPs?" (KRASNER, 1972. p. 161). Krasner argues that the behavior of states is determined by leadership values, and SOPs are a needed rational procedure to coordinate policies. Furthermore "an emphasis on the procedural limits of large organizations cannot explain non-incremental change" (KRASNER, 1972, p. 164). Krasner's criticism focuses on the power of the President and that policy is oriented by values and beliefs. Concerning the President, Krasner (1972, p. 167-169) states that:

> "Through the budget the President has a direct impact on that most vital of bureaucratic interests. While a bureau may use its societal clients and congressional allies to secure desired allocations, it is surely easier with the President's support than without it (…) The success a bureau enjoys in furthering its interests depends on maintaining the support and affection of the President (…), bureaucratic analysts ignore the critical effect which the President has in choosing his advisors, establishing their access to decision-making, and influencing bureaucratic interests (…) The ability of bureaucracies to independently establish policies is a function of Presidential attention. Presidential attention is a function of Presidential value (…) Within the structure which he has partially created himself he can, if he chooses, further manipulate both the options presented to him and the organizational tools for implementing them".

In the same direction, Robert Art (1973) argues that a President, when he deems an issue of great salience, he can control bureaucracy and ensure his intent will be realized. According to the author (1973, p. 478): "organizational procedures can cause slippage, but they do not automatically or mechanistically do so. Whether they do so depend on the President's degree of determination not to permit them to do so".

It is argued in this dissertation that these authors ignore precisely the point in what BP scholars engage: What sustains presidential power? What makes millions of people to entrust constitutional powers to one person? Is it not reasonable to assume, without having to demerit ideological motivations or faithful actions, that people have tangible and material interests? Would not these people expect the executive to meet their interests? Presidents sit on a privileged position and are a unique actor and BP researchers never denied it. Nonetheless, presidents have to offer in order to achieve, they depend on a complex and vast network of decision-makers, amongst them, *veto players* (TSEBELIS, 2002). The consequence is the inevitable bargaining game, including by the President, in the domestic arena.

Furthermore, Krasner (1972, p. 169) argues that "objectives are ultimately a reflection of values, of beliefs concerning what man and society ought to be". The author also states that "for both the missile crisis and Vietnam, it was the "baggage" of culture and values, not bureaucratic position, which determined the aims of high officials" (1972, p. 166). In his critique, which he calls "Allison's Wonderworld", Krasner argues that "Adherents of the bureaucratic politics framework have not relied exclusively on general argument. They have attempted to substantiate their contentions with detailed investigations of particular historical events" (1972, p. 169).

This dissertation contends that *outcomes* as a reflection of "values, beliefs, or culture" of decision-makers are much more problematic and contingent driven in terms

of a framework for analysis. Can one precisely infer intentions or beliefs relying solely on speeches, decisions, or actions? Personality traits, apart from having to rely on profound psychological and neurological tracing techniques, albeit argued possible with the emergence of recent techniques and concepts[30], are also and further circumscribed by historical particularities. However, this study does not engage in ontological discussions concerning specific persons.

One the other hand, a valid criticism put forward by Art (1973) is the failure of bureaucratic politics to offer a response to the level and circumstance of deviation from presidential decision by BP. Freeman (1976) argues that BP gives too much emphasis at a middle range bureaucratic in-fighter, pursuing descriptive accuracy of all the actors involved, and neglecting the power structure. According to Freedman (1976), there is a false dichotomy in BP between logics and politics. He states that politics can consist, not only of competition between contradictory interests, but of coalition building, lag-rolling and repression. The power structure resultant from politics that underlines government interest and decision, Freedman (1976) argues, can be compatible with a rational/logic driven model. A power structure depends on the distribution of power resources among group interests[31]. Freeman (1976) highlights the President's privileged position in the control of power resources, even if acknowledging that "strategic resources can be used to create tactical resources, but it should be emphasized that they cannot provide total control" (1974, p. 448). Beyond the ability to anticipate all pivotal issues, the sheer pressure of the Congress or the Military, for example, are in a position to resist policy-making. Freeman's central critique (1976) is that deviation by pulling and hauling should not be the focus of analysis, as the power structure can provide a stability of policy, following from a defined "national interest". From the point of view of this study, Freeman's study does not necessarily contradict BP perspective in this sense, since authors such as Hilsman (1992), Neustadt (2008), Huntington (1961), Schilling (1951), Allison and Halperin (1972) did not deny the important role of the presidential position nor a need to build a compromise, or a winning coalition, in the decision-making process.

[30] An important breakthrough on these techniques was put forward by: (WALKER, SCHAFER, YOUNG, 1998).

[31] According Freeman (1976, p. 447): "The particular structure of power will depend on the distribution of those power resources that can be utilized in the furtherance of group interests. The outputs of the policy-making process can be said to reflect the relative strengths of those involved, so that stability in a power structure will result in a certain stability of policy".

The difference rests in the relative importance given to intragovernmental disputes in the bureaucratic arena, and the level of deviation from decision towards implementation, which can only be settled by a large range of empirical studies, including the one of this dissertation.

Rosati (1981) studying the SALT I (Strategic Arms Limitation Talk) negotiations in both Johnson's and Nixon's administration makes an important contribution towards an analytical framework which incorporates the distinctiveness of the President, BP and "Local Dominance", correlating the importance of the former three with two variables: i) criticality of the issue and; ii) presidential involvement. The result is the following:

Table 2.1- Rosati's Appraisal of actor's dominance

Resultant	**Variable 1: Criticality of issue**	**Variable 2: Presidential involvement**
Presidential Dominance	Highly critical Issue	High Presidential involvement
Bureaucratic Dominance	Intermediate critical issue	Organizational and Individual involvement is high and Presidential involvement is low

Source: (ROSATI, 1981).

Nonetheless, in the decision-making process *per se,* Rosati adheres to the subjectivity and hard instrumentalization, in terms of research, of the already discussed introduction of "the beliefs, personalities, and modes of thinking of the participants will have a direct effect on the decision-making process" (ROSATI, 1981, p. 251). Albeit the important point made by Rosati regarding the decision context in terms of crisis and time available for decision, he also relies on "the importance of values as perceived by the decision-makers" (1981, p. 248) in a specific situation. It is important to restate that this study does not deny the importance of these factors. It is only highlighted here the circumstantial character of this kind of approach if one were to investigate a case, or set of cases, and that it behooves scientifically to address decision-making in defense decisions, specially resource decisions, to draw a *ceteris paribus* clause in this sense.

2.23- Recent Developments and Reviews Regarding BP

The debate put forward by the first critiques regarding the source of a player's stand was carried on throughout the 1990's. Art's argument questioning how one can infer that a player stand depends on how he seats if people occupying the same seat make different kinds of decisions was endorsed by Welch (1992;1998). Welch (1992, p. 122) argues that "if the idiosyncrasies of particular individuals determined these important actions and policies, specifically bureaucratic determinants can hardly have played an important role"[32]. According to Welch (1992, p. 122), the same "problem" in BP's development is reflected in the decision-making process, since "bargaining skills and advantages" are also idiosyncratic. Allison (1969; 1972), in large issues like budget and procurement- a player's stand can be predicted with high reliability. In this regard, Welch (1992, p. 132) argues that "if preferences and positions correlate strongly with positions only on such issues as budget allocations and turf battles, then Model III's explanatory power would seem to be extremely limited". Nonetheless, if Allison's Model has predictive power regarding the stands of important players in issues like budget and procurement issues, for example, it is argued here that the model, is instead highly powerful. Budget and acquisition is the material basis for a wide range of issues (e.g., capacity building; geopolitical aid; burden-sharing amongst alliances; human and capital resource mobilization).

Welch (1998) argues that whilst BP has remained a fruitful paradigm for students of decision-making, it has failed in the sense of theoretical development. The author focuses his criticism in the already mentioned problem of determining the interest of players and organizations. He argues that "–exactly how does one disentangle organizations and officials' preferences and power – and likewise, raises sob interesting and thorny ontological questions" (WELCH, 1998, p. 214). Nevertheless, while stating the obvious "(…) the chief obstacle (…) explanations of state behavior remains deciding what to put in it and what to exclude (WELCH, 1998, p. 212)", Welch proposes a "menu" of endless possible concepts and variables to introduce into an improved BP paradigm. Finally, the author states that a useful paradigm must develop theories that "are logically consistent with their axioms and assumptions, employ only operational concepts, and permit the derivation of falsifiable hypotheses" (WELCH, 1998, p. 141). However, while

[32] Welch (1992, p. 129) states that "for every Winston Churchill or Caspar Weinberger there is a James Watt or Anne Burford whose attitudes and actions prove to be antithetical to the interests and preferences of the organizations they represent".

trying to focus in the determination of a player's position and focusing his criticism towards this "gap" in BP theory, Welch moves even farther than from the development of what he states as a useful paradigm.

Hart and Rosenthal (1998) argue that the BP approach is more fruitful in balancing explanatory scope and in-depth process knowledge to manipulate variables then theories which would try to account the whole governmental politics, as the latter could not develop a distinction between actors and context. However, they propose that BP should be analyzed from a dependent variable point of view as well, since most studies utilize it as an independent variable which affects outcomes. Hart and Rosenthal 1999, p. 237) hold that treating BP as a dependent variable "is necessary before one can correctly appreciate its impact. We should study why BP manifests itself more frequently and differently in some issues, policy domains, or countries than others". From this perspective, they argue that the driving forces which result in BP:

> "The bureaucratic division of labor within the executive branch is the driving force of BP (…) political attention and limited resources have to be divided among them. This view sits well with evidence from social psychology, suggesting that it takes very little to create self-sustaining tensions between members of different faction within a larger collectivity. (…) but hardens when bureaus succeed in recruiting their political masters to join the fight at the cabinet level. It is in this world that relations between bureaucrats and politicians are purely hybrid. (…) Soon the political leaders embrace their respective departments view of things, and find themselves opposing one another more along bureaucratic than ideological and party lines" (HART, ROSENTHAL, 1998, p. 237).

Hart and Rosenthal's study is insightful, from the point of view developed here, since it points out for what is considered here the main contribution of BP: that there are conflicting interests among inter-governmental individuals and organizations and this affects the outcome and the process of decision-making.

BP politics has resulted in a variety of studies, some of which tested in case studies (BEARD, 1976; BERGERSON, 1980; HALPERIN, KANTER, 1973; RHODES, 1994; MCKEON, 2000), questioned its internal logic (BENDOR, HAMMOND, 1992) or endorsed partially and proposes further developments (ROSENTHAL, 1990; GRINDLE AND THOMAS, 1991; ROSENTHAL *et al.*, 1991; ROSATI 1981; AUERBACH ET AL, 1981; ANDEWEG, 1993). This Chapter started with the BP discussion since it is central to the domestic level overall and auxiliary hypotheses presented at its end. Nonetheless, it benefits this study to present other models of decision-making developed by the epistemic community in order to raise important issues and enhance critical dialogue

regarding decision-making. First, a problem-raising section will be presented regarding the choice of variables in decision-making. The last section dialogues with three alternative models of decision-making. Put together, these two sections are aimed at enhancing and problematizing the BP discussion in order to develop and sustain the domestic theoretical framework of analysis and hypotheses conducted by this study in its empirical cases.

2.2- Political Science: The question of who Decides

This section intends to be transitional and problem-raising as it deals with the issue of decision making in more abstract terms. Since its establishment as a distinct field science, Political Science has engaged a fundamental issue: Who decides? In other terms, who rules and who obeys: "one of the greatest themes of political analysis and, as it sums up, maybe the most significant, is to determine who actually governs society" (MEYNEUD, apud BOBBIO, 2016, p. 222-223)[33]. As if it was not complicated enough, while studying politics, one has to attend to other fundamental issues: i) difference of governing actors among issues; ii) the process of deciding; iii) the constrains and context of ruling, both internal and external to the society in question. The development of academic research in the twentieth and twentieth-one century has shown that the choice of actors, even among methodologically solid driven research, involves a necessary level of arbitrariness by the student of politics.

From a more general theoretical building perspective regarding decision-making in politics as a whole towards more recent developments regarding specifically

[33] For good examples, see: (TRUMAN, 1971; DAHL, 1967; MILLS, 2000; OLSON, 1965; WALKER, 1991; MCFARLAND 2004; SCHATSHNEIDER, 1975). In Political Science, there is a long tradition of theoretical production regarding the domestic struggle for power from Dahl's pluralist to Mill's elitist perspectives. Elite theory, for example, has its roots in the end of the nineteenth century with Italian authors such as Gaetano, Mosca and Pareto, who searched for a general positive theory of Social Science. For a better understanding of Elite Theory in the Italian tradition, see: (BOBBIO, 2016). Mill's theory of elites was focused on the high ranks of United States' society, where he argued that power was concentrated on the military, political and economic elites. However, the most interesting aspect of Mill's theory was his extensive empirical investigation which revealed the origins of the members of the "Power Elite" had solid social ties which permitted the same people to circulate amongst positions in the military, government and private sector and, hence, gave them a greater cohesion (MILLS, 2000). This perspective was previously utilized by this author (DALL'AGNOL, 2018) to analyze Reagan's economic and military policies. Nevertheless, it is argued here that the elitist tradition is more fruitful for the analysis of decision making in more general terms, applied to investigate the general direction of policy-making. Theories of the Military Industrial Complex, or the "Iron Triangle" have a similar argument as the one put forward by Mills, see: (DOMBROWSKI, GHOLZ, 2006; MEDEIROS, 2004).

disciplines dedicated to Foreign Policy decision-making, the debate become complex and widened in terms of variables, issues, actors and levels of analysis.

Different studies point out to a wide range of possible conditioning factors of foreign policy. This applies both to the domestic and international level of analysis. Authors like Wallace (1982), Stein (1991) and Mesquita (2003) give weight to causality between dissuasion, arms race and alliances, respectively, and foreign policy making. At the domestic level, while authors like Alex Mintz and Karl de Rouen (2010) point out to five main variables: i) economic interests; ii) public opinion; iii) two level games; iv) electoral cycles, other authors such as Hudson (2014) emphasizes the leader's role, bureaucracies; cultural and identity perceptions, group dynamics, national attributes, among others. Hellen Milner (1994) stresses actors' interests, domestic institutions and information distribution among decision-makers[34].

Regarding units of analysis, according to Mintz and de Rouen (2010, p. 18-21), they can be approached by FPDM (Foreign Policy Decision-Making) in a threefold manner: the individual, groups and coalitions. The previous section already discussed in a sense the first unit of analysis, the individual, by approaching the President's role debate. Nonetheless, recent developments on the field investigate personality, cognition and perceptions of important individuals in foreign policy decision-making. There is a strong interdisciplinary relation, thus, with compartmental psychology and neuroscience. Margaret Hermann (1991), for example, argues that individuals have a preponderant role in crisis situations, as for example a war declaration decision.[35]. At a middle-range analysis, groups have proven to be fruitful in terms of units of investigation. The dynamics of group decisions can be applied to important decision-making instances of foreign policy, such as the NSC. Important concepts such as *groupthink* (JANIS, 1982), for example, that internal group dynamics leads groups to be excessively self-confident, and, by consequence, to make suboptimal decisions – have been developed through this lenses of analysis. As for coalitions, individuals cannot decide by themselves. There is the necessity of bargaining amongst different sectors in order to build a coalition capable

[34] Several other domestic factors which influence foreign policy were identified by literature such as class struggle, elite role, institutional structures, among others. For a solid review, see: Chris Alden and Amnon Aran (2017, p. 63-67).

[35] For a systematic literature review of the individual's role and psicology in FPDM, see: Alex Mintz e Karl DeRouen (2010) and Chris Alden e Amnon Aran (2017).

of implementing foreign policy. Hagan (2001) introduces the concept of *minimum-winning coalition*, which refers to the minimum necessities to maintain a coalition in power. Literature that investigates coalitions, therefore, dialogues with the study of elites. A relatively recent theoretical development on this unit of analysis, the Advocacy Coalition Framework (ACF), will be addressed in the subsequent section. From the point of view of this dissertation, coalition study is better applied in the attempt to explain the general overall defense strategy and its political objective, which demand a more solid coalition.[36]. In this sense, a theoretical lens that attempts to explain decision-making correlates with issues, since many have particular aspects and other are more general, foundational.

Beyond units and level of analysis there is the question of issues in foreign policy and defense decision-making. Foreign Policy is constituted by a wide variety of issues, and for each of them, different players engage themselves, as: i) financial aid; ii) geopolitical aid; iii) commercial agreements; iv) sanctions; v) military interventions, among others. Especially important for this dissertation are the aspects, which involve Large-Defense Projects, such as R&D and production collaboration and arms-trade. It is argued here that although there is a variety of actors and issues in decision-making in defense and foreign policy, it is necessary to give special attention to the process of budgeting and acquisition, as it is the "central arena" that provides the necessary resource mobilization and distribution to materialize any specific policy.

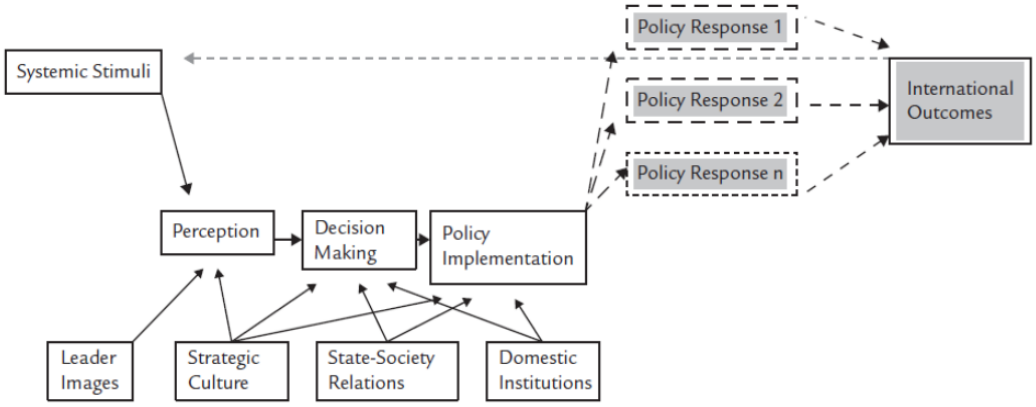
As it was anticipated, this section attempts to be problem-raising. Theoretical and empirical studies developed in an attempt to explain decision making in foreign policy are far from any consensual or few more general models. If one were to build a model that incorporates levels of analysis, relevant actors and issues, as, for example, in a form of a matrix, it would be so extensive and complicated that it would lose all its explanatory power. The most recent example is Neoclassical Realism[37], which maintains neorealist main independent variable (which they call systemic stimuli) and wide variety of intervenient variables and processes to explain both policy and international outcomes (Figure 2). In its most recent development, Neoclassical Realism organizes four sets of

[36] See: (DALL'AGNOL, 2018; DALL'AGNOL, 2021).

[37] Neoclassical Realism was defined by Giddeon Rose (1998). For a better understanding of the studies associated to this perspective, see: (BROWN, 1995; CHRISTENSEN, 1996; SCHWELLER, 1998; WOHLFORTH, 1993; ZAKARIA, 1998; DUEK, 2009; WOHLFORTH, 2009; STERLING-FOLCKER, 1997).

domestic intervenient variables in its model: i) leader's perception; ii) strategic culture; iii) State-society relations, and; iv) domestic institutions (RIPSMAN, LOBELL, TALIAFERRO, 2016, p.16).

Figure 2.1- Neoclassical Realism's Model of Foreign Policy



Source: (RIPSMAN, LOBELL, TALLIAFERRO, 2016, p. 81).

What is clear from the mode is the increasing difficulty of building a framework for explaining decision-making. Irreconcilable ontological and epistemological theoretical propositions are put together, and supposed determinants are always increasing. That is in line with Walt's criticism when he argues that Neoclassical Realism incorporates domestic variables in an *ad hoc* manner with no relation of hierarchy amongst them (WALT, 2002, p. 211)[38].

It goes beyond the scope of this study to develop a general model of foreign policy. Nonetheless, what this dissertation proposes, regarding the problems outlined in this section, is that it is possible to develop a simpler framework to guide decision-making analysis. In this sense, it was given centrality to BP in this chapter, since it provides some assumptions, which in the mean, have a strong explanatory power.

2.3- Other Models of Decision Making Procedures and Outcomes

The models presented here are relevant because of their wide impact on the debate and because they dialogue with issues analyzed in this dissertation. They are models of decision making which try to incorporate a broader dimension in comparison to BP. A

[38] For further criticisms of Neoclassical Realism, see: (DALL'AGNOL, 2020; NARIZNY, 2017; VASQUEZ, 1997; LEGRO, MORAVCSKIK, 1999).

critical dialogue amongst these perspectives can be useful in developing the proposed hypotheses in this study. Furthermore, the models presented in this section are an attempt to explain major policy changes and thus they relate to innovative projects. Change involves risk and dedicated attention by the actors. In this sense, these models dialogue both with decision-making and its outcomes: incremental policies or major modifications. Hence, they also are linked to the discussion of economic issues presented in Chapter 3 and the budgetary process presented in Chapter 4.

3.31- Advocacy Coalition Framework (ACF)

The main unit of analysis of ACF are the coalitions, which dispute decision-making and outcomes at various levels of government and through a large set of issues called policy subsystems. It was first put forward by Sabatier and Jenkins-Smith (SABATIER, 1986; JENKINS-SMITH, 1990; SABATIER, JENKINS-SMITH; 1988). By 1999, the model had its main propositions which were already outlined. Following debate and criticism has further developed the perspective. At the micro-level, individuals, specialists, interest groups, among others, seek to influence a subsystem (e.g., environment) attempt to influence policy. Actors in a coalition perceive a problem in a similar way called deep core beliefs, which are very general normative and ontological assumptions about values and politics (SABATIER, 2007). In this sense "beliefs are largely the product of childhood socialization and, thus, very difficult to change (…) and are subsystemic wide in scope, highly salient and have been a major source of cleavage for some time" (SABATIER, JENKINS-SMITH, 1999, p. 134)[39]. Beyond fundamental beliefs there are secondary beliefs which address specific policy issues within the subsystem, as participation guidelines, rules and budgetary applications of a program and so forth. A coalition can be affected by external factors such as the social economic environment and changes in public opinion, for example. A degree of consensus needed for major policy change interacts with exogenous constraints to lead to possible policy outcomes. In sum:

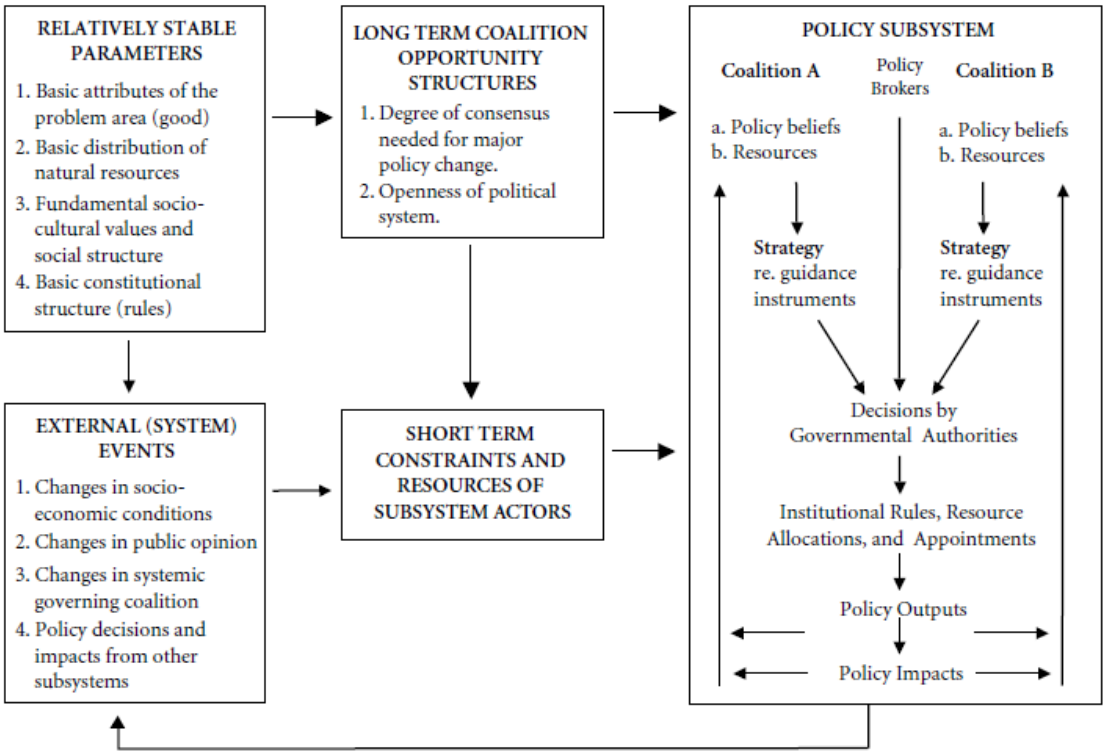
> "ACF predicts that stakeholder beliefs and behavior are embedded within informal networks and that policymaking is structured, in part, by the networks among important policy participants (…) participants will seek allies with people who hold similar policy core beliefs among legislators, agency officials,

[39] Paralleling a growing policy network literature and a growing recognition of the importance of interpersonal relations to explain human behavior (HOWLETT, 2002; GRANOVETER, 1985; PROVAN AND MILWARD, 1995; SCHNEIDER ET AL. 2003; THATCHER 1998).

> interest group leaders, judges, researchers, and intellectuals from multiple levels of government" (SABATIER, 2007, p. 196).

Critiques of the ACF revolved around the relative influence of material self-interests and their place relative to core beliefs (SABATIER, JENKINS- SMITH, 1993; PARSONS 1995; SCHLAGER AND BLOMQUIST, 1996; ELLIOT AND SCHLAEPFER, 2001; NOHRSTEDT, 2005). Nohrstedt (2005), for example, found that actors prioritize short-term interests regarding party cohesion and voting maximization instead of policy core beliefs. At first, core beliefs and secondary beliefs were the center of analysis and coalition forming. The development of the model has pushed research to include variables which reflected a more materialist perspective.

Figure 2.2- ACF's Analysis Framework



Source: (SABATIER, 2007, p. 202).

Other changes in ACF included the summing of variables such as public opinion, information, mobilization of personal and financial resources and skillful leadership

(MINTROM, VERGARI, 1996; MULLER, 1995). Furthermore, internal shocks, viewed as major changes within the policy subsystem were added[40].

This dissertation does not deny that public mobilization around an issue is part of policy and policy change. Nonetheless, the need to include in ACF's model resource mobilization and player's self-interested motivations are confluent to some of BP's central propositions and the argument put forward here. Furthermore, by focusing on senior players, we can reasonably assume that other important variables such as public opinion and information are embedded in the player's stand and need of support from its constituency (or organization) which will affect his stand. One does not necessarily have to focus on the source of human motivation to explain decision-making and outcomes. The conflict among different stands reveal in a large part what is being disputed and what affects the policy outcome.

2.32- The Punctuated-Equilibrium Theory

Punctuated-equilibrium theory dialogues with Incrementalism and is foremost important on budgeting and acquisition matters. Thus, in this section, the general aspects of the theory will be presented.

According to Incrementalism, policy-making usually are characterized by marginal changes, stability and smooth changes from the past. Nonetheless, Punctuated-equilibrium argues that albeit this is usually the case, political procedures produce large-scale departures from the past (KINGDON, 1995; BAUMGARTNER, JONES, 1991;1993, DODD, 1994; KELLY, 1994). Punctuation-equilibrium incorporates the already cited bounded rationality assumption and the analysis of political institutions to focus on agenda setting and issue definition (TRUE, JONES, BRAUMGARTNER, 2007). Bounded rationality is also a basic assumption of Incrementalism, since it stresses that actors are cognitively limited in processing multiple agendas, and, thus, by making choices usually are aligned with the already established *status quo* (WILDAVSKY, 1964). However, according to Punctuated-equilibrium, the same spans of attentions, both in individuals and government, can in specific situations deviate major attention to a specific issue (ROBINSON, 2005; 2006, MCFARLAND, 2004). The interaction between

[40] For a systematic review of the applications of ACF, see: (PIERCE *et al.* 2017). In this study, the number of times ACF was used, across different issues and countries, is analyzed.

political institutions, interest mobilizations, and bounded rational decision-making, according to the theory, may lead to a greater salience of a specific issue:

> "(…) within the spotlight of macropolitics, some issues catch fire, dominate the agenda, and result in changes in one or more subsystems. The explanation for the same political institutions producing both stasis and punctuations can be found in the processes of agenda setting—especially the dynamics produced by bounded rationality and serial information processing" (TRUE, JONES, BRAUMGARTNER, 2007).

According to Jones (1994, p. 185), "When a policy shifts to the macropolitical institutions for serial processing, it generally does so in an environment of changing issue definitions and heightened attentiveness by the media and broader publics". What the theory calls "Monopoly Structures" of decision-making can respond with negative feedbacks, and, hence, Incrementalism prevails. "But if pressures are sufficient, they may lead to a massive intervention by previously uninvolved political actors and governmental institutions. Generally, this requires a substantial change in the supporting policy image" (TRUE, JONES, BRAUMGARTNER, 2007, p. 159). Similar to the ACF, Punctuated-equilibrium theory is based on the premise that the need to explain large changes in policy from pressures created by actors unsatisfied with the prevailing *status quo.* Nonetheless, the focus of Punctuated-equilibrium is not shared beliefs, but instead the conjuncture of pressure through information to generate sufficient attention and pressure to attract the attention of decision-makers and pressuring positive feedbacks that result in a punctuation outcome[41].

Punctuations are most clearly observed in budgeting since it is the material condition for any policy (TRUE, JONES, BRAUMGARTNER, 2007). Giving that this dissertation focuses on large-scale innovative programs, a punctuation on program level will be usually observed if the program is set in motion. Budgeting researches from a Punctuated-Equilibrium perspective are, thus, outlined in Chapter 4. Nonetheless, this dissertation holds, in accordance with the argument made regarding ACF, that the pressures exercised in decision-makers, and the variables which attempt to determine them, will be incorporated in the stands made by senior players. Epistemologically, this simplifies analysis and makes it more operational. Nevertheless, the centrality of

[41] For applications of the theory on different issue areas such as regulatory drug review, environmental policy, education, firearms control and state hospital rates, see, respectively: (CECCOLI, 2003; REPPETO, 2006; BUSENBERG, 2004; WOOD, 2006; SALKA, 2004; MANNA, 2006; MCLENDON, 2003; MULHOLLAND, SHAKESPEARE, 2005; ROBINSON, 2004; TRUE, UTTER, 2002; MCDONOUGH, 1998).

information outlined by the theory is a necessary aspect to investigate in empirical analysis, since information flows among the actors analyzed is a source power and material enhancing for individuals and organizations. Withholding information, and the information available for players, impacts choice, as it defines alternative outcomes.

2.33- Veto Players

A last theoretical development judged important to be discussed here is Tsebelis' Veto Player Theory, since this dissertation treats intergovernmental processes, especially among senior decision-makers. According to Tsebelis (2005, p. 442) "veto players are individual or collective decision-makers whose agreement is required for the change of the status quo". Since change, new policy outcomes, or in the case of this study – innovative large-scale defense projects – base themselves on previous arrangement, it is argued that a certain number of important actors are needed to depart from the prevailing policy.

Tsebelis's theory has the intent of generality and parsimony in the sense of being applicable to all governmental institutional arrangements (parliamentary, presidential autocratic governments). Here the focus relies on his hypotheses regarding presidential systems. Important to the game amongst veto players is the sequence of moves established by legislation, if one of the veto players selects among the options of outcomes- controls the agenda (TSEBELIS, 2005). Knowing the preferences of agenda setters might, according to Tsebelis, lead to the identification of the outcome. Utterly important to this study is Tsebelis argument regarding the congressional role in presidential systems:

> "Who is the agenda setter in a presidential system? This is a question that has to be answered for each country and sometimes the answer may vary by issue area. However, by and large, in presidential systems it is the Congress that makes a take-it-or-leave-it offer to the president. Generally, the president can accept that offer or veto the bill, in which case some qualified majority can overrule the veto (…) I am speaking about a very precise function of Congress, that it elaborates legislation, it can modify it at will, and present the president with a fait accomplis, i.e., having a bill come out of a conference committee and then approved by both chambers" (TSEBELIS, 2005, p. 456).

Nevertheless, as it was argued, a committee leader, for example, relies on information to make his stand as well as incorporates other variables pointed out by the literature (e.g., public opinion). This gives organizations (e.g., military services) an important power, since the pursuit of power by an organization relies on the monopoly of information and role, as well as budget maximizing. Tsebelis argues that in a system with many veto players, as the case of the United States, bureaucracies and the judiciary will

be more independent. Nonetheless, their role depends if the veto players are or not in consensus, their independence varies in the inverse proportion of consensus of veto players. Many veto players create space for bureaucrats to play their principals against each other. Consequently, in systems with many veto players, bureaucrats have more freedom to interpret the law. This argument has been advanced by Thomas Hammond and Jack Knott (1996), Terry Moe (1993) and Moe and Michael Caldwell (1994). Regarding the possibility of change, Tsebelis' hypothesis is straightforward:

> "(…) if the preferences of the different veto players surround the status quo (the status quo is in the Pareto set of the veto players), whether they are close to it, or far away from it, no change or only incremental change is possible (depending on whether the veto players are individual or collective). If the preference of one of the veto players is located close to the status quo only incremental changes are possible. If the preferences of all veto players are far apart and in the same direction relative to the status quo, then significant changes are possible" (TSEBELIS, 2005, p. 463).

Thus, the sequence of moves, the knowing of agenda setters summed with the knowing of actor's stands regarding the status quo, can lead to a prediction of a change (TSEBELIS, 2005).

What is similar between the three theoretical constructions outlined in this section is the necessity of a form of consensus, or coalition, to produce major changes. This dissertation recognizes that the neglect of the ontological and epistemological discussion of the sources of human motivation might dampen the richness of analysis. Nevertheless, the independent variable treated here is best investigated from a *proxy manner.* This will develop in the sense of some of the propositions outlined here, especially from BP theory, while both recognizing the imminent conflict between individual's goals alongside with conflictual organizational preferences and the necessity of a certain degree of consensus among senior players to produce change. Hence, the last section is dedicated to outline the analytical framework of domestic politics to tackle the issue of large-scale defense projects, within the main hypothesis, some auxiliary hypotheses and parameters for analysis.

2.4- What to expect?

We can argue, for instance, that players are guided by enhancing their material interests and position, which are related to their position in the government. Senior players will vary according to issue, since, for example, different departments or congressional committees are divided by subject. Nevertheless, senior players are traceable, conflicting

objectives can be observed and the outcome derives from the possibilities created by this scenario. Materiality, and, thus, budget disputes are in the core of policy implementation. In the case of Large-Scale Defense projects, as it will be demonstrated in Chapter 4, senior players include certain congressional committees. The DoD and the different services play a central role as well. The assumption of conflicting interests in the BP framework allows the student of politics to observe not only the positions and bargaining among these players but within the respective organizations.

The pillars of BP, setting aside subjective or personal idiosyncrasies already excluded from this dissertation, it is argued here, opens the possibility for larger sets of comparisons, among different countries and is applicable to other issues, since it has a material base and a guideline for specific actor choice. Specific to the issue discussed here, however, is the necessity of a variable treating technological feasibility and innovation (Chapter 3).

Reviewing the literature allows us to draw some characteristics of the process in which large-scale defense projects are developed. These important insights will not be tested in this dissertation since each of them demand a deep analytical investigation and empirical testing. Nonetheless, they will unenviably appear on the process-tracing of the case studies and comparison amongst them. Hence, the literature insights listed below will be treated in an *an passant* manner. Nevertheless, this does not mean that they are not important for the success or failure of large-scale defense projects and can offer significant complementarity for the analysis put forward here and important conclusions, as well as future research topics. After reviewing the main frameworks of domestic political analysis, understanding that they have explanatory preciseness, it is presumed that one can observe: i) Organizations will try to protect their area of expertise and activity (by monopolization of information and the defense of designated role {e.g., flying within the Air Force}) in order to be able to play that card in budget negotiations; ii) Actors are at the mean budget maximizing, and conflict is most highlighted within the budgeting process.; iii) The players stand can be treated as incorporating other variables that literature finds important without contradicting the assumption that they are in general guided by self-interested material and positional goals (public opinion, electoral concerns, constituency and jobs and interest groups); iv) Information retention and sources are important to understand the substance of the political dispute, thus, information leverage is also a source of bargaining advantage.

After reviewing and debating the main theoretical and empirical constructions regarding domestic politics, agenda setting and implementation, this dissertation now introduces the relation between the domestic angle of analysis and Large-Scale defense projects. The independent variable inferred here: as *the strength of consensus between and among Congress and the Executive)* and the dependent variable (success or failure of large-scale innovative defense projects), taking into account the theoretical stand developed in this dissertation, results in the main hypothesis of this Chapter:

Main Hypothesis: *The success of a large-scale project, defined as the relative accomplishment of the projects initial purposes will be strongly influenced and positively related to the degree of consensus between and within Congress and the Executive.* High success of a large-scale defense project is understood here as a scenario were production reaches full development and scale production. Failure is understood here as a low achievement in comparison to the projects initial goals and ultimately, at the limit, the cancelation of the project.

The main hypothesis and the debate put forward by this chapter, regarding domestic politics entails for the need to investigate additional auxiliary hypothesis:

a) The degree of consensus, nonetheless, depends on the Executive side: to reach an outcome which compromises between self-interested individuals and organizations within and among the services and within and among the Office of the Secretary of Defense (OSD) and the Office of Management and Budgeting (OMB). This entails the need for solid civil-military balance, which holds true for the relationship between Congress and the Military.

b) The Congressional role is crucial and its internal scale of consensus depends on a compromise between self-interested individuals and organizations within and among the main committees of the issue (House and Senate Armed Services Committee {HASC/SASC}, House and Senate Budget Committees (HBC/SBC and the House and Senate Appropriation Committees {HAC/SAC}. Furthermore, there is a need of consensus building in the floor to approve the bills and guidelines issued by the committees.

c) The split between the Senate and the House on this matter has to be negotiated.

Albeit the analysis chosen here is mainly qualitative, strength of consensus requires some parameters of analytical guidance. Utilizing them for comparison, process-tracing can demonstrated the relevance of some key: i) disagreements between senior players, attempts to use veto powers and harsh bargaining observed through the process, briefly outlined in the main hypothesis (more detailed in the subsequent chapter) will signalize lower consensus; ii) parochial interests (including inter-service rivalry) will interfere negatively on a consensus building process; iii) major divisions between civil and military preferences (e.g., fiscal austerity versus budget expansion options will interfere on the dispute for consensus regarding the projects; iv) partisan opposition among senior players can dampen the strength of consensus required for the success of large-scale projects; v) the difference between the budget expectations and new challenges of the project from its beginning and along the process has a direct relation with consensus building.

This Chapter aimed at developing a framework of analysis, strictly from a domestic point of view, to sum with the external threat (Chapter 1) angle of inquiry. Albeit domestic disputes almost intuitively affect foreign policy and defense matters, as it was demonstrated here, it is not easy to understand how and which actors play decisive roles. The theoretical developments in the field point to innumerous independent and intervenient variables which might affect foreign policy outcomes. In this sense, this dissertation develops a framework which draws on some assumptions – especially from BP – and argues towards the development of hypotheses that allows one to investigate the success or failure of large-scale defense projects. It is argued that the main arguments and structure of the model can be applied to other issues and countries. Nonetheless, there are issue contingencies that have to be further and future developed in this sense. In the case of defense projects, technological feasibility, innovation and socioeconomic dynamics are crucial for the explanation proposed in this dissertation. The following chapter addresses these issues.

CHAPTER 3-RESOURCE MOBILIZATION AND INNOVATION

> *"War is a matter not so much of arms as of expenditure, through which arms may be made of service".*
>
> *(THUCYDIDES, History I)*

What are the necessary foundations for innovation and mobilization needed for the success of large-scale defense projects? The subject matter of this dissertation requires dealing with an economic debate, the material conditions for the success of large-scale defense projects. It differs from other issues regarding foreign policy or defense. In this sense, this Chapter is issue-driven and aims at putting forward a hypothesis presented towards the economical/technological feasibility of large-scale defense projects, formally outlined at the last section. Hence, it is more specific to this dissertation in comparison with the variables treated in the two previous chapters, namely, the level of threat, and consensus among and within the Executive and Congress, which, it is argued, can be developed theoretically to be applied to other issues of foreign policy and defense.

Large-scale defense projects require a massive material mobilization, which involves numerous actors and processes. Since these endeavors are built upon different ways of producing and allocating scarce resources, they are also a subject for defense economics. Incentives to firms and government, specific market characteristics, the industrial and logistical defense base, procurement and R&D efforts are all subjects that affect the structural ground of the issue. These topics are addressed in the two subsequent sections.

Efforts are introduced in a contingent scenario, and actor's stands will be observed in a specific socioeconomic and external threat context, in a debate which revolves around the main points of cost efficiency and effective success, guided by strategic considerations. Albeit, at the heart of the process, there is the simple matter of risk, as it is inherent to innovation, firms and other actors have to be willing to deal with uncertainty. There is no way of determining *ex ante* if a project is viable, in technological feasibility matters. Actors will have to coordinate throughout the process, attempting to reduce uncertainty and risks. This dissertation argues that the risks can be observed through the time-period of the project, and demand curve revisions (in costs, quantity of

procured arms and schedule) are an approximate estimate of the viability of a project in achieving its initial goals. The chapter is developed building upon to this argument. Demand curve revisions can generate a proxy measure of technological feasibility and, hence, it is the main variable presented here. Technological feasibility is a condition for the success of large-scale defense projects. Other conclusions and premises, derived from further theoretical debate and framework of analysis construction are introduced at the end of the chapter and are derived from the theoretical debate put forward here and are attempted to give guidance to empirical investigation, combined with the main hypothesis.

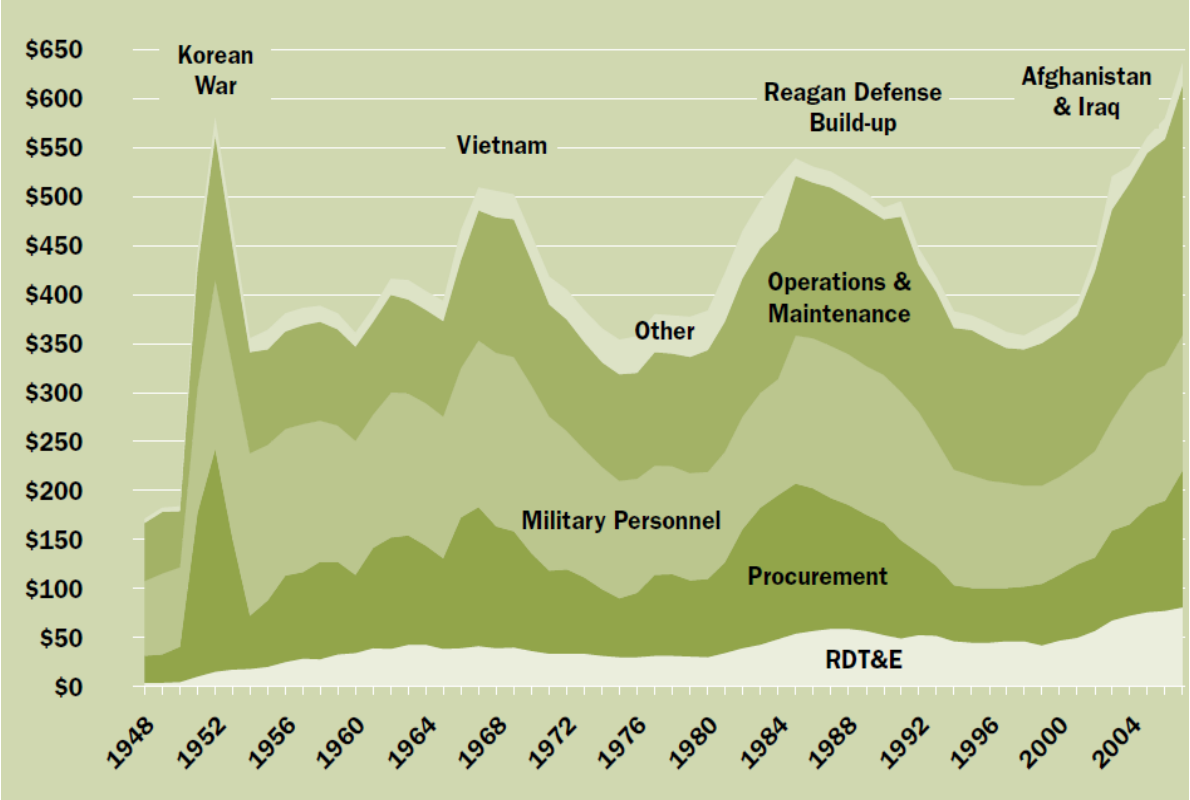
3.1- The Defense Industrial Base and the U.S Case

The development of defense production comes from two main sources: states' systematic coordination and organization and the development of economic relations in the civilian sector. States have historically organized themselves in order to meet the challenges of war (TILLY, 1990; GOUREVITCH, 1978; ELIAS, 1993; HINTZ, 1975). Since the mid XVIII century, the Industrial Revolution has enabled scale production by private firms and, thus, a greater participation of this form of organization in the defense sector. Modern defense production is a web of many institutions, both private and public, with sometimes conflicting interests and polemic trade-offs such as: private *versus* public productivity; internationalization versus national concerns; guns versus butter; research and development (R&D) costs and benefits; *spin-off* versus *spin in,* among others. These issues revolve around what literature addresses as the Defense Industrial Base (DIB).

In the U.S, consolidation of a permanent armaments industry of vast proportions came with the advent of the Korean War and the beginning of the Cold War at the time of the thermonuclear revolution. In 1950, the National Security Council 68 (NSC-68) was implemented, which recommended a "rapid build-up of U.S political, economic, and military strength" (WATTS, 2008, p. 12) in order to counter growing Soviet Power. Soon after, an *ad hoc* NSC committee produced NSC-68/1 which planned a duplication in defense spending from 1951 to 1953. New technology like nuclear submarines, large aircraft carriers, ballistic missiles, satellites and high performance jet aircraft made the U.S defense industry, in the 1950's, the largest industrial sector of U.S economy and extremely popular in the stock market (SCHERER, PECK, 1962; ISAACSON, THOMAS, 1968). At this time, as it can be seen in the graph below (Figure 4.1), the defense budget grew substantially. The defense budget has substantial weight on the

success or failure of innovative defense projects and, thus, Chapter 4 will be dedicated exclusively to its analysis.

Figure 3.1- DoD's Budget by Category (2009 U$ Billions)



Source: (WATTS, 2008, p. 8). Data: Office of the Under Secretary of Defense (Comptroller), National Defense Budget Estimates for FY 2009, March 2008, pp. 62–67.

Budget fluctuation can be affected by external threats, bureaucratic and economic issues, among others. These variables also affect the industrial base and its issues. With the consolidation of the U.S DIB, the DoD grew substantially in size, which transformed the acquisition system in adding to the decision-making process a number of new bureaucracies and individuals. Military Services, bureaucracies and contractors are all budget-maximizing actors, which lead to efficiency problems, discussed with further detail in the third section of this chapter. In order to better understand the economic and political issues which surround the DIB, it behooves this study, at this moment, to conceptualize it.

The concept of DIB is not straightforward. Scholars usually understand it as the companies that provide defense equipment and materials with strategic objectives to the defense ministry. These products can be lethal large or small weapons systems; non-lethal

but strategic products (e.g., vehicles, fuel, infrastructure) and other products consumed by the military (e.g., food and clothing) (DUNNE, 1995, p. 402). Given this large scope and complex interconnectivity among different branches of production, it is often hard to define and map the DIB. Furthermore**,** firms can be main contractors or subcontractors for large defense projects, they can be more civil or military oriented and they can engage in international trade. These issues, among others, has led authors to restrict the concept of DIB to only those firms engaged directly in the development and production of goods and services specific to military engagement (ANDRADE, 2016; SIPRI, 2020).

Some authors such as Amarante (2012) employ a broader approach to the concept[42]. The author argues that since war has become more technologically complex, an analysis of the DIB must include what is "under the surface" of defense resource production, or what he calls the scientific-technological *Iceberg*. The *Iceberg* concept includes not only the military product, but the logistics, production, conception and R&D elements that surround the DIB. This holistic view of the DIB entails the need to include a wide variety of actors in the analysis such as universities, engineering firms, industrial firms, service firms, technical teaching facilities, among others.

As it was argued in Chapter 1 of the present study, Clausewitz's concept of strategy as the "engagement for the purpose of war" is more fruitful for the analysis here, since it is more precise and empirically operational then the concept of grand strategy. In parallel, this dissertation incorporates a notion of DIB that includes the conception, development and production of military equipment mobilized specifically for military purpose. In the same way as grand strategy, the more holistic view of the DIB will be inevitably present in the descriptive overview of large-scale defense projects, although not scrutinized here. In order to analyze the DIB in this more restrictive way, it benefits this dissertation to introduce the types of products and the actors that are embedded in this definition.

Walker *et al.,* (1998) and Schofield (1993) suggest a taxonomy, which enlists military products in a hierarchical manner ranging from the more complex defense oriented systems to the basic materials that are necessary for the production of defense equipment: (i) Military strategies and concepts (high level planning); (ii) Integrated

[42] An interesting DIB concept is presented by the Brazilian's ministry of defense as "the group of firms, state or privet-owned as well as the civil and military organizations who participate in the R&D, production, distribution and maintenance of strategic defense products" (BRASIL, 2005).

weapon and information systems (e.g., national early warning systems); (iii) Major weapon platforms and communication systems (e.g., aircraft, battleships, etc.); (iv) Complete weapon and communications component parts (e.g. torpedoes); (v) Sub-systems (e.g., gyroscopes); (vi) Sub-assemblies (e.g., sights, fuses) (vii) Components (e.g., integrated circuits); (viii) Materials (e.g., semi-conductors)[43]. Adopting this hierarchy provides this study with the identification of the main actors that constitute the DIB necessary for specifically military engagement purposes. Since this dissertation investigate large-scale defense projects, the focus will be on items (i) through (iv).

Item (i) entails the necessity to include as main actors the DoD high officers and the top levels of the Executive. Prime defense contractors integrate a variety of subsystems to deliver a final product. As it will be discussed below, this process usually involves a small number of large firms with R&D capacity and which can assume high risks. Items (ii), (iii) and (iv), thus, can be analyzed taking into account large defense firms and those key political actors which participate on the decision-making process[44]. Other kinds of products will be discussed only if they are quintessential to the project in question, as is enrichment of uranium for the development of nuclear forces, for example. Nonetheless, since the projects analyzed here are mainly highly innovative, both applied and basic science are decisive. Hence, universities, government research facilities and think tanks will be taken into account in the empirical investigation, although only to the extent that they are directly linked to the military ends of the project.

3.12- DIB as a Specific Sector

The defense market has specific features and this investigation has to take into account these idiosyncrasies. The first and foremost characteristic of the defense market is the State as the sole buyer. Governments monopsonic role determines the demand side of the market and affects the main features of the supply side as well. Defense firms have developed historically in a particular way and the higher they move in the market's hierarchy the more the nature of capital equipment, labor skills, and the organization of production become specific to the sector (HOOPER, BUCK, 1991). Some of the specificities are: An emphasis on performance of high technology weaponry rather than on cost (KALDOR, 1991); close relations between contractors, procurement executive

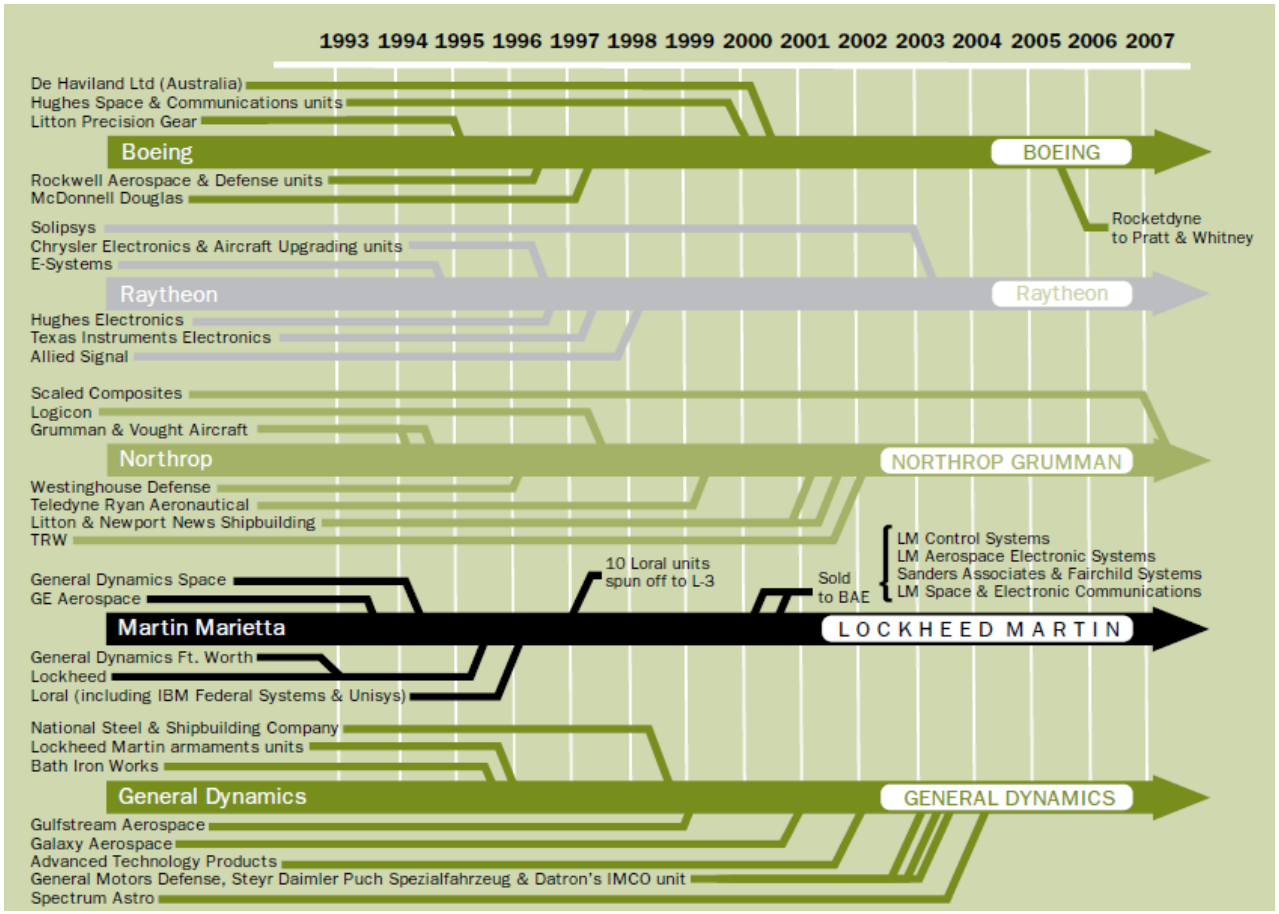
[43] For a discussion on this taxonomy, see: (DUNE, 1995).
[44] Budgeting, as will be discussed in the next chapter, is a crucial process for explaining decisions regarding large-scale defense projects. Thus, key congressional committees, the White House and the DoD are important actors.

and the military (DUNNE, 1995); high R&D costs that can be financed by government and; elaborate rules and regulation on contracts (SCHERER, 1964). According to Dunne (1995, p. 408), “the structure of the market entails both barriers to entry and barriers to exit, which have led, until recently, to the DIB showing remarkably stability in terms of its composition of main contractors”.

Differently from the first decades after the World War II, when the U.S DIB was consolidating and competition in the defense market was thriving, the supply side of the sector has become more and more characterized by few possible suppliers (Figure 3.2). The development of the U.S DIB has favored this feature due to some factors, for example: i) Large-Scale projects became the main sort of contract making entry costs to new coming firms high and some long-term high-scale projects a “must-win” for the competitors; ii) Since the 1960’s the U.S government has incorporated other priorities to the budget making the defense industry less attractive; iii) Civilian markets became more attractive in terms of profit[45]; iv) Strict regulations and highly specific and technically advanced requirements made the industry harder to entry; v) the cycle of defense expenditures, commonly related to external threats (Figure 3.1). These issues are correlated with incentives and procurement problems, further discussed in the third section of the present chapter. The oligopolistic tendency of the defense market increased highly in the 1990’s, when a sharp decrease in defense expenditures, following the collapse of the USSR (Soviet Union), coincided with Clinton’s administration decision to withdraw any overhead costs associated with the downsizing of procurement[46].

Figure 3.2- Main Defense Suppliers (1993-2007)

[45] See: (WATTS, 2008).
[46] See: (WATTS, 2008).



Source: (WATTS, 2008, p. 32).

In combat aircraft production, several companies, including large firms such as North American and Rockwell International were absorbed into Boeing and Lockheed Martin, a supply side duopoly. Northrop Grumman, after having the B-2 stealth bomber program canceled in George H. W Bush's presidency, had a major setback. The company, however, has been a major contractor of Unmanned Aerial Vehicles (UAVs) (WATTS, 2008). The same trend was observed in the armored vehicles industry, where General Dynamics has won almost all the major contracts. Few competitors in the supply side may lead to economic inefficiency as well as an exaggerated bargaining power to the contractors, characteristics which will be expected to appear in more recent large-scale projects (WATTS, 2008; DOMBROWSKI, GHOLZ, 2006).

The monopsonistic character of the demand in the defense market arises issues regarding economic efficiency. Defense Economics scholars have to engage in the study of the procurement process, budgeting, legislation, R&D and economic incentives, sometimes adapting theoretical insights from economics and engaging with other disciplines like Public Policy and Political Science, for example. Besides the discussion

about peace and war issues, the most controversial matter regarding the defense industry is its economic efficiency. Modern government has evolved into a provider of social benefits and thus military spending has been target of criticism as it poses the dilemma of guns versus butter, since there are opportunity costs for expenditures in other, civilian, sectors (BRZOSKA, 1995). Since defense spending is an input measure, the first issue to be raised is: how to measure its benefits? The output of military spending is usually seen as a public good, measured in the form of security, deterrence or strength. Besides from important data issues, these benefits cannot simply be measured by a relative sum of manpower and equipment as war depends on a number of non-pecuniary factors such as training, motivation and leadership (WIBERG, 1984; GOERTZ AND DIEHL, 1986) [47]. There is no straightforward model for measuring an "optimal defense expenditure demand" as its output is controversial and there are theoretical issues regarding the political constraints that distort market behavior.

Literature is not consensual on the economic impacts of military expenditure[48]. Some authors advocate that government military investment has positive effects in the economy, such as the provision of high skilled jobs, industrial planning, technological spin-offs and even the solution of underconsumption or overaccumulation crises (CYPHER, 1986; DEGER, SEN, 1995; DIAMOND, 2006; MOWERY, 2010; MCDONOUGH, 2010). In contrast, there are studies which observe increasing spin-in, diversion and path dependence effects (DAVID, HALL, 2000). Furthermore, critics have noticed that the DIB has "crowded out resources, both investment and human capital, has reduced civil technological development, and has had externality effects on other companies. It has reduced industrial efficiency and international competitiveness" (DUNNE, 1995, p. 423).

In great powers such as the U.S, the DIB has to embed or even produce the latest and most innovative technological advances. Historically, the DIB has been at the heart of important innovations. Nevertheless, since the 1980's, economists have observed that innovation has been characterized by a spin-in effect towards the defense sector, that is, technology has flowed from the commercial/civil sector to the DIB. Additionally, the

[47] Different countries, as well as different scholars and institutions, employ different indicators to measure "defense burden". See: (RINGSMOSE, 2010). Usual measures are the percentage of defense expenditure of the GDP (Gross Domestic Product) or government spending.
[48] For a good appraisal of the literature on the subject, see: (RAM, 1995).

private sector has surpassed government in R&D investment[49] . Furthermore, O&M (Operation and Maintenance) and personnel expenditures have grown in percentage as a share of the defense expenditure, putting downward pressure in procurement, the main source of revenue for the DIB[50]. All of this, as a consequence, has dampened the attractiveness of being a part of the defense industry. Government's ability to control and access technology has reduced, and the private sector provided a crescent appeal as a career choice for the best engineers and researchers (WATT, 2008). As a result, efficiency matters have gained increasing importance to the DIB. Procurement and incentive issues of the defense market are crucial in evaluating and improving its efficiency.

3.2- Efficiency, Procurement and Incentives

Theoretically, the most efficient use of equipment would resemble an optimization problem in which the market would adjust in an environment of profit seeking competitive firms. The cost function, in this case, would make firms to substitute expensive with cheaper components. These incentives are, nonetheless, absent in military firms as the lack of competition and nature of employment contracts make no strong pressures for minimizing costs (SANDLER, HARTLEY, 1995, p. 157). In military procurement, one might argue that there are incentives working on the opposite way, that is, to avoid substitution, since "each service will seek to protect its budget and maintain its traditional monopoly property rights (i.e. over air, land and sea), so reducing the opportunities for efficient substitution between the armed forces" (HARTLEY, 1995, p. 483)[51].

Conflicting objectives within and between the executive, legislative and private sector will substantially affect planning, organizational and incentive issues. The defense budget is a canonical case of this kind of dispute due to its massive proportions. As it was argued in Chapter 2 and will be further exploited in the subsequent chapter, dedicated to the budgeting process *per se*, decision-making and incentives will be decentralized distorting possible pure cost or performance regards. Services choose their weapons and

[49] See: (LESKE, 2018; STOWSKY, 2014, WATTS, 2008).
[50] See: (WATTS, 2008).
[51] Hartley (1995, p. 483) identifies a less intuitive aspect of substitution incentive as he argues that regarding the location of bases, apart from constituency issues: "bases in attractive locations confer non-military benefits (e.g. proximity to cultural and leisure facilities in a nation's capital; the opportunities for using training areas for leisure pursuits).

possible alternatives while Congress and the Office of the Secretary of Defense supervise the process. Nevertheless, as argued by Rogerson (1995, p. 340), since it is difficult to objectively measure military performance, Congress will have a strong incentive not to delegate decision-making and, therefore, it will work towards controlling and managing the process[52].

Regarding the economic relations between the main actors, a few models have been developed by analysts. Since Congress appropriates the amount for each department of the US's federal government, some insights have been achieved by modeling the relations between Congress and DoD. Following the assumption that bureaucrats will try to maximize their budget by exercising a monopoly power as the only possible supplier of a product, the result is that, in the case of Defense, DoD exerts power by controlling program decisions in the early stages of their development (NISKANEN, 1971; ROGERSON, 1995). Since programs are appropriated annually, bureaucrats can make complex technical decisions that will affect the marginal costs and benefits issues that Congress will face in forthcoming fiscal years. Furthermore, the military can induce Congress to choose higher quality technologies and at larger quantities, as they present options with low decrease in marginal cost but that require large-scale production (ROGERSON, 1991). Nevertheless, if defense firms are included in the model, one can observe a source of power that Congress holds as they control the contractual arrangements between military services and contractors (LAFFONT, TIROLE, 1991; MARSHALL, MEURER, RICHARD; 1991;1994).

The procurement process, issues and the incentives for both the demand and supply sides of the market are tightly interrelated, albeit these issues have changed substantially due to historical contingencies of the DIB. A specific defense industry might take into account a purely objective approach focusing "on defense criteria only, namely, costs, performance, delivery and the risks attached to the various competing proposals, so ignoring any wider industrial and economic benefits" (HARTLEY, 1995, p. 472). Nonetheless, in the actual procurement process, government's decision might be influenced by constituency, job, re-election and economic growth considerations. The main point is that government is authorized to change, reduce or cancel a project during its development. Ultimately, purchasing defense equipment is done in a scenario of high

[52] For a different perspective, see Posen (1984). The author argues that civilians will delegate decisions to the military due to their expertise on such issues.

uncertainty, especially since these difficult choices have to be taken, depending on the system, over time horizons up to 40 years. A cost-benefit analysis has to take into consideration rivaling equipment in terms of their life-cycle costs– maintenance and operation– of the total fleet. Furthermore, strategic implications and military features of the equipment before its alternatives and even international market's alternatives are part of the cost-analysis and political disputes in procurement (ROGERSON, 1995). Delivery schedules are a major source of uncertainty regarding cost projection and firm/government relations, as it will be evident in the historical appraisal of budgeting and the large-scale defense projects discussed in this dissertation.

Decisions made in this uncertain scenario will affect actors' incentives and behavior since limited information and economic institutions play a decisive role in the procurement process. "Huge uncertainties pervade the process and complete long-term contracts are generally impossible to write and difficult to enforce" (ROGERSON, 1995, p. 311)[53]. As it was argued in Chapter 2, government is a complex hierarchical institution and incentive issues within its structure– among its main actors and agencies– also affects defense market interactions. Regarding uncertainty, Peck and Scherer (1962) argue that there are those internal to the project in question, which are present due to the technological unknowns, especially at the design phase of a new project, and uncertainties due to externalities, such as variation in external threats, the availability of substitute weapons or changes in the political willingness to purchase specific weapons. As a consequence, "DoD typically does not find it feasible or desirable to sign long-term fixed-price production contracts" (ROGERSON, 1995, p. 313)[54], since the weapon's features can change substantially throughout the design, development, production and delivery phases.

Due to these challenges, production contracts are signed annually. Competition is usually harsh during the design phase, where a single winner is chosen based on the design's projected performance, cost and maintainability issues. The contract is most commonly awarded to a single firm due to economies of scale. Large-scale projects have typically no close substitute and, thus, competition is limited and winning a major contract

[53] For formal models of the procurement problem with single and multiple agents, see: (ROGERSON, 1995).

[54] Burnett and Scherer (1990, p. 304-405) point out that "DoD's failed attempt to use such contracts in the 1960s (which was referred to as the total package procurement approach) is generally thought to have conclusively demonstrated the infeasibility of this approach".

may mean a large share of a firm's possible market. The effects of lack of competition and the ultimate monopolistic role played by the winning firm are usually countered by legislation, which determine that the price will take into account historic and projected accounting costs, which are meticulously audited. A "profit" term is also added to compensate firms for the cost of capital and risk-bearing (ROGERSON, 1992; 1995; MEYERSON, 1967). The contractors are expected to provide current accurate and complete cost projections when they negotiate annual contracts of production with the DoD, according to the Truth in Negotiations Act (TINA). As was pointed out by Kovacic (1991), TINA legislation works as a sort of cost-reimbursement contract since its application resembles more a cost-based than a true fixed-price contract[55]. Especially prone to risk, uncertainty and, thus, gives further importance to the incentive problem is R&D procurement.

R&D efforts are at the center of competition between countries for innovation. As a result, for example, in the U.S, R&D expenditure has grown in proportion to total military spending. The consolidation of the DIB in the early Cold War was accompanied by an increasing government emphasis on R&D. From 1948-1960, R&D grew at an average annual rate of 18%. R&D has also grown in relation to procurement in general. In the same period, procurement increased at an average rate of 8.3%[56]. R&D represents a significant portion of procurement, "(…) over the period 1948-2007, total R&D funding has been about 42% of DoD's cumulative procurement spending" (WATTS, 2008, p. 11). This reveals that while DoD highly prioritizes innovation, many projects never materialize into production of new equipment. As a result, solid incentives have to be given to military firms in order to compensate the risks of R&D spending.

Historically, the U.S government has invested in R&D through three main channels: i) performance of R&D in government laboratories; ii) direct contracts with private firms and other institutions (e.g., universities); iii) awarding major contracts by an acquisition method known as "procurement by design and technical competition". Since World War II, R&D investment by the government has increased rapidly in real value, specially through direct contracting. Nevertheless, inducing firms by sponsoring design competitions in federal mission-oriented R&D expenditure continues to account for a substantial amount of the country's R&D investment. In the "procurement by design"

[55] For further details, see: (ROGERSON, 1995).
[56] Data available at: (WATTS, 2008, p. 11).

method, government reveals its demand for technological innovations and firms compete for the procurement contract by developing their design for the project with their own resources, and, thus, government induces private R&D (LICHTENBERG, 1995, p. 434).

In the design of a new weapon there are high risks due to technological unknowns, bureaucratic and political challenges and possible external threat changes. Hence, incentives for R&D are done in a uncertain scenario, and, consequentially, have price determining issues, as it was already argued above (PECK, SCHERER, 1962; ROGERSON, 1995)[57]. Furthermore, firms worry that they would never recover their expenses (which are usually very specific to a particular project and, thus, requires investment in physical capital and professionals that cannot easily be used in different projects). As a result, government has to concede different forms of guarantees to the investing firms to assure the incentive for innovation. First, government, different from typical commercial consumers, purchases the value of the R&D investment, as well as the final product. Also, after winning the competition, the firm will be awarded "follow-on" noncompetitive contracts, which accounts for the most part of the firm's revenue[58]. Given these compensations, firms usually end up submitting bids below anticipated costs on the initial competitive contracts[59].

Regarding the result of government incentives on inducing the quantity of private R&D, Lichtenberg (1988;1995) developed an econometric study analyzing private R&D response to government procurement in general, and design competitions in particular[60]. Analyzing data between 1979 and 1984, the author concluded that slightly over half of induced increase in private R&D was the result of the increase of government procurement[61]. Lichtenberg also estimated that a $1 increase in competitive procurement induces a 54 cent increase in private R&D expenditure while noncompetitive contracts

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[58] Lichtenberg (1995, p. 435) points out that "in fiscal year 1984, for example, the value of noncompetitive follow-on contracts after design competition was 2.72 times as large as the value of competitive contracts associated with these competitions".

[59] In this sense, design competitions resemble what economic literature defines as a "contest". In a contest individual's compensation (in this case, whether he is awarded the contract) is determined by his relative position towards other competitors instead of his individual output (marginal product) (NALEBUFF, STIGLITZ, 1985; LICHTENBERG, 1995). In this kind of compensation scheme, these authors argue that agents are induced to abandon their natural risk aversion character.

[60] For a more general analysis on P&D effect on innovation, with data by sector, see: (SCHERER, 1984; SCHMOOKLER, 1966; TERLECKYJ, 1974; 1980).

[61] The study's limits of the 0.95 confidence interval are 0.430 and 0.626 (LICHTENBERG, 1988).

had a negative effect on private R&D. The results suggest that all stimulus to private R&D comes from competitive acquisition. Lichtenberg (1995) shows that firms, as noted above, invest in private R&D expecting future procurement noncompetitive contracts. After competition, according to Lichtenberg (1995, p. 437), "losers of the competition reduce spending because the prize is no longer at stake; the winner reduces spending because the government is now willing to directly sponsor the R&D via contracting". Literature further argues that noncompetitive contracts can increase the profit margin of firms in comparison to profits in the commercial market since contracting firms are able to transfer overhead and pension costs of their commercial operations to government (LICHTENBERG, 1992; ROGERSON, 1992; THOMAS, TUNG, 1992).

Another major issue concerning cost-efficiency of military production is the optimization of capital investment and production facilities. This affects both the demand and the supply side of the defense market since both will lose with plant closures and job losses, for example. The most obvious solution to this problem would be resource reallocation in the form of conversion from military equipment production to civil goods and services. Supply-side problems include the highly specific nature of defense products, which can hardly be transposed into civil goods. Some examples are stealth and armor technologies and plants that construct nuclear-powered submarines and inter-continental missiles (HARTLEY, 1995; DUMMAS, 1977; 1986). Similarly, military R&D focuses on highly specialized military requirements and secrecy strategies, prioritizing performance over costs and, as a consequence, is less marketable in the civil sector (HARTLEY, 1995; NADAL, 1994, UN, 1993).

Furthermore, the monopsonistic side of the demand side makes defense firms vulnerable to governmental decisions and purchases, making conversion hard, since the nature of these firms has typically a "national champion" trait, relying on subsidies and protectionist measures. In the U.S, after World War II, companies mobilized for the war defense effort returned to their original economic sectors. Nevertheless, with the consolidation of the DIB, conversion to the civil sector has become harder. Beyond the motives above mentioned, the dependency on the requirements of the DoD, has consolidated, over decades, a highly specific form of business in the defense sector, since firms have already compromised its investments in production facilities and technical know-how and managing strategies, characteristic to DoD's demand. Conversion issues affect market economies as much as centrally-planned or transitional ones, albeit in

different way. In the 1990's, conversion was a major concern in the transitional economies of the former Soviet Union, since a large part of their industrial plants were directed to the production of defense equipment[62]. According to the United Nations (1993), a further distinction has to be made between developed and developing nations (UN, 1993) due to the social impacts of different decisions regarding the matter.

Legislation advances in the U.S have tried to mitigate the efficiency, incentives and procurement problems outlined above. One of the most important regulatory turning points was implemented by Secretary of Defense Robert McNamara, who served the post from 1961 to 1968. McNamara appointed Charles Hitch as comptroller for the Office of the Secretary of Defense (OSD), in order to implement the Planning, Programming, Budgeting System (PPBS) on Pentagon's annual budget cycle[63]. The executive began to analyze cost-effectiveness in order to choose among weapon programs. Furthermore, firms became obligated to provide the government with detailed cost information about their activities:

> "(…) the federal government and the Congress imposed standards, specifications and regulations on defense industries that increased the divergence between the behaviors of companies performing defense-related work and those able to employ standard commercial practices," which resulted in the unintended but increasing segregation of defense and commercial operations" (WATTS, 2008, p. 23).

Recent important developments occurred at the beginning of this century, including Department of Defense (DoD) Directive 5000.1, The Defense Acquisition System and DoD Instruction 5000.2. These initiatives were an attempt to improve and update PPBS, which was renamed as Planning, Programming, Budgeting and Execution (PPBE), in order to emphasize the execution phase as a priority. Furthermore, under Secretary of Defense Donald Rumsfeld, the Joint Capabilities Integration and Development System (JCIDS) was introduced, which redefined acquisition requirements and evaluation criteria for defense programs (DoD, 2020). These legislation developments will be explored with more detail in the subsequent chapter, as they are at the center of budgeting matters.

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[62] Hartley (1995, p. 485) gives the example of Ukraine. According to the author in the past, 700 industrial enterprises accounting for 18% of industrial production and 1.2 million workers were dependent on defense orders; by 1994, there were no orders!".

[63] McNamara's PPBS, due to its importance, will be further explored in the upcoming Chapter.

3.3- Innovation: Theoretical Insights

As it was argued in Chapter 1, international competition thrives states to innovate militarily. Innovation is thus inasmuch as important as procurement, production and distribution issues of defense economics. Purchasing innovation further accentuates the problems outlined in the present Chapter, as uncertainty is even higher in these kind of investments. Historically, defense production has always operated at the front of high-tech innovation in order to meet its challenges. Nevertheless, since the 1980's, as it has been already mentioned, there has been a tendency to the commercial sector surpass defense technological advancement, making the discussion about innovation and possible incentives to promote it in the defense sector, even more important.

Demands and challenges to the U.S defense effort include developing ways to successfully counter jungle warfare, urban combat, guerrilla and other missions involving irregular warfare and peacekeeping. This has resulted in a large number of casualties over the last century, most of them in the ground forces[64] (SCALES, 2003). Since 2001, associated with these new challenges, there has been an increasing demand from the DoD, to keep up with warfighting concepts as Network Centric Warfare, Effort Based Operations and Cyberwar. Furthermore, areas such as counter-terrorism systems, counter-mine systems, as well as outsourced administrative-services and battlefield logistics support, have gain importance (WATTS, 2008).

This dissertation investigates the reasons underlying the success or failure of large-scale, mainly innovative, defense projects. Innovation investigation, entails unraveling domestic disputes and external threat issues. There are different variables which could dampen efforts in R&D and government successful incentives for, and acquisition of innovative goods. A simple and almost intuitive fact is that technology has its limits. Technological feasibility is certainly a determinant for success or failure of large-scale projects. Nevertheless, R&D, procurement, incentives, and other issues raised in this Chapter make isolating this variable especially difficult[65]. How innovation works and theoretical developments on this area can further elucidate this matter.

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[64] These challenges also rose the problem of the limits of technology in surpassing the so called "Clausewitzian Friction". For a good analysis of this issue, see: (WATTS, 2004).

[65] While the overall performance of US military technologies and weapon systems has been excellent, the industry has failed, on more than one occasion, to provide systems with the promised capabilities, or only done so after following delays, increased costs, or both. Recent examples of major program failures stemming from cost overruns, schedule slippage, or performance include: i) the termination of the National

According to Fagerberg (2004), innovation is the implementation of an invention. Therefore, the conception, an innovative response to an ongoing threat, for example, has to be operationalized, along with the needed knowledge, resources, abilities and other inventions and innovations required to commercialize the final product in order to be considered an innovation. This dissertation adopts such idea as it investigates large-scale defense projects, considering the materialization or success of the innovation only in the case of the realization of the objectives outlined in the conception of thus projects. Especially important of defense economics analysis is what literature identifies as the "systemic nature of innovation" (FAGERBERG, 2004, p. 13), in which the elements of innovation reinforce or weaken the system as they interact. Innovation is, thus, inherently a collective endeavor as different actors interact and are interconnected.

Since defense is usually organized in a national level, it is necessary to observe the interconnections between private and public actors in a systemic view of this scope of analysis. Cristopher Freeman (1987, p. 1) introduces the concept of national system of innovation (NSI) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". This research approach was introduced in the context of growing technological competition as a result of growing Asian economies in the 1970's and 1980's, and resulted in a number of comparative and quantitative studies to understand the factors that resulted in the success of innovation on different countries[66]. Reppy (2000) argues that the NSI approach is a significant advance of innovation studies, which were traditionally confined to the firm level analysis[67]. Nonetheless, this theoretical approach, since it is more comprehensive, it inevitably entails the problem of its large number of factors and variables, making it difficult to point out their relative weight in a possible causal link (REPPY, 2000).

Reconnaissance Office's (NRO's); ii) Future Imagery Architecture program; iii) termination of Army-Navy Aerial Common Sensor, and; iv) the scrapping of the Coast Guard's Deepwater program to produce the first new coastguard cutters in more than three decades. (WATTS, 2008, p. 49).

[66] See, for example: (FAGERBERG, SRHOLEC, 2018; FAGERBERG, SRHOLEC, VERSPAGEN, 2009).

[67] Reppy (2000, p. 2), states that: "Whereas conventional economic theory locates innovation in the firm, depicted as an optimizing machine running an automatic pilot, and seeks to construct general models of technology diffusion across firms, the NSI approach provides space for the role of government policy, legal institutions, educational and training institutions, and even norms and regimes. Interactive processes and feedback loops are emphasized; no room here for linear models of innovation. Success or failure in innovation can be affected by any of the constituent elements of the system, and weaknesses in one area may be compensated for by strength in another".

Furthermore, research has pointed out that differences between sectors have to be taken into account. Pavitt (1984) has demonstrated, through the development of a taxonomy of industry sectors, which ones transferred technology to other sectors, contributing with an empirical appraisal to decisions of investment with the purpose of innovation. Another conceptual framework that can be fruitful for discussing defense innovation is the Triple-Helix-Model, presented by Ranga e Etzkowitz (2013). The progress of science and its strict relation with innovation has led authors to give a greater weight to universities[68] and basic and applied science research to discuss innovation[69]. The authors identify a triad between universities, government and industry and develop their model in a systematic manner with solid empirical support.

Mowery (2010) points out that the one buyer characteristic of the defense industry is a determinant force to explaining innovation and R&D in the sector. Dombrowski and Gholz (2006, p. 20) argue that this factor makes a large part of the literature dedicated to innovation non applicable to the defense industry. One specific feature of the sector is the source of investment in R&D, which comes from the defense budget in the form of contracts awarded for innovation projects dedicated to specific weapon systems or equipment, previously requested by the military. This form of contract diminishes the risk of R&D investment, as the firms do not have to generate a "normal rate of investment". Nonetheless, it reduces incentives for private investment in defense innovation, since the firms will choose to spend government money then their own resources (DOMBROWSKI, GHOLZ, 2006, p. 21).

Another major issue in defense innovation is its intrinsic political nature. According to Dombrowki and Gholz (2006), political considerations are more important than typical economic calculations in the establishment of the firm's strategy of investment when dealing with defense R&D. According to the authors, defense firms need a great political know how to establish solid relations with the government. Furthermore, success in the defense sector requires that firms have a solid knowledge of military tactics, operations and doctrine, in order to discuss innovation projects with their

[68] Investment in basic and applied science are particularly important to analyzing United States' defense innovation in the post-cold war period, given the increasing amount of spending in R&D in this period.

[69] According to Ranga and Etzkovitz (2013, p. 238): "The Triple Helix thesis is that the potential for innovation and economic development in a Knowledge Society lies in a more prominent role for the university and in the hybridization of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge".

buyer. These requirements usually create an entry barrier to newcomers in the demand side, as it entails the need for a solid network of relationships, military expertise and a high understanding of the government decision-making process.

In order to explain the success or failure of large-defense projects, the mentioned theoretical developments in innovation literature can provide interesting insights and directions. Albeit, as it is argued here, taking into account its limits. The large quantity of relevant factors and idiosyncrasies at a national[70], regional and sectoral level constrains the possibility of a more general model to analyze innovation. Thus, parameters and relevant actors to explaining success or failure of military innovation have, to some extent, to be chosen in an arbitrary *ex ante* scenario. Apart from the boundary established here to take into account high levels of decision making and actors strictly linked to the production of military means, the analysis of innovation success has to be put forward by proxy variables, given its systemic and complex nature. This was done in Chapter 2, regarding domestic politics and will also be necessary in the present chapter, so that it enables the formulation of causal hypotheses to analyze the projects in a comparative, systematic manner, with parameters well established.

3.31- The Intellectual Property Issue

Directly related to innovation are the mechanisms of protecting the products. The means of protecting intellectual property (IP), in the defense market, are different from usual IP legal channels as patents, trademarks and copyrights[71], since security issues are taken into account. Thus, non-institutional methods of protecting IP are relevant to the discussion of innovation and DIB. Among these, are: secrecy; lead-time; non-disclosure agreements and complexity. Usually, defense innovations are characterized by a combination of all of these strategies. Firms and the state will sign non-disclosure agreements, and competition, both in markets and international politics can stir up a race

[70] National case-studies are good examples of the operability of a NSI perspective applied to the defense sector. Sertafi (2000) demonstrates that in the case of France there is a greater participation by the State and government oriented firms in the innovation process. In the case of England, analyzed by James (2000), there has been an increasing role played by private firms, both national and foreign. In the same perspective, Vekstein (1999) conducted a study of Israel, and concluded that security concerns impeded a *spill-over* effect of R&D investments in defense to the civil sector.

[71] For an analyses of different means of protecting IP, see: (MAY, 2006; SWAN, 2009).

for lead-time and complexity. Secrecy is the foremost important IP strategy for innovation in defense. In this case, no one has access to the content of the innovation[72].

There are positive and negative aspects of using secrecy as a IP strategy. The advantages include a reduced cost of legal issues, further R&D enhancement before the commercialization of the innovation and an indefinite time of IP protection. The main disadvantages are the inherent possibility of leakage and the lack of protection against reverse engineering (BOS, BROEKHIZEN, FARIA, 2015; P. 2621). Specifically, in the case of defense, there is a conflicting political and meritocratic issue. Since states are the ultimate buyer and security is considered a public good, they allege that they should have exclusive IP rights. Nonetheless, in states that there is a large private sector participation in the defense sector, as is the case of the U.S, incentive and remuneration issues have become relevant. Renaud Bellais e Renelle Guichard (2006) argue that lack of proper regulatory framework of IP in the defense industry seriously harm technological spill-overs: "current intellectual property laws and practices do not fit technology transfer from government-funded, secrecy-based defense R&D to the privately-funded, patent-based civilian industry" (BELLAIS, GUICHARD, 2006, p. 285)[73].

In the case of the U.S, there were significant advances of IP legislation in the defense industry, although it remains ambiguous in many aspects. The U.S Constitution states that Congress is responsible for promoting property rights. Until the 1980's the DoD had a wider control over defense related property rights. Due to pressure from the private industry, the Defense Procurement Reform Act of 1984 established that an IP section has to be included in defense acquisition contracts[74]. As it was mentioned, after winning the contract, the firm enjoys a monopoly power of the good in question and, thus, has great bargaining leverage in the negotiation. Contends between firms and government

[72] Lichtenberg (1995) and Sertafi (1995) have demonstrated empirically a low rate of patent registration in the defense industry of the United States and France, respectively.

[73] Furthermore, the authors make suggestions towards establishing limits to secrecy and promote a greater cooperation between the civil and military industry: "(…) four recommendations for the establishment of a legal framework that would allow for the creation of an effective market for defense technologies: revealing adequate information about innovations and technology; determining the right perimeter for patents or other means of protecting intellectual property; reducing uncertainty about contractual terms between the state and its industrial partners; and setting up mechanisms to facilitate the development of civilian applications (BELLAIS, GUICHARD, 2006, p. 285).

[74] Regarding the Defense Procurement Act Reform of 1984, see: (VAN ATTA *et al.,* 2007, p. 7).

arise specially in the cases regarding data systems, software and maintenance of defense equipment, since legislation is ambiguous on those matters[75].

International IP rights have evolved institutionally since the founding treaty of the World Intellectual Property Organization (WIPO) in 1967, an intergovernmental organization that is part of the UN system, since 1976. WIPO is responsible, among other things, for supervising international property right treaties, including the Trade-Related Aspects of Intellectual Property Rights (TRIPS). Furthermore, WIPO provides technical assistance to its members and registers international patents and trademarks. Defense industry issues, regarding technology transfer and innovation, are mostly regulated by bilateral agreements or within alliances. In these cases, a number of tradeoffs and concerns, including economic efficiency, burden-sharing and security problems, are present.

3.4- Internationalization *versus* Nationalization: Efficiency and Security Concerns

Some of the same trade-offs present in IP debates regarding defense are embedded in the major issue of national *versus* international markets at a decision-makers point of view. This discussion is especially important for large-scale defense projects, since their high cost and technological difficulties could be overcome by international collaboration between partners or within formal alliances. Furthermore, oscillations in defense spending, procurement and its incentives, affect the firm's strategies and their tendency to look for international markets. In the U.S, the scope of the defense industry makes this especially true. From 1970 to 1976, at the advent of the *détente,* for example, foreign defense sales in the top twenty-five U.S defense firms "rose from under 4 percent of the revenues to over 20" (WATTS, 2008, p. 23).

The choice between protectionism or liberalization is an issue since political economy has existed, and encompasses all economic sectors, albeit security issues arise while discussing possible defense market cooperation or liberalization of trade, even among allies.

A more orthodox economic perspective within literature points out to a promotion of comparative advantage that would result from international specialization from more open defense markets, which would decrease industry costs. Regarding the balance of

[75] For further analyses, see: (VAN ATTA *et al.*, 2017. p. 51).

payments, while defenders of protectionism emphasize the deficit problem, adherents of a more pro-market perspective argue that international division of labor would enhance welfare, saving resources, and ultimately creating jobs by a subsequent allocation of resources to more productive sectors of the economy (HARTLEY, 1995). Furthermore, economic cooperation between states in the defense market, it is argued, could diminish the risk of costly R&D programs at the same time of avoiding their duplication, as well as enhancing scale-production benefits.

Advocates of a more economic nationalist perspective sustain that protecting the DIB, by supporting subsidies and entry barriers, as it was already mentioned, would create jobs, promote important scientific advances, generate high technology, contribute to the balance of payments, and generate spin-offs to the civilian economy[76]. The spin-off versus diversion effect is particularly important to justify high military expenditures, beyond security matters. Whilst adherents of the argument that defense expenditure generates negative externalities, diverting the resources from directly investing in technology generating programs for the civil market[77] (or even investing in health, education, among others), some authors argue that defense competition would enhance innovation:

> "For many observers, the obvious explanation for U.S. dominance of high technology markets the post-World War II period was the cross-subsidization of its civilian technology by investments on military R&D. Aircraft design, space technology, nuclear power, and solid-state electronics are examples of areas that benefitted from large-scale military spending, either for R&D or procurement or both" (REPPY, 2000, p. 9).

Nonetheless, the arguments of the discussion mentioned can be identified with two extremes: a country's choice to completely open the defense market or to purchase all equipment and technology domestically. In between them, several possibilities arise. Defense industry collaboration will not be accomplished naturally among contenders, and, thus, the debate revolves around alliances and partnerships. Within NATO (North Atlantic Treaty Organization), for example, a case of a relatively solid and enduring alliance, proposals of a free-trade area among all its members, a sub-set of its members or specific regions are commonly discussed (HARTLEY, 1995). More radical options, such as a centralized procurement office "purchasing common equipment offer the

[76] For a good assessment of defense international trade and its impacts on national economies, see: (FONTANEL, 1995).

[77] Japan's Ministry of International Trade and Industry (MITI) was an example of direct investment on civilian technology.

greatest cost savings but, politically, it is the most difficult to implement" (HARTLEY, 1995, P. 468). Furthermore, there are different possibilities of deciding which equipment can be liberalized. Strategic equipment such as nuclear systems could be excluded from the free-trade area, for example. Regarding large scale defense projects, specialists such as Moravcsik (1990) and Hartley and Sandler (1990) say that collaboration could be achieved by *just retour* or competition. "Choices are required on the type of equipment to be purchased, the role of competition and the extent of the market in the selection process, the choice of contractor and the type of contract" (HARTLEY, 1995, p. 468).

Regardless of the aforementioned arguments, which are mainly normative propositions, states – especially large powers whom face a scenario of intense international competition, like the United States – would generally prefer indigenous production of defense equipment. Besides the major external threats issues, possible collaboration, even among solid partners, can be explained by domestic variables. High-level decision makers will be confronted with bureaucratic and contractor's interests. Especially in large-scale defense projects, as it was extensively argued in the previous chapter, bureaucracies and interest groups will advocate for monopoly of information and technology, maximization of budget, prestige, among others. Politicians will be worried about their constituencies since defense firms produce a large number of jobs and revenue. As a result:

> "(…) the armed forces, bureaucracies, contractors and scientists within each partner nation will insist upon imposing their requirements, ideas and technical aspirations. Bargaining is inevitable. At the start of the program, each partner nation's armed forces will insist upon their operational requirements; firms will compete for project leadership; and each country's scientists will demand to be involved in the most exciting technical advances" (HARTLEY, 1995, p. 475).

This chapter has so far attempted to address the main issues regarding the production of military means. In order to do so, the concept of DIB was introduced, together with its main features in the U.S case. It was observed that efficiency, procurement and incentive matters induce challenges to the DIB, and trade-offs present themselves, especially in the case of innovative large-scale projects. Sensitive technology, interstate competition, uncertainness regarding the future of the project, parochial and bureaucratic interests, are some of the features that further complicate decision-making. The scope of large-scale projects enhances their political and economic importance, as they become pillars of resource mobilization and allocation strategy, and their success or failure has a large weight on the country's future. All the economic

problems presented so far can affect, in one way or another, efforts of innovation. At this point, the present dissertation will sustain hypotheses addressing the success or failure of large-scale projects from the economic and technological perspective.

3.5- What affects Large-scale Innovation efforts?

Costs and schedule are at the heart of success and failure of large-scale projects. The economic and political issues addressed in this chapter such as efficiency, negative and positive impacts of defense spending, nationalization or internationalization of the DIB, incentives to innovation and procurement, among others, have to be taken into account by decision-makers when dealing with future decisions regarding technological efforts and resource allocation in the defense sector. In a monopsonistic market, the one buyer's decisions will be expressed in the demand curve variations. The response of government, revealed by changes in demand ultimately define the present and future of the program. Different variables affect the governmental demand, which can be reviled by the elasticity of the demand towards projects along the different phases of its development and delivery.

Along with the development of a large-scale project, new information is made available to decision-makers. Changes in the character or level of external threats, technical issues of the project– including its technological feasibility– and possible available substitutes can affect decisions in the Capitol and the DoD regarding demand revisions. Through this process, bureaucratic and parochial interests will also pressure for demand curve revisions[78]. Ultimately, government can alter the requirements, quantity and ultimately cancel a large-scale project.

The success of a program, understood as the accomplishment of its initial objectives, will be represented in the government's demand elasticity towards its procurement, through the successive demand curve revisions (identified in the appropriation schedule). This dissertation argues that technological feasibility is determinant and thus cannot be left out of an explanation or the success or failure of a large-scale defense project. A proxy variable to measure technological feasibility, which

[78] Scherer (1964, pp. 54-53) suggests that even systems that have no obvious technical or operational substitutes are "threatened" by rival systems in the bureaucratic competition for budgetary support. In the early 1960's, for example, according to Watts (2008), (offensive) Polaris missiles and the Nike Zeus ballistic missile defense programs were regarded by top Defense Department (DoD) officials as substitutes, in effect.

is hardly possible in an *ex ante* scenario can be isolated by observing demand curve revisions along the development of the project. Demand curve revisions incorporate the technological feasibility aspect of the project. Together with the domestic political and external threat variables, observing technological feasibility can provide a solid explanation to the outcome of large-scale defense projects. However, this does not mean that other important factors, some of which were already discussed here, cannot affect demand elasticity. Nonetheless, as it was already argued, due to the complex systemic nature of innovation, a degree of arbitrariness in the choice of variables to test is inevitable.

3.6- What to expect?

It is not the purpose of this dissertation to exhaust the hypotheses put forward by defense economic issues regarding large-scale defense projects, acquisition, international collaboration, efficiency and effectiveness, since, as it has been demonstrated, studies in these subjects are far from a consensual matter in the discipline of Defense Economics and it would be unproductive to attempt to test all the main ideas that literature offers. Nonetheless, some premises outlined here that should be empirically observed in the comparative large-scale projects studies.

Regarding parameters of success, albeit player's stands will be also motivated by cost optimization, the wait of economic efficiency will be subordinated to strategy and (understood as the engagement of military means) and effectiveness. As for the U.S' DIB characteristics, both within the supply side and the demand side, the defense expenditure should be cost-inefficient in theoretical economics terms, as the underlying risk of innovation in defense and the security prioritization requires guaranties to actors which impact negatively competition and conversion. Relating to Chapter 2 and the discussed bureaucratic and inter-agency conflicts, dispute among actors and parochialism is expected, dampening economic efficiency in procurement and acquisition matters and resource distribution. Finally, since innovation is systemic and inherently uncertain, in order to succeed, actors will have to coordinate to share the burden of the initial steps: R&D and contractual arrangements, for example.

Technological advancement in an interstate competitive environment might make economic nationalism in defense prevail, especially regarding critical components of the innovative frontier. Advocates of economic nationalism will try to enhance their

bargaining power arguing in terms of security concerns. Consequentially, cooperation among allies can be expected, but international economic liberalization in defense will be subordinate to national strategic concerns.

Despite the important inferences and conclusions outlined in this Chapter regarding Defense Economics, a *sine qua non* condition for the success or failure of large-scale defense projects[79] is its technological feasibility. Whilst trade-offs exist in almost all economic issues discussed, the mere possibility for production, or in other terms- the material imperative- remains the crucial aspect for large-scale innovative projects. As resources are devoted to the system's research and development, information about the true cost of acquiring the system is generated, and the degree of technological uncertainty is reduced. To test the relation between the innovative technological feasibility variable and the dependent variable (success or failure of large-scale innovative defense projects) the main hypothesis of this chapter is:

Main Hypothesis: In order to measure in a proxy manner technological feasibility, it is assumed that, through the extent of the project, between t1 and t2, for example, the variation of the demand between the initial projected cost of the project and the real acquisition cost and the difference between projected and real schedule gives among others, an approximate of the technological feasibility of the project. Thus, schedule and cost revisions should be analyzed as a *proxy* variable to determine a projects' technological feasibility. Technological feasibility should be analyzed through the empirical investigation of the project's development. Alongside with cost and schedule modifications, persisting contestation of the technical challenges put forward by specialists and interested actors in the project are also indicators of the project's technological feasibility. It is argued that the tracing of these indicators can provide an approximate – since there is no precise measurement available – evaluation of the technological feasibility issue. In this sense, the projects are analyzed from the conceptualization towards the development, testing and acquisition of the project's resulting innovative product or its abandonment during the process. *Ex ante*, an innovative project entails technological feasibility risks. Throughout its development, it

[79] Defined, earlier in this dissertation, as *the relative accomplishment of the projects initial purposes.* High success of a large-scale defense project is understood here as a scenario were production reaches its initial objective. Failure is understood here as a low achievement in comparison to the projects initial goals and, at the limit, the cancelation of the project.

can prove itself feasible or persistent challenges and doubts surrounding the project weakens it. At the limit it demonstrates itself to be totally feasible or unfeasible. How it affects the project, however, it is argued here, is that even though if at the end it proves itself technologically feasible, technological feasibility matters during its development impact the result to the limit that it is cancelled or greatly modified relative to its initial goals.

The conclusions outlined in this section will serve as a guide to the empirical investigation and will be put to test, mainly through approximate qualitative observable historical reconstruction, focusing especially on the indicators which provide a proxy variable of technological feasibility. The next chapter will be focused on process. The process of budgeting and acquisition will reveal the issues outlined in this and the two previous chapters, since in the budgeting "arena", threat, domestic disputes, technological and efficacy matters, will appear in the form of conflicting interests and arguments by players. Understanding the process, thus, behooves the analysis.

CHAPTER 4- THE CORE OF DISPUTE: BUDGETING

> "*The victories and defeats, the compromises and the bargains, the realms of agreement and the spheres of conflict in regard to the role of national government in our society all appear in the budget. In the most integral sense, the budget lies at the heart of the political process" (WILDAVSKY, 1964. p. 5).*

Aiming towards a framework of defense politics analysis, it is argued, in this dissertation, that one can operate and draw variables and hypotheses from structure, actors, processes and issues. Chapter 1 engaged in the structure of the International System and the variable of external threat. Chapter 2 sustained hypotheses by analyzing the main actors in defense decision-making. As for Chapter 3, the economic structure of a given nation at a certain period- and also, in more generable abstract terms- was studied. Issues regarding the economics of defense are complex and involve *trade-offs* and ongoing debates. Nonetheless, given the systemic nature of innovation and the variety of actors involved in the economic processes underlying large-defense projects, a proxy variable was suggested, along with a main and auxiliary hypothesis, in order to develop the theoretical framework, which will be confronted with the empirical object.

Besides more general economic processes and regarding the issue of large-defense projects, a more specific and quintessential process presents itself– budgeting. In budgeting, structure and the main actors appear in a sense that their role can be inferred. Furthermore, economic *trade-offs,* strategic and tactical considerations are considered in the arguments and decision-making process in a more objective way.

There is no policy without resource mobilization and allocation. Achieving political objectives through national security policy without a correspondent budget is merely political rhetoric (ADAMS, WILLIAMS, 2010). According to Adams and Williams (2010, p. 222), "Analysts of the national security policymaking rarely dig into the politics of the budgetary process". To analyze the politics of budget, its many actors and the interaction among them, the formal process and its regulations is imperative in order to understand national strategy, especially when decisions don't appear "rational".

Besides reviewing the importance of some actors such as it was done in Chapter 2, the aim of this chapter is to present the process of decision-making from an organized

and schematic point of view. In order to achieve this aim, legislation, Congress' role and committees and the DoD structure of decision-making will be outlined. It is important to say that this chapter is mainly descriptive and counts almost solely on the existing literature, which has already engaged in organizing the process of budgeting itself. Hence, this is a transitory chapter between the theoretical discussions realized in the previous chapters and the subsequent comparative case analysis. The aim here is to provide a connection between structure, actors, process and issue. This will make it clearer to trace the large-defense projects analyzed in this dissertation, especially regarding the their lifecycle, important steps and documents to be attentive while studying the empirical cases.

4.1- Theoretical Accounts on Budgeting

In the United States, budgeting planning and analysis derives from public policy studies. Briefly put, public policy is the channel through government acts and budgeting is the function of government that mobilizes resources and allocates them to accomplish the effects of those actions. It is argued here that explaining the process that lies at the core of large-scale defense projects allied with some public policy definitions, a more broadly analysis of the US' Federal Government and the specific defense budgeting process is a useful theoretical/empirical transition towards analyzing the case studies comparatively. Nonetheless, the descriptive character of public policy and legislation, if one aims at explaining decision-making, has to be allied with theories such as the framework put forward in Chapters 2 and 3. The economic issues raised in the previous chapter underlies all budgeting discussions as well.

In the 1970's and 1980's scholars developed the stages model in order to explain and evaluate public policy (JONES, 1970; ANDERSON, 1975; BREWER & DE LEON, 1983). The stages model consists in five steps of public policy: i) agenda setting; ii) formulation; iii) legitimation; iv) implementation and v) evaluation[80]. As for agenda setting and formulation, information and prioritizing certain societal issues are the key factors. The actors and processes capable of setting the agenda can be viewed by an elitist approach, a more pluralistic mechanism (which would involve greater participation of society and the media, for example) or a government centered point of view– which bureaucracies and state-centric policies have privileged position to act besides pressure

[80] For a detailed analysis of the stages model see: (CANDREVA, 2017).

groups. Formulation can also be opened or more closed within government, albeit the policy alternatives often involve large debates in society as they have to demonstrate efficiency and effectiveness regarding both important budget and moral considerations. Legitimation derives from the division of power intrinsic to democratic societies, were rules and checks and balances between the three powers will affect public policy and its possible constraints. Implementation is all about the actual policy *versus* the designed model, with factors like the time horizon or information flows among the various actors involved in implementing can alter substantially the results of the intended policy (PETERS, 2013). Finally, evaluation analyzes the effectiveness and efficiency of the policy, which can be complicated since social issues are multivariable and causality is hard to identify.

Other models which relate to public policy in general and budgeting by consequence are: i) Incrementalism; ii) rational limitations; iii) Punctuated-Equilibrium; iv) Advocacy Coalition Framework; v) model of Muddling Through and; v) Institutionalism[81].

Nonetheless, especially important for the discussion of defense budget is Incrementalism. Put forward by Aeeron Wildavsky (1964), incrementalism advocates that in wealthy nations with stable economies and government revenues, the current budget is a small amount larger or lower than the previous year. Empirical studies hold the hypothesis true. Jones and Baumgartner (1993), argue that Wildavsky's analysis prevails most of the time, but is interrupted by dramatic external or internal events. In the case of defense, wars are the intuitive example of such hypothesis. Important to this dissertation is Demarest`s (2017) hypothesis, which sustains that incrementalism does not hold true in the case of individual budget components, or more specifically, in the case of his study, individual defense programs:

> "Contrary to expectations, budget outcomes are frequently volatile and unpredictable at the individual program level. Congressional authorizing and appropriating committees modify the Army's funding request significantly for a large proportion of programs. Budget outcomes at the program level cannot be attributed to a single explanatory factor, but rather are a result of a combination of the program's technical characteristics, actions taken by the defense industry, and traditional political considerations. The Army's ability to manage program funding and influence these powerful factors by engaging with members of Congress and professional committee staffers is related to the quality of their interaction (…) reliable budget outcomes may be more likely

[81] See: (CANDREVA, 2017; HAYES, 2015; DEMAREST, 2017; SIMON 1965; BAUMGARTNER, JONES, 1993; SABATIER, JENKINS-SMITH, 1993; MINER, 2006).

> when the Army requests incremental funding adjustments to existing programs (DEMAREST, 2017, P. 2). (...) Program funding is markedly non-incremental, and is not confined to a particular or consistent subset of programs. Individual program funding fluctuates wildly as political and programmatic battles are won and lost, contrary to the conventional portrait of an immovable budget" (DEMAREST, 2017, p. 12).

Given the importance of Demarest`s theory for large-defense projects, dialogue with its premises is indispensable in the subsequent chapters, which are dedicated to the comparative empirical cases. Demarest's hypothesis has a strong tie with Punctuated-Equilibrium Theory, discussed in Chapter 2. The authors working in this framework have attempted to produce a model of national budgeting (JONES, BAUMGARTBER, TRUE, 1995; 1996; 1998; 2000; TRUE, 1995; 2000; JONES, SULKIN, LARSEN, 2003; JONES, BAUMGARTNER, 2005). Demarest's work and both ACF and Punctuated-Equilibrium theory depart from incrementalism, recognizing its merit in explaining inertia and empirical solidness at most of the time, albeit attempting to explain significant changes reflected in the budget. For Jones and Braumgartner (2011) the agenda-based model of policymaking and the serial shift model of decision-making together produce a pattern of punctuations and equilibria in the budget processes.

Other authors already investigated intensively the matter[82]. According to John Padgett (1980;1981) there is "the occasional occurrence of very radical changes" (PADGETT, 1980, p. 366). Thurmaier (1995) suggested that decision-makers shift from economic to political calculation after being sourced with new information and thus, punctuations in the budget occur. Jones and Braumgartner (2011, p. 168-169) argue that:

> "Because we expect the dynamics of budget decision-making to occur at all levels, we hypothesize scale invariance. That is, we expect the underlying, nonnormal distribution of annual changes to be evident at all levels of aggregation (program, function, subfunction, and agency (…) That is, we expect subfunctions to be more leptokurtic than functions, and functions to be more leptokurtic than higher aggregations".

This is consistent with first findings in literature: "although it is basically incremental, the budget process does respond to the needs of the economy and society,

[82] See: (OSTROM, 1978; KAMLET, MOWERY; 1987, KIEWIET, MCCUBBINS, 1999; SU, KAMLET, MOWERY, 1993; KIEL, ELLIOTT, 1992; MANDELBROT, 1963; PADGETT, 1980; MIDLARSKY, 1988; BAK, CHEN, 1991; PETERS, 1991). For investigations on budget punctuations applied to other countries, see for the United Kingdom, Denmark, Germany, France and Belgium, respectively: i) (JOHN AND MARGETTS 2003; SOROKA, WLEZIEN, MCLEAN, 2006); II) (BREUNIG 2006; MORTENSEN, 2005), III) (BREUNIG, 2006) IV) (BAUMGARTNER, FRANÇOIS, FOUCAULT, 2006), V) (WALGRAVE, VERONE, DUMONT, 2005).

but only after sufficient pressure has built up to cause abrupt changes precipitated by these events" (DAVIS, DEMPSTER, WILDAVSKY, 1964, p. 427). Punctuated-Equilibrium theory also recognizes "yet subsystem politics and the bureaucratic regularity of annual budget submissions constitute endogenous forces that favor continuing with the same decision design" (JONES, BAUMGARTNER, 2011). Nevertheless, the higher level of variance at project level and the leptokurtic expected graph, if the theory holds, will be evident in the subsequent chapters, giving Punctuated-Equilibrium Theory a strong importance to the investigation proposed here.

Although there are different propositions and ontological assumptions from the sources of punctuations, the cited literature attempts to explain their occurrence. The authors base their developments from Simon's bounded rationality concept to explain the prevalence of incrementalism and, in some cases, the attention given to specific necessities that demand radical change. This dissertation, as it attempts to explaining innovative large-scale projects, adheres to the studies that suggest that budget punctuates at all levels (e.g., project, subfunction). Jones and Braumgartner (2011) maintain that budgeting is a stochastic process and it is extremely difficult to specify precise causal linkage among all of the variables which produces change in the budget. Nonetheless, is this not the case with almost all political matters? The overall historical defense budget correlates strongly with external threats and the distribution of power, which provides solid evidence by the literature presented in Chapter 1, which argued that states mobilize and build capacities according to external threat. Whilst the overall defense budget can be explained largely by external threats, the model suggested here, in accordance with Demarest (2017), is that domestic political factors and the economic technological development structure (framework developed within the two previous chapters) can explain budget fluctuations in large-scale defense programs in a precise manner.

In this Chapter, a detailed process regarding budgeting will be outlined with an emphasis on organizational and processes regarding its main actors. However, some simple concepts are useful at this time for clarification of the United States' federal budget process.

Mandatory legislation does not require annual appropriation or authorization and some examples include Medicare, Social Security and Interest on the national debt. As for discretionary spending, the amount is reviewed and requires it to be revisited on an annual basis. Candreva (2017, p. 52) points out that mandatory programs have grown in

relation to discretionary spending. In the Fiscal Year (FY) of 2017, for example, mandatory spending accounted for 70% of the total of federal budget. For budgets to be in a reasonable level of stability, or to occur a surplus, the government must count mainly on revenues in the form of individual and corporate taxes, treasury issued bills, notes, bonds, among others, which would ideally be larger than the governments outlays- according to Candreva (2017, p. 55), there were only 4 surplus budgets in the last 40 years (1998-2001).

As it will be detailed further, Congress passes two bills (authorization and appropriation acts) each FY. The appropriation committee is subdivided in twelve subcommittees, each dedicated for a major account of budgeting. Nonetheless, in the case of defense, for example, this committee structure can be decomposed for purposes of analysis into appropriation titles. The defense budget is appropriated in six titles: i) military personnel; operation and maintenance (O&M); iii) procurement; iv) RDT&E; v) military construction and family housing and; vi) other. Some legislation and process aspects of budgeting will be outlined subsequently in order to a better placement of large-defense projects in the general appropriation process.

4.2- Budget Process and Legislation

Constitutionally, the legislature is responsible for taxing and spending decisions. The executive, on its side, has veto authority over appropriation bills, which can only be overrode by congressional two thirds majority. Historically, however, legislation has evolved in budgeting matters.

Figure 4.1- Budgeting Legislation

Budget and Accounting Act of 1921 (P.L 67-13) established the framework for modern executive branch budget process. It consolidated budget power in the executive office of the president by:

- Creating a national budget system
- Creating the Bureau of the Budget (now the Office of Management and Budget)
- Requiring the President on annually submit to Congress a consolidated budget for the federal government

To balance the increase in executive power, Congress also created a central audit agency to be organizationally aligned with the legislature: the General Accounting Office, now the Government Accountability Office.

Congressional Budget and Impoundment Control Act of 1974 (P.L 93-344) governs the role of Congress in the U.S budget process. This legislation gave more budget power to the Congress by:

- Creating the Congressional Budget Office
- Creating Budget Committees in each house
- Creating the Budget Resolution and Reconciliation processes
- Adding time for congressional action by shifting the fiscal year three months
- Removing the presidential power of impoundment and replacing it with a mechanism where the president can request a recission of appropriations

Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm-Rudman-Hollings I), **Balanced Budget and Emergency Deficit Control Reaffirmation Act of 1987** (Gramm-Rudman-Hollings II), **Budget Enforcement Act of 1990**, **Balanced Budget Act of 1997**, **Deficit Reduction Act of 2005**, **Budget Control Act of 2011**, **Bipartisan Budget Acts of 2013 and 2015**- these where all measures that sought to minimize budget deficits through a variety of mechanisms such as spending caps, automatic rescissions, sequestration, pay-as-you-go provisions, etc

Source: (CANDREVA, 2017, p. 94).

Up to this date the federal budget process is regulated by the legislation outlined above. Before entering the specificities of the defense budget decision-making process and its actors, it fits this study to look at the federal budget process more generally. Budgeting in the U.S is divided in four phases: i) formulation; ii) legislative enactment; iii) executive budget execution and; iv) report, audit and evaluation[83].

Firstly, the executive branch formulates the budget working together with the Office of Management and Budget (OMB) through its Circular A-11 (Preparation,

[83] For a more detailed analysis, see: (CANDREVA, 2017; ADAMS, WILLIAMS, 2010).

Submission and Execution of the Budget) and the different departments that compose the executive in order to align them with the government`s priorities, fiscal and monetary policies and compliance to the A-11. Usually, this process, as the others, happen simultaneously and ahead of the FY in place, given the complexity and contends that might be risen. Disputes are settled by the president which submits his budget on the first Monday in February of each year. It is not by accident that the famous "State of the Nation Address" is usually given a few weeks earlier.

Secondly, Congress may accept and approve or reject the whole proposal or modify parts of it. The Congress has support agencies such as the Congressional Budget Office (CBO) and the Library of Congress who give accounts on the programs and their impacts, as well as the economic situation in general, providing the committees with important information. The General Accountability Office (GAO) prepares assessments of programs, giving recommendations for improvements. Congress, regarding budget, acts through three committees: i) House and Senate Committees on the Budget ii) The Authorizing Committees, and; iii) Appropriation Committees. House and Senate Committees on the Budget will hold hearings, examine economic consequences, debate and hold floor votes on the budget. For example, the House and Senate Armed Services Committees (HASC and SASC) provide views and estimates on the budget`s defense proposals (CANDREVA, 2017). The work of the budget committees, however, do not have status of law. As for the Authorizing Committees, they are responsible for oversighting and controlling executive power. Jurisdiction is given according to category. HASC and SASC hold jurisdiction on "National Defense budget function in general, including DoD and the DoE's (Department of Energy) nuclear weapons activities and selective service systems" (ADAMS, WILLIAMS, 2010, p. 202). Authorizing committees approves appropriations for the programs in the Act, including individual programs; it permits them to exist (CANDREVA, 2017).

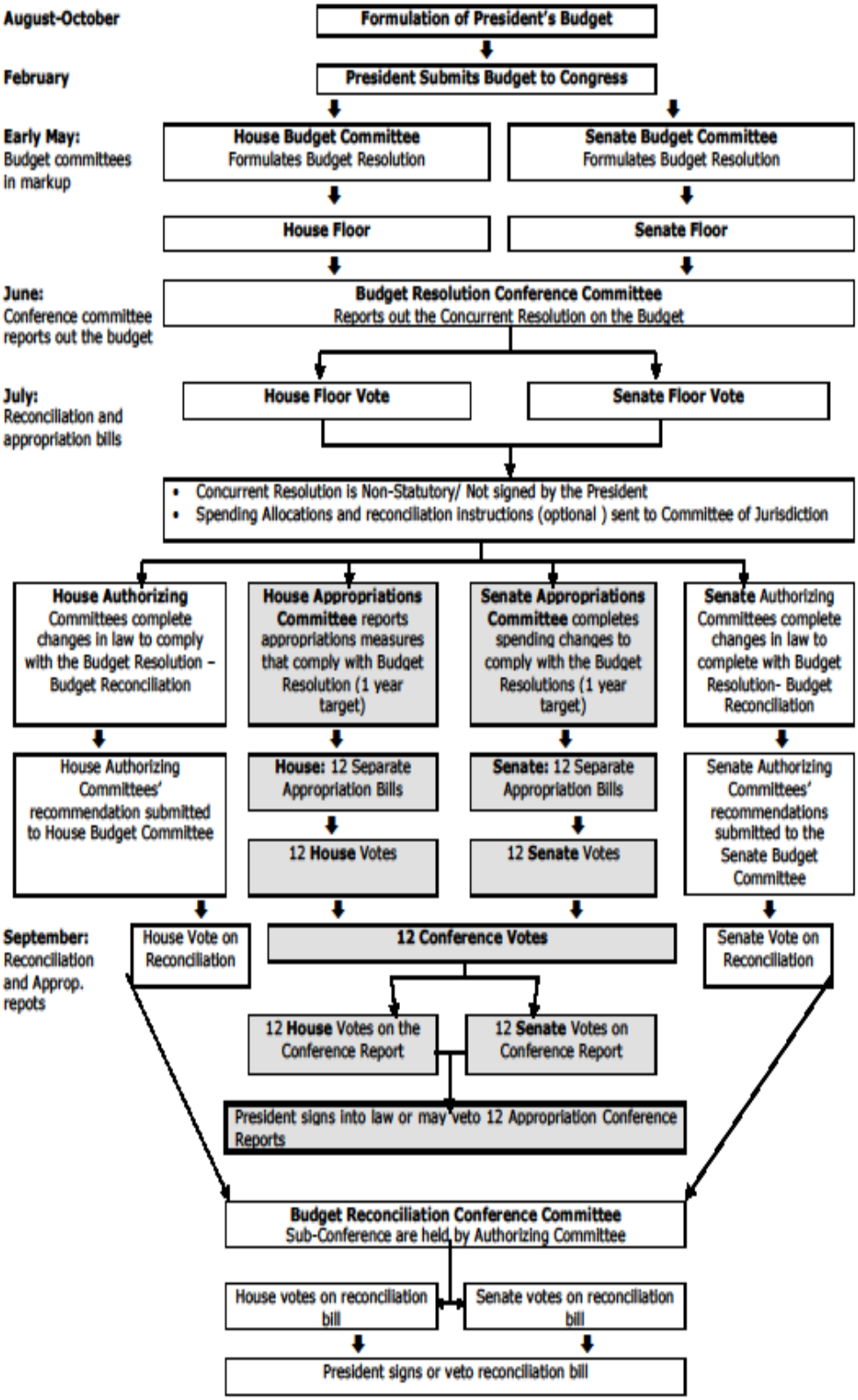
> "All major procurement programs and their specific quantities are authorized, as well as force levels, pay raises and benefits, the creation, modification, or dissolution of command structures, the (dis) establishment of military bases, the boundaries of authority between partner agencies (e.g., DoD, Department of Homeland Security, Central Intelligence Agency), and more" (CANDREVA, 2017, p. 103).

Authorizing committees produce bills, which after both chambers vote, goes to the White House for signature, becoming law. Pivotal to the budgeting process in legislative enactment is the appropriation phase held by the Senate Appropriation

Committee (SAC) and the House Appropriation Committee (HAC). These committees are divided into twelve subcommittees and are responsible for drafting the discretionary appropriation bills. Defense has its own subcommittee albeit other subcommittees like "Homeland Security" and "Military Construction, Veteran Affairs and Related Agencies" as well as those regarding energy and foreign operations inevitably affect defense decision-making and plans. The Chairman of the Appropriations Committee has broad authority for allocation of money among subcommittees, which will each elaborate a bill and report to the whole committee. After passing both floors, preferably before October 1st, the beginning of the FY, the bill goes to the president to be signed.

Usually appropriation bills do not pass in time for the beginning of the next FY. Furthermore, the authorization bills overlap the ideal time framework for the Congress' budgeting process (SATURNO, TOLLESTRUP, 2016). In this case, in order to the government keep functioning, Congress authorizes temporary appropriations, or continuing resolutions (CRs). As CRs have a previously determined time framework, even though others can be issued, departments have to plan their budgets accordingly. Important to the discussion put forward in this dissertation is that no new programs may start under a CR and programs that were set to end are forced to continue. In defense projects, this is a major set down, due to the often desire of new contracts or to pass programs to the next phase (CANDREVA, 2017). Analog to the third phase mentioned above – executive budget execution– Congress oversights the budget to make sure that the bills enacted are fully fulfilled. In this sense, Congress can "withhold" from a department, for example, procurement funds in defense can be withheld pending the milestone decision to advance into the production phase, depending on the evaluation made by Congress.

Figure 4.2- FY Budgeting Process



Source: (NHIB, 2018).

Usually, in the case of military contingencies operations, they are funded by the already appropriated amount. In extraordinary cases, DoD may submit a supplemental appropriation request to Congress. As mentioned, the fourth phase of the federal budget process– Reporting, Auditing and Evaluation– is also about Congress ensuring that its laws are faithfully executed. In this sense, the GAO, as the central auditing agency of the federal government oversees receipt and application of public funds. Furthermore, the OMB evaluates performance, procurement practices, financial management, information technology, among others. Auditing is divided among a financial audit, a performance audit and a compliance audit (CANDREVA, 2017, p. 112). In the following topic, specificities of the actors involved in defense budgeting will be outlined.

It is important to point out that the DoD has a structure to dialogue with Congress throughout the FY. In the case of the Army, for example, a Chief, Legislative Liaison (OCLL), headed by a two-star general and a substantial staff, keeps constant interaction with HASC and SASC, as well as discussions regarding Army procurement program authorizations (DEMAREST, 2017). Other important actors such as the OMB, the CBO and the Secretary of Defense staff also interact with Congress, as it will be demonstrated in the next section.

4.3- The DoD's Role in Decision-Making

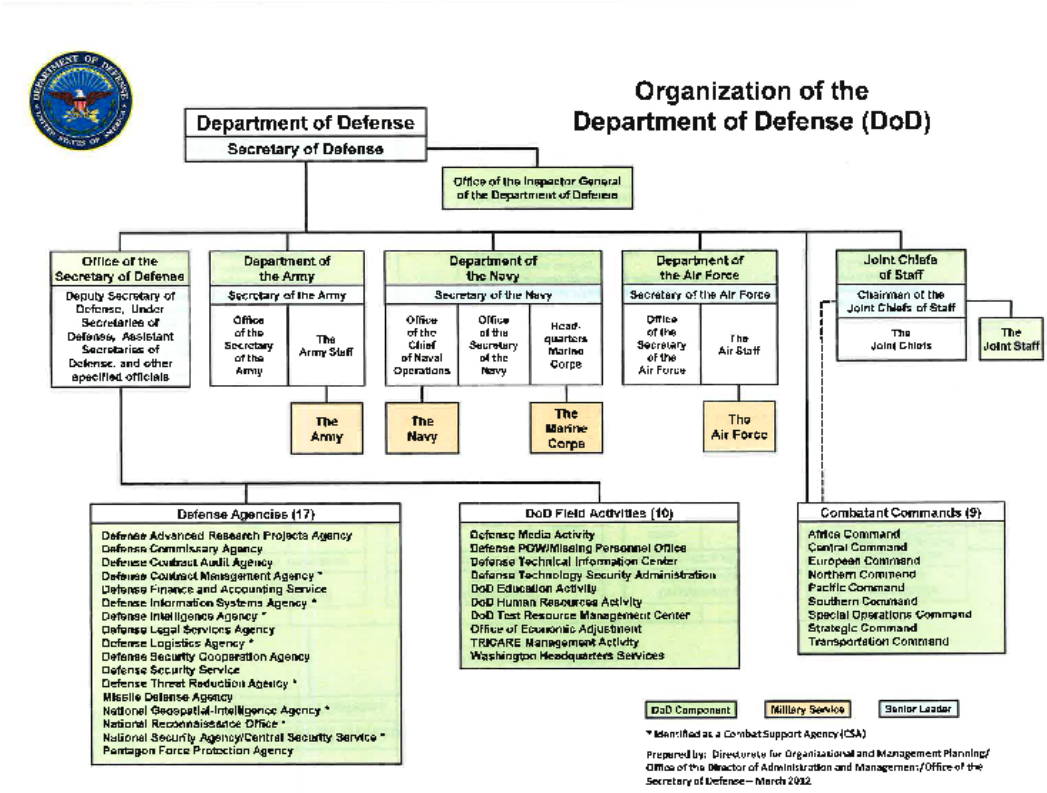
The DoD is by far the largest department in the U.S federal government. By 2010 it already counted with 1.4 million active-duty personnel, 850,000 paid members of the Guard and Reserve and 700,000 civilian employees (ADAMS, WILLIAMS, 2010, p. 92). By consequence of its complexity, its internal organization and planning processes has to be meticulous. In order to assure civilian control over the military, Secretary of Defense Robert McNamara introduced the Planning, Programming and Budgeting System (PPBS) during the 1960's.

Basically, the PPBS system was aimed at providing civilian political direction to military resource allocation and, by consequence, to strategy. In the planning phase the services develop the programs and submit them for revision made by the Secretary of Defense (OSD). OSD programs the defense directions, adjusting possible problems, in order to tune them to the budget request to Congress. In the Goldwater-Nichols Act of 1986 PPBS was modified, introducing more voice to the Joint Chief of Staff (JCS). In 2003, it was renamed to Planning, Programming, Budgeting and Execution process

(PPBE). Furthermore, the Quadrennial Defense Review (QDR) were mandated after 1996 to be submitted to Congress in the beginning of each presidential term[84].

Components of DoD such as armed services and agencies participate in the PPBE. They make drafts of their preference for the development of the Program Objective Memorandum (POM), which is a five; or six-year plan. Components also draw Budget Estimate submissions (BES)- a tow-year budget plan.

Figure 4.3- DoD Organizational Chart



Source: (DoD, 2020).

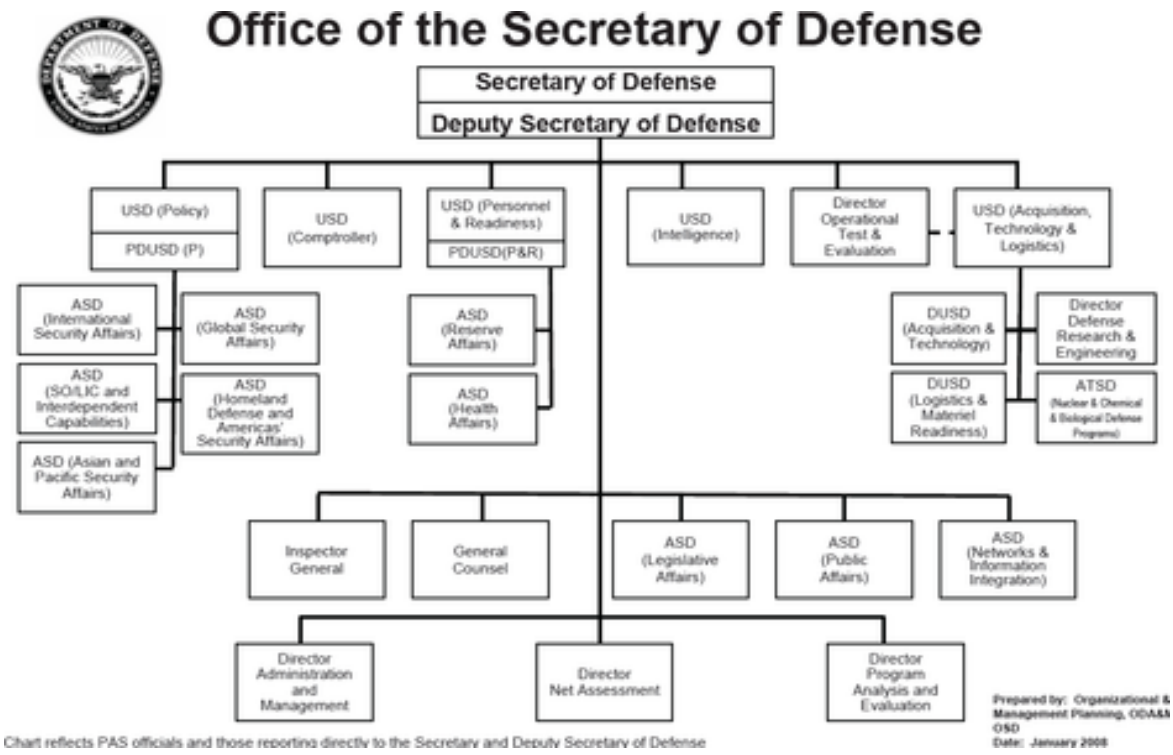
The Joint Chiefs of Staff as well as the Combatant Commands have a crucial role in PPBE. The chairman of the JCS develops the National Military Strategy and the Chairman's Program Recommendation (CPR), accesses the POMs through the Chairman's Program Assessment (CPA). The COCOMs (Combatant Commands) issue Integrated Priority Lists (IPLs) each year and work with services to integrate their operation budget requirements. Nonetheless, the services and its commanders are subject

[84] The historical facts outlined in this paragraph were based on: (ADAMS, WILLIAMS, 2010).

to strict civil supervision by the Office of the Secretary of Defense (OSD) and the OMB during each phase of the PPBE.

According to Adams and Williams (2010), three undersecretaries of the OSD play a decisive role on the PPBE process: i) Under Secretary of Defense for Policy (USD(P)); ii) Director of Program Analysis and Evaluation (D(PA&E) and the DoD Comptroller (USD (C).

Figure 4.4- OSD Organizational Chart



Source: (DoD, 2020).

The USD(P) plays the role of starting to plan aligning strategy requirements with resources available. The PA&E prepares fiscal guidance to allocate resources among the different agencies and military departments as well as manages planning for the Joint Programming Guidance (JPG). Its office gathers the database necessary for the Future-Years Defense Program, or FYDP, and conducts cost-benefit analysis regarding tradeoffs and alternative to service plans, programs and budgets. In the PA&E, there is a group specialized in developing estimates of the future costs of individual defense systems and programs- the Cost Analysis Improvement Group (CAIG) (ADAMS, WILLIAMS, 2010, p. 98). As for the Comptroller's role, it is centered around the budgeting phase of the PPBE and fiscal accountability effort for execution. The Comptroller advises the

Secretary of Defense in budgetary and fiscal matters. Furthermore, other undersecretaries as the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L) will appear as players in the moment this dissertation analyzes large-scale defense projects.

The defense planning process *per se* begins in the White House, as strategy serves political objectives. The White House develops the National Security Strategy (NSS) within the National Security Council (NSC). Following that, the DoD develops the National Defense Strategy, which is signed by the Secretary. Given these general guidelines the office of the USD (P) works with the SLRG and the COCOMs to draft the Strategic Planning Guidance (SPG), which is more detailed and should represent the possible objectives given the resources available. Afterwards, the OMB develops the fiscal guidance for the DoD, which has to accommodate the SPG with OMB's guidance to develop the Joint Programming Guidance (JPG)- which instructs and provides metrics and goals to capabilities and programs (ADAMS, WILLIAMS, 2010).

Reviewing the program before issuing the bill for the President requires the interaction of multiple actors. Components submit their POMs and BESs to the Comptroller and the PA&E who review budgets and programs. The chairman of the JCS, can provide assessments and raise issues for debate. In this stage, the OMB can also participate. Finally, the OSD submits the program to the President. Regardless of presidential power, it is necessary to point out that the White House has also to deal with agency coordination and bureaucratic interests within its own structure, for example, in the NSC and with the OMB. As stated by Adams and Williams (2010, p. 162):

> "For the President, the budget is his most important tool for shaping the policy agenda and implementing policy goals. Budget planning and program execution are at the heart of the relationship between the White House and the executive branch agencies. The budget generally the focus of policy disagreements and negotiations with the Congress. Consequently, the budget planning tools and processes in the White House are a crucial ingredient of national security budgeting".

4.4- Budgeting is Politics

The end of strategy has a political aim. A good strategy has to constrain parochial interests in the sense that the one, in a democratic state, achieves a balance between interest groups, military-civil relations, and so forth. The process and organizational/institutional arrangements outlined in this Chapter are a complex and

schematic way of U.S' way of trying to achieve this balance, especially since Secretary McNamara's initiatives in the 1960's.

In the previous chapter, the main economic issues regarding the mobilization and distribution of defense resources were revised. As it was showed, economists have tried to develop models that would achieve a quantifiable "optimal defense spending level". That is to say, in terms of public policy, expenditures that would result in efficient and effective outcomes. Both Keynesian or neoclassical approaches were developed, authors still emphasize the political nature of military spending and attempt to incorporate these variables in analysis (SMITH, 1995). Dudley and Montmarquette (1981), for example, study the impact of the demand for military spending from the median voter. It is argued here that public opinion has to be taken in consideration while the government justifies and evaluates levels of defense spending.

Rationality is an important part of economics and other discipline's developments and is discussed regarding budgeting as well. As it was argued in Chapter 2, governments cannot be seen as unified rational actors. Instead, they operate in a conflicting environment, with bureaucratic interests, inter-service rivalry, lobbying and other variables affecting their choices. Some authors give weight to class struggle and thus incorporate class interests in the determination of defense policy, developing Marxist models to engage in the issue (SMITH, 1977, 1978; GRIFFIN, WALLACE, DEVINE, 1982). Even if one would assume instrumental rationality, information processing capability would have to be taken into consideration, making optimal strategies conditioned by a questionably informed decision-maker. This Chapter shows that with the variety and quantity of actors involved, an optimal flow of information along the process would be at least questionable. According to Smith (1995, p. 76):

> "While it may be plausible to assert that rationality, bureaucracy or political pressures impose constraints which reduce the freedom of choice of governments in setting their military expenditure and thus provide structure and predictability on choices, it is less plausible to assert that these constraints are constant. But variation in the constraints will produce structural instability and loss of predictability".

The result is that the dispute for budget, and on the main point of this dissertation, large-scale defense projects, is subjected to historical contingencies and idiosyncrasies. Therefore, the detailed empirical tracing of the process (outlined in the sections above) is quintessential. The process also gives important clues into what documents that should be given emphasis, as for example, the POMs. A proper analysis, hence, incorporates

many of the important variables treated in this thesis, such as domestic turns, bureaucratic decision-making processes and foreign threats. Nonetheless, Candreva (2017) analyzes the general trends of defense budgeting; while this study focuses on specific large-scale projects. There are certainly dialogue among both assessments, albeit there are factors which differs them- which this dissertation will engage in the following chapters.

As stated by Adams and Williams (2010, p. 221) "without resources, national security policy is largely rhetoric. Policy is shaped and implemented through the budget process". A National Security Strategy or the intentions of the President have to go through a complex process to be objectively translated into its respective objectives, if and when that happens. This Chapter has shown the significant role played by Senior Policy Officials, which are one of the President of directing defense politics, by political appointments. Nevertheless, consensus is hard to achieve while dealing with other important actors. Congress plays a crucial and decisive role on allocating resources, auditing and evaluating defense politics. Congress holds the "power of the purse". Bureaucracies involved, especially military services, will rarely voluntarily down-size its missions or shrink its budget and prestige. That gives special importance to civil-military relations. Industry, constituency issues and public opinion are also of large importance, and as it was argued it Chapter 2, albeit not in a fully representative manner, can be represented, as a *proxy,* in Congress's decision-making process, as well as incorporated in the considerations of the White House and the DoD while deciding. In terms of specific programs, there is a constant interaction between actors:

> "Every program has a manager, normally a colonel or a lieutenant colonel for most major defense acquisition programs. The program manager understands every aspect of the program and works closely with the companies contracted to manufacture the system. Program managers are usually located near their program's production facility (…) Department of the Army Systems Coordinators, or DASCs, directly represent the program manager inside the Pentagon. Major acquisition and budget decisions are made in Washington, DC, that may affect a program manager located in Huntsville, Alabama. The program's DASC attends critical meetings and represents the program's interests" (DEMAREST, 2017, p. 60).

4.5- From Theory and Process towards Materiality

Large-defense projects have specificities that make them unusually complex when compared to regular and incrementally adjusted programs: i) as they are long-term planned, environment uncertainties (both domestic and international) are greater; ii) as they are usually highly innovative, by consequence, technological challenges give further

uncertainty to thus project; iii) the large amounts of resources involved give extra intensity to the political and economic conflicts among the actors involved.

In the DoD, programs are divided by categories, called DoD Acquisition Categories (ACAT), based mostly on prices. ACAT I programs are classified as major defense acquisition programs or that require sophisticated equipment or required advanced information technology (DEMAREST, 2017). Furthermore, there are four steps followed by the DoD to develop programs: Materiel Development Decision, Milestones A, B, and C. These four steps correspond to: i) competition among companies for the design of the project; ii) R&D and viability checks; iii) initial development phase and; iv) initial production at a low rate. Finally:

> "After gaining approval from the Office of the Secretary of Defense and Congress, the program enters the full-rate production and deployment phase of the acquisition life cycle, and the system is ultimately delivered to soldiers (…) The entire process averages eight to 12 years from the day a requirement is identified to the day the soldier wields a corresponding capability on the battlefield (DEMAREST, 2017, p. 41).

Taking into consideration the theoretical developments and discussions of the three previous chapters, the methodology and objectives outlined in the Introduction, this dissertation turns now to the detailed *process-tracing* and analysis of the elected large-scale projects, tests the framework for comparison, mostly derived of the hypotheses put forward in chapter's 1,2 and 3.

PART II- HIGH STAKES AND HIGH RISK: An Analysis of large-scale, high-cost and long term defense projects.

"The idea of restraining the legislative authority, in the means of providing for the national defense, is one of those refinements which owe their origin to a zeal for liberty more ardent than enlightened".

Alexander Hamilton

"Politics is almost as exciting as war, and quite as dangerous. In war you can only be killed once, but in politics many times."

Winston Churchill

CHAPTER 5- DIVING DEEP: THE NUCLEAR PROPELLED SUBMARINE

"At the end of 1957 the pressurized-water reactor technology developed by Admiral Rickover and the organization he created was being applied to submarines, surface ships, and civilian power. Nuclear Propulsion was revolutionizing undersea operations, but how it would affect surface operations and civilian life, where application was slower, remained to be seen. Admiral Rickover, who had led the effort from its beginning, continued to exercise vigorous and personal leaderships. In the struggle to extend the application of the new technology, he was often on the national stage, dealing with senior military officers and officials of the defense establishment as well as congressional leaders" (DUNCAN, 1990, p.1)

The preceding chapters were aimed at developing a theoretical framework to explain the success or failure of large-scale projects in comparison to their initial objectives. The framework was constructed by analyzing the potential impacts of the international system, domestic politics, technological feasibility and economic background regarding these projects. Hypotheses and variables were developed and laid out at the end of each chapter, with the exception of Chapter 4, which focused on the legislative and political development of the required process to mobilize resources for these projects.

Methodologically, the framework is tested by comparative case-studies of two projects in the successful spectrum and two on the unsuccessful spectrum. Tracing the development of these projects has the potential of observing and isolating the most important facts and processes that impact success or failure. In this sense, the case-studies are aimed at testing the theoretical framework and the hypotheses put forward in the previous chapters.

This Chapter analyzes the process of developing nuclear propelled submarines, especially its first – The USS Nautilus – from its conception, through its development and its major outcomes. The first section is dedicated to studying the early conceptions and prospects of the nuclear propelled submarines and nuclear reactors, which were envisioned due to the success of the nuclear developments of the Manhattan Project. Technological challenges and basic concepts are outlined, as well as the early participation of important actors. Furthermore, nuclear propelled submarines are compared to diesel electric submarines in order to demonstrate the advantages that would be the result of a successful project. In the following section, the Chapter focuses on the

development of the submarine *per se*, over the years, and its successful outcome, highlighting the process, external threat issues and actors involved. The third section investigates some outcomes and issues– as civil use and proliferation– that followed the development of nuclear reactors. As external threat and domestic politics were thriving further innovation, some military results and developments are also highlighted. The final section concludes the case study in the light of the theoretical framework developed here. Hypotheses and the results expected from the proposed model are compared with the case analyzed in this Chapter.

5.1- Conception, Motivations and Prospects

The first Nuclear Propelled Submarine – The USS Nautilus- was the result of the quantic physics revolution which gave birth to the Manhattan Project and the atomic energy revolution. Therefore, before introducing the submarine project *per se*, it befits this study to make a brief overview of the background and previous events of its construction.

The first half of the twentieth century, especially the decades of 1920's and 1930's, experienced a revolution in the fields of physics and chemistry, which would make possible the world's entry into the atomic age. Ernest Rutherford, investigated the atom and its possible structure, with a first solid model presented by Niel Bohr (RHODES, 2012). Furthermore, from Chadwick's experimental investigation of the neutron in 1932 and Leo Szilard's theory that an element that would be split by neutrons to generate a chain reaction to Pierre and Marie Curie's discovery of the radiation of energy from elements, the first steps were pathed. Enrico Fermi and his team worked on bombarding neutrons into elements to generate artificial radioactivities and Otto Hahn's discovery and the latter demonstration by Herbert Anderson of nuclear fission, consisted of this scientific revolution (RHODES, 2012).

With the ascending Nazi party on Germany and the Exodus of scientists that followed, many of this research was transferred to the United States, where Robert Oppenheimer and Ernest O. Lawrance had been building the way towards an American school of physics (RHODES, 2012). At that time, scientists were concerned that the Germans were developing a chain-reaction process that would culminate in an atomic bomb. Albert Einstein, already a famous and popular scientist at the time, sent a letter to President Franklin Roosevelt warning him of this danger. This was the birth of the

Manhattan Project, which would finally be successful in leading to the world's first atomic explosion in Los Alamos, New Mexico.

The success of the Manhattan Project demonstrated the benefits of mass resource and scientific mobilization to overcome technological difficulties and build-up national capabilities. Actors such as Congress, firms and bureaus as the Atomic Energy Commission (AEC) would soon be mobilized for studying and investing in the other uses of atomic energy, civil and military. This resulted in decades of a series of mobilizations and issues regarding atomic energy. Bureaucratic Politics, technological feasibility issues, economic risks considerations and the IS structural scenario all came into place affecting the events that followed. The actions and relationships amongst these actors and issues are treated in further detail in the two subsequent sections. In this section, after a brief presentation of the "stage setting scenario" that gave genesis to the project, the study focuses on the basics of Atomic Energy Generators, the conception to use it in submarines and the possible advantages that this would entail.

As soon as the allies were thriving towards victory, another threat was building up with the rise of the USSR as a major power. In the Navy, officers were concerned with the fact that the Soviet Union (USSR) had built the world's largest force of submarines in the world, and continued to build even more during the following years (CLANCY, GRESHAM, 1993, p. 9). Furthermore, the loss of the monopoly over atomic weapons in 1949 and the outbreak of the Korean War in June 1951, urged the United States' elites to further develop capabilities. R&D projects entail uncertainty and risk, and the results are unpredictable *ex ante.* External threat, however, thrives mobilization effort. In the years following World War II, the U. S. Navy found itself with an aging fleet of diesel submarines ill-equipped to deal with the new rules of a new type of war, the Cold War. This new face-off with the Soviet Union emphasized espionage over confrontation, and electronic warfare over torpedo shots. In secrecy and stealth, the submarine became a pillar of vigilance and a valuable asset in a possible confrontation with the Soviet threat (MILITARY, 2021).

As soon as the results of the Manhattan Project started to reveal themselves successful, navy officers began to suggest the possibility of achieving either a controlled chain reaction or a chain reaction of an explosive character to be used by ships and submarines (NAVY, 1960). When the War ended, the Naval Research Laboratory (NRL) under the direction of Admiral Bowen was anxious to develop possibilities to use nuclear

power for ship propulsion. Nonetheless, access to information from the Manhattan District would prove itself difficult because they had no clearance to access the project, which would violate the Presidential directive of August 1945 (NAVY, 1960). Senior Navy military leaders forwarded a letter to the Secretary of War Patterson, who stated that the Navy should participate in R&D projects that could lead to the use of nuclear power for ships. Collaboration among scientists of the Manhattan District and Navy researchers and personnel could officially begin and efforts for the use of atomic energy in the field of ship propulsion, by consequence (NAVY, 1960). Other interdepartmental arrangements had to be made and, naturally, some conflicts would arise during the following years. However, there was no serious contends within the Executive, in the initial years. Serious bargaining efforts and leadership skills were observed in the development of nuclear propelled submarines and ships.

Congress soon entered the picture. The McMahon Act, named after senator McMahon, who drafted the bill known as "The Atomic Act of 1946 (Public Law 79-585)", was approved. The bill transferred the U.S atomic energy development program from the Manhattan District to a civilian agency, the Atomic Energy Commission. The Commission was to carry out several responsibilities such as foster private R&D, control the dissemination of information about nuclear technology and to manage the production, ownership and fissionable material. Private ownership of the material, was firstly prohibited, although the commission could authorize their loan for use in appropriate facilities (ALLEN, 1977). Furthermore, Congress' participation in the atomic energy program was conducted by the creation of the Joint Committee on Atomic Energy (JCAE), which would guarantee a close supervision and influence by Congress on the following programs (ALLEN, 1977; DUNCAN, 1990). However, transferring the main responsibilities to the AEC, the conduction and confidence on the Executive's in the events that followed, showed a high consensus among Congress and the Executive.

Regarding the scientific, technical and theoretical challenges of developing a nuclear reactor for propulsion, some aspects behooves this study. The basic phenomenon that makes a nuclear reactor generate heat (energy) is fission. Fission consists of splitting the nucleus of an atom into two parts, which releases around 200 million electron volts and generates more neutrons (ALLEN, 1977; CROCKCROFT, 1956). The new neutrons move on splitting other nucleuses, which in turn, produces other neutrons and so forth. This is what happens when a particular fissile material is assembled into a particular

configuration of sufficient mass (ALLEN, 1977, p. 1). This is called a chain reaction. Enrico Fermi was the first to achieve a self-sustained chain-reaction, and the scientists of the Manhattan Project were, then, responsible for the beginning of the atomic age.

The referred sufficient mass is also called “critical mass” and a possible nuclear reactor “achieves criticality” or “goes critical” when this mass is obtained. The challenge of developing a nuclear reactor, for civil uses or for military uses– in naval vessels as well– is to control the chain reaction, regulating the rate of the neutrons produced (ALLEN, 1977; CROCKCROFT, 1955; BRITANNICA, 2021). The main fissile materials used are uranium-235, plutonium-239 and uranium-233. A nuclear reactor needs basically fissile materials for fuel, a coolant and a moderator. The fissionable material is surrounded by a moderator, which aims at slowing the energy of neutrons so they interact better with the fissile material. The heat passes into a cooling system, usually a water circuit, to prevent it from boiling and to maintain sufficient seal, so that it cannot contaminate the rest of the power plant (BRITTANICA, 2021; COCKCROFT, 1956). A nuclear reactor provides the heat that powers a steam turbine, and drives a propeller. The results are impressive. The fission of one gram of uranium releases as much heat as the combustion of 2 tons of oil (COCKROFT, 1956, P. 464).

Basically, reactors can be engineered using different combinations of materials for fuel, coolant and a moderator. The years that would follow the intention to produce these reactors to propel ships or submarines, airplanes, or electricity for civil use, would be of intense research around different combinations of engineering in this sense. This would count on the participation of the AEC, the Military and large-firms which demonstrated interest and had the authorization of utilizing the appropriate labs for engineering and operating different prototypes, or first-of-a-kind reactors and building and testing combinations of fuel, moderator and coolant in test facilities and experimental reactors (ALLEN, 1977, p. 4).

At first, the Navy was not sure whether it was yet technically feasible or possible to launch a R&D program on nuclear propulsion. Other high priority projects, regarded as urgent for the Navy would have to transfer, in terms of mobilization of personnel and resources, precedence for the nuclear propulsion program. Nonetheless, as it was already stated, senior leaders soon engaged in the program as the NRL, who emphasized that “surfaced or partially submerged submarines could easily be detected with the present radars and that the need for extended submerged operations was imperative” (NAVY,

1960). From the beginning, a particular skillful bargainer and leader, then Captain Rickover, firmly believed and articulated with several departments and leaders in behalf of the propulsion project. He would become one of the leading figures in the propulsion project and the following development of the nuclear energy applications in the years to come.

Rickover, a trained navy engineer, believed that water could be used circulating the reactor, through its core to a steam generator. This steam generator gave its heat to a secondary system, and water was converted to steam to drive a turbine. In the primary system, water was kept under pressure to prevent boiling. Radioactivity made it imperative that two independent loops were necessary (DUNCAN, 1990). In theoretical terms, this idea was not Rickover's, but he believed it could be successfully developed. As a leader, acting within the AEC and the Navy he put forward a tremendous amount of effort to develop such reactor. Self-interested bureaus reached a consensus on the importance and acted together towards the development of the project.

In the development phase of the propelled Navy, which will be treated in the next section, other technical issues arose. The basics of the challenge of achieving the goal of nuclear propulsion and its conception were treated so far, alongside with the interactions of the main actors and the description of a growing external threat in the international scenario. At this moment, this study turns itself to the advantages of a nuclear navy, and more specifically, nuclear propelled submarines. This will demonstrate the importance of the project, in innovation and strategic terms, and the nuclear revolution that followed.

The main question regarding particular large-scale defense projects is why risk the development of an uncertain technological innovation, utilizing large amounts of tax-payers' dollars? Why do institutions mobilize themselves and give priority to certain projects, which are *ex ante* impossible to determine their success? As it was stated, external threat was building up, the development of atomic energy technology seemed promising and institutions were eager to build the material capacities which could give an enormous economic and strategic advantage to the United States. Innovation was then mandatory, as it was argued in Chapter 1. The differences between the at the time diesel propelled submarines and the forthcoming nuclear propelled submarines, or other uses of nuclear generators, were large. The national elites, including private firms, perceived the wages at steak promising.

Pre-nuclear submarines had to approach the target on the surface to avoid draining battery, submerging only near to the target, making them easy to recognize by the enemy. Furthermore, they utilized low speed (around two or three knots), again to avoid battery wasting. At top speed, usually utilized to evade a counterattack, made the battery, at its full charge, last only around two hours (BRITANNICA, 2021). The result of the necessity of conserving battery was that diesel-electric submarines could not engage fast surface warships, such as aircraft carriers, due to the low speed and quietness that they had to engage the targets. Nuclear propelled submarines are highly superior, especially regarding speed, depth, and time submerged. This was a result of energy generation.

Speed requires power. Nuclear propelled submarines would increase speed in large quantities. The first nuclear propelled submarine, the USS Nautilus, main object of this Chapter, achieved a submerged speed of over 20 knots. That gave the submarines the power to evade surface ships. Further technological developments resulted on the Skipjack class, which was commissioned in 1959 and could reach a top speed of 30 knots (BRITTANICA, 2021). Sustained speed can also be useful to deploy submarines to distant patrol stations. Nuclear submarines' fuel supplies are theoretically unlimited, although due to the capacity for storage they could initially remain at sea for about two or three months, reaching rapidly the patrol area, making them highly superior in tactical terms. According to Crockroft (1956, p. 464) "The most important military characteristic of the nuclear submarine is that a single fuel charge lasts for a very long time". The first charge of the Nautilus land based prototype lasted for 24 years though probably not at full power all the time.

Active sonars, in the 1950's, could detect submarines through sound waves that bounced of their hulls (BRITTANICA, 2021; CROCKROFT, 1956). Early nuclear submarines were susceptible to detection because of the noise produced by its machinery; the pumps required to circulate the coolant could not be turned off without melting the reactor core. Later on, silencing became priority. The pumps of pressurized-water reactors were redesigned to be quieter and hulls were coated with sound-absorbing material. A great advantage of nuclear propelled submarines was depth. Deep-diving submarines could combine speed for a better evasion and make better use of its own sonar. Previous submarines could determine target range and bearing but not their depth. New sonars could distinguish targets at different depths. At high speed, the risk of descending below a safe operating depth was reduced and the downward motion could be corrected. These

developments were strong motivations for investing in nuclear submarines[85]. Through the passing of decades, other countries developed nuclear Navies, a topic which will be treated in the last section of this Chapter. Nonetheless, most Navies still count on diesel electric powered submarines, do to cost, nuclear proliferation issues or technological barriers. In this sense, research has been conducted to combine diesel electric submarines with fuel cells in powering the submarines (PIPER, RAJAKARUNA, 2010).

Given the prospects of developing a nuclear propelled submarine and the institutional developments so far, in July of 1951, Congress authorized the construction of the world's first nuclear powered submarine (NAUTILUS, 2021). Congress was willing to take the economic risks and political risks, mentioned previously in this dissertation, due to the strategic importance and promising technological feasibility of the project. The now Admiral Rickover, had convinced the Navy and other Bureaus of the urgency of nuclear propulsion and was assigned as director of the Nuclear Power Branch of the Navy's Bureau of Ships by mid-1948's. In the AEC, the creation of the Division of Reactor Development, directed by the nuclear physicist and engineer Lawrence Hafstad, would work closely with the Navy and would be coordinated under Navy's Nuclear Power Branch under Rickover's supervision (ALLEN, 1977). Rickover set an ambitious plan to design and build a reliable nuclear reactor that would propel a submarine in a full-scale demonstration that nuclear-power submarines worked by January 1955. The schedule was thus very tight, around five years. And as it was already stated, the Navy was warried that this project would interfere in other priorities. Bureaucratic and leadership skills were needed. Different actors would participate in this herculean task, which was taking shape in Rickover's mind in 1947, when he had already set the goal to get the submarine propulsion project full-scale operating. So far, the motivations, early conceptions and incentives for building a nuclear powered submarine and to utilize nuclear energy for other purposes were outlined. The next section treats in further detail the development of such projects and the results, highlighting the political, technical and economic facts of this case.

[85] Through the passing of decades, other countries developed nuclear Navy's, a topic which will be treated in the last section of this Chapter. Nonetheless, most Navy's still count on diesel electric powered submarines, due to cost, nuclear proliferation issues or technological barriers. In this sense, research has been conducted to combine diesel electric submarines with fuel cells in powering the submarines (PIPER, RAJAKARUNA, 2010).

5.2- The Development of the Nautilus and Beyond

The development of the Nuclear Reactor to be utilized in submarines and the naval fleet in general followed decades of programs and outcomes. Here, in the first place, this dissertation focuses on the success of the innovations on Nuclear Propelled Submarine and Nuclear Reactor programs for submarines, which would result in the mentioned outcomes for several consequences in United States' defense and civilian energy use. The first steps were firmly leaded by Rickrover, which played the role of the leader in the conception, design and the necessary political ties.

Rickrover's schedule and efforts were successful. In 1954, the US Nautilus, the first nuclear propelled submarine was commissioned, with a single power plant that could be suffice for surface and submerged operations. Two prototypes were developed during the process, the Nautilus and the Seawolf, the first utilizing pressurized-water and the second liquid-metal scheme. With the authorization of Congress, Nautilus was supported by President Harry S. Truman at the Electric Boat Shipyard, Connecticut on June, 1952. On January 17, 1955, Nautilus first Commanding Officer, Commander Eugene P. Wilkison, gave word "Underway on Nuclear Power". Over the next years, Nautilus "shattered all submerged speed and distance records" (NAUTILUS, 2021, p. 1).

The development process, although highly successful, was not easy. The team leading the project had to overcome technical and political challenges. Congress, as stated above, defined the initial rules and transferred to the Executive full development, with no serious disputes about economic risk or cost, however emphasizing a firm directive that any considerations had to be subordinated to the national security strategy. Between 1947 and 1953, AEC aimed at developing propulsion for aircrafts, as well. Nonetheless, the Massachusetts Institute of Technology (MIT) evaluated the development of a reactor with enough power-to weight ratio for aircrafts, could only be feasible in fifteen years. Although the project received substantial R&D resources throughout the 1950's, the project was canceled in 1961, due to the lack of advance in technological feasibility.

Regarding the nuclear propelled submarine, however, some technical difficulties should also be examined. Under the influence of radiation, water decomposes and becomes chemically reactive. The uranium fuel has to resist the corrosion of the water. Therefore, a material which is resistant to corrosion and does not propagate the chain reaction must the sheathed in the fuel (COCKCROFT, 1956, p. 461). During the

development process, the chosen metal was Zircalloy, an alloy of Zirconium. The reacting core must also have a control system to shut down the chain reaction. This is done by control rods moving in and out of the core which absorb neutrons. Materials, such as the Hafnium associated with Zirconium would be chosen as control rods (COCKCROFT, 1956, p. 461). However, if the water heats and density falls the chain reaction shuts itself off alone. In this case, withdrawal of the control rods should maintain the chain reaction. These technical issues were, however, resolved by R&D efforts and political support.

After April 1948, the AEC gave formal and high priority status for the development of a water cooled reactor for submarine propulsion (NAVY, 1960). Thus, that Executive bureau was very confident about the project. From the beginning, industrial giants were involved in the project– Westinghouse, General Electric (GE), Backcock and Wilcox, and Allis-Chalmers. After World War II, GE had taken the management of the Hanford plutonium production plants, with the assistance of the AEC which build the Knolls Atomic Power Laboratory. Therefore, GE was, apparently, the most obvious choice for conducting the nuclear propelled submarine project, since it had an innovative, research-oriented facility. Nonetheless, the AEC was reluctant at first to transfer the project to GE, since plutonium for weapons were perceived as the highest national security priority and hence, GE should not be "distracted" by other projects (ALLEN, 1977).

Nevertheless, since GE had experience with sodium as a heat transfer medium, the firm agreed to design and build a land-based prototype of the submarine intermediate reactor (SIR). However, Rickover had the conviction that the submarine reactor should be a thermal reactor using slow neutrons (ALLEN, 1977, p. 15). Rickover believed that physics demonstrated that a Pressurized Water Reactor (PWR) design would be accurate. As GE's sodium-cooled intermediate power breeder project had an early failure, Rickover envisioned and got permission for a concurrent development program, overlapping stages usually required by the Navy, and, consequently, overcoming possible impediments of BP politics (ALLEN, 1977).

Westinghouse seemed a promising alternative. The Navy's Bureau of Ships executed a contract with the firm for detailed designs of a land-based prototype for submarine propulsion reactor. The conception was in accordance to Rickover's ideas, since the firm had already conducted engineering studies on the properties of pressurized water and heat transfer, and this fitted Rickover's preference for thermal reactors

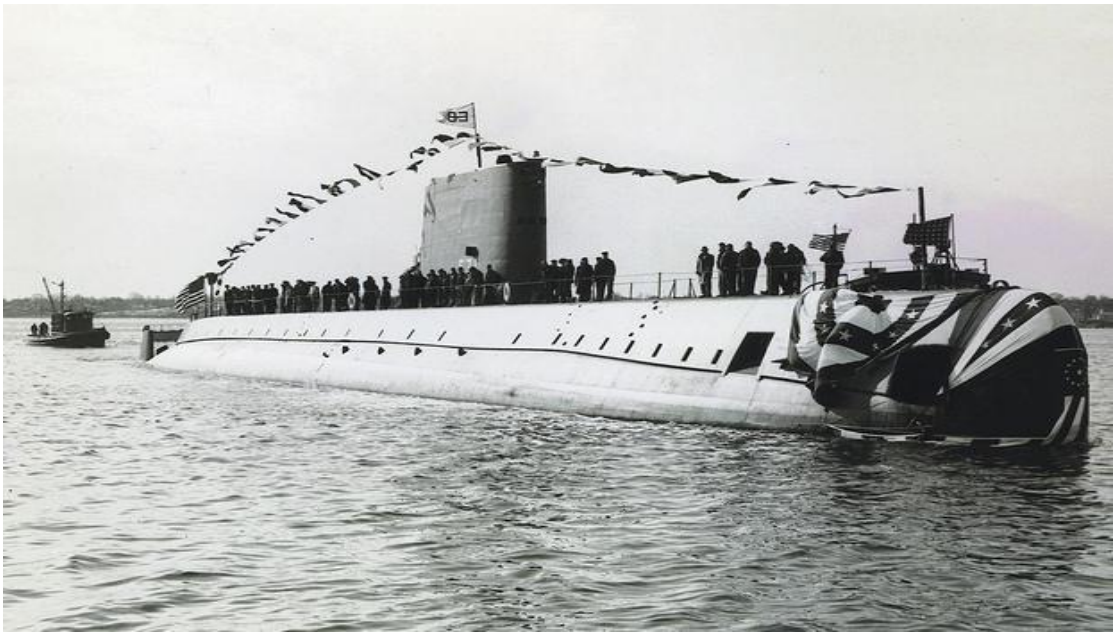
(ALLEN, 1977). The project was named Project Wizard and aimed to design and develop a power conversion system for a naval vessel, utilizing as a heat transfer pressurized water. As a result, by the 1950's, two reactors were being developed simultaneously and competitively for submarine propulsion in two industrial laboratories: GE's Knolls lab and Westinghouse's Bettis lab in Pittsburght (ALLEN, 1977). Both firms found the prospects for developing these reactors attractive. This demonstrates that in terms of economic risk calculations, as it was treated in Chapter 3, there was an accordance between actors.

Rickover bet high in pushing the pressurized water reactor concept. The first stage, called "Mark I" was proven successful. The reactor went critical in March 1953 and completed a trial run during the next two months. "The reactor operated perfectly" (ALLEN, 1977, p. 17). The operational success demonstrated that pressurized water reactor design was ahead of other concepts that the AEC was exploring. The short period of time from the conception towards the successful test was a clear sign of technological feasibility and economic viability of the project. GE had not been as successful in gearing up at the "Mark I" at Knolls. The pressurized water reactor became operational as a submarine power-plant and generated electricity in its demonstration project. This was to be the Nautilus, the world's first nuclear propelled submarine.

> "Nautilus was launched on 21 January 1954 by Mrs. Dwight D. Eisenhower at Groton, Connecticut. Following additional fitting-out and extensive tests, the submarine embarked on her shakedown cruise on 10 May 1955. Over the next several years, she underwent various types of testing and trials, and took part in the U.S. Navy's development of new antisubmarine warfare (ASW) tactics — which had to be adapted to the advanced capabilities of Nautilus "(NAVAL HISTORY, p. 1).

The GE's project went on as well, and concentrated on an intermediate power breeder reactor. Years later the project became the Submarine Intermediate Reactor which finally designed and constructed a propulsion system for the second nuclear powered submarine: The Seawolf. Nonetheless, problems like leakage in the Seawolf reactor led to the abandonment of its liquid-metal scheme. The future submarines and reactors would be developed with a preference to the pressurized water reactors.

Figure 5.1- The Nautilus



The christening ceremony for the USS Nautilus (SSN 571), Jan. 21, 1954. The Nautilus was the U.S. Navy's first nuclear-powered submarine. (Photo: U.S. Navy). Source: (MILITARY, 2021).

Figure 5.2- The Seawolf

The USS *Seawolf* off the coast of Key West, Fla., 1958. *U.S. Navy Photograph*. Source: (Brittanica, 2021).

The USS Nautilus proved itself to be a highly successful program. In the years following its commissioning, it achieved many unprecedented marks. Given the rise of the Soviet threat, especially due to their achievement in 1957, of launching the world's first artificial satellite- Sputnik I, a successful transit over the North Pole (given the obvious geopolitical benefits for the Cold War), could be a solid response. Nautilus was set to this mission. "Operation Sunshine" was then launched, as the attempt of a fully submerged transit over the North Pole (NAVAL HISTORY, 2021, p. 1). In its first attempt, the Nautilus was blocked by drift ice in the artic Chukchi Sea. The second attempt, departing from Pearl Harbor on July 23, 1958, was successful. In august 1958, Nautilus had reached the North Pole-90 degrees north. Surfacing in Greenland, the Commander in charge, Willian R Anderson and the 116 man aboard were personally congratulated by President Eisenhower and awarded the Presidential Unit Citation (NAVAL HISTORY, 2021; NAUTILUS, 2021).

In 1959, the Nautilus went to Portsmouth Naval Shipyard, Main, for a complete overhaul and the replacement of its second fuel core. In 1960, Nautilus departed for training, and deployed to the Mediterranean Sea and became the first nuclear powered submarine assigned to the U.S Sixth Fleet. In 1966, Nautilus entered record books when logging for 300,000 miles underway. Nautilus continued to participate in a variety of developmental testing programs while working alongside with the modern submarines she had preceded for twelve years (NAUTILUS, 2021, p. 1). Nautilus demonstrated to the Navy the importance of building a nuclear fleet. In 1956, the USS Skipjack was launched with a dirigible-type hull and a single propeller. A new class- the Thresher- entered the fleet in the early 1960's. Many would follow, as it will be described in the subsequent section (MILITARY, 2021). Nautilus was finally decommissioned on March 3, 1980, after a career of 25 years and over half a million miles steamed (NAUTILUS, 2021).

The importance of these facts were unprecedented. Nautilus gave birth to the Nuclear Navy revolution. With strong support of Congress, a close relation among the AEC and the Navy, and a strong R&D and innovation effort, it was made possible. The following years would be of continuing development of the Nuclear Navy, applying the nuclear propulsion and the possibility of deploying nuclear weapons in surface ships and submarines. Rickover, as a leader, continued to be a pivotal actor in articulating the bureaus and other political actors to this development. As the Cold War competition

further tightened, this successful project was indispensable. The next topic is dedicated to some outcomes of the Navy's nuclear program that followed, the development of Submarine Launched Ballistic Missiles (SLBM's), the adoption of the technology by other Navy's, concerns about the leaking of technology and nuclear proliferation. Furthermore, the application of nuclear reactors to generate electricity for civilian uses, was a clear *spin-off* of the project, and had been envisioned early by the AEC and firms interested in exploiting these possibilities. This topic will also be treated. The final section of this Chapter will relate the theoretical framework and its assumptions and hypotheses to the nuclear propelled submarine project.

5.3- The Outcomes

The possible civilian uses and nonproliferation issues that atomic energy and the development of controlled nuclear reactions through generators were the most direct outcomes of the nuclear program. Nevertheless, civilian use of atomic energy and non-proliferation issues are altogether other topics of study and do not fit the purposes and scope of this dissertation. However, some early developments regarding these themes will be highlighted. Both topics are of course interrelated, since the technology for civil use is basically the same that would be required– plus delivering vessels– to other countries to join the nuclear power status. This is foremost a national security and external threat issue, which endures to the present.

As it was treated in Chapter 3, conversion issues can be difficult in terms of cost, political disputes and risk regarding the profitability of possible markets. Nonetheless, dual use (civil and military) seemed an encouraging option, since electricity generation with nuclear reactors could be a structural economic transformation in the basis of production. To implement the innovation, however, was a challenge. This study emphasizes some early conceptions. Nonetheless, during the next decades, and especially with the implementation of the budgeting process described in Chapter 4, over the leadership of Secretary Mcnamara, nuclear energy civilian use would be a pivotal matter.

Even though AEC and Congress were prioritizing national security, civilian use of nuclear energy was early on their agenda, especially if it proved economic competitively. The AEC began to examine the civil applications of atomic energy in 1947, although a variety of technical and security issues required attention. During the war, safety issues had been resolved by locating fissionable material, like plutonium,

production and research facilities at isolated spaces. In the early stages of R&D, nobody had certainties of how fissionable materials would react in high temperatures and exposure to radioactivity (ALLEN, 1977, p. 10). Laboratories such as Oak Ridge, Tennessee and Argonne, Illinois, were located in cities such as Chicago, and safety issues became important. Isolation considerations had to be considered. Safety requirements for a civilian reactor had not been established by the time.

The early projects warranted funding and integration of several efforts into a consistent and cohesive program. Three lines of development were selected (ALLEN, 1977, p. 11): i) A Material Testing Reactor (MTR), to be developed jointly by Oak Ridge and Argonne in Idaho; ii) A remote site to test and built an Experimental Breeder Reactor (EBR-1) at the same remote site; iii) An intermediate power breeder, to be leaded by GE in its Knoll s Laboratory. The lines of R&D and the actors were to be very similar to the military development, including the technical challenges regarding materials, coolants and moderators and effects of high temperature and high radiation on these materials. Controlling nuclear chain-reactions required materials for reflectors to capture and reflect neutrons back to the core, the development of pumps and valves and corrosion resistant fuel elements (ALLEN, 1977, p. 11) The first tests utilizing sodium as a cooler proved ineffective, even though it had good heat transfer properties, it proved corrosive and not compatible with water systems.

Regarding economic issues, the AEC, operating in the Hanford, Washington production reactors, build for military purposes, observed highly difficult technological and safety problems. The Hanford plants poured out much heat, dumping it on the Columbia River, and without further development could not generate electricity efficiently (ALLEN, 1977, p. 12). Even in the event of it being successful, it could not be economically competitive at the time. Hydroelectric plants, operating in the region, had been supplying electricity with low cost for years.

During the next years and decades, however, some of these initial challenges began to be surpassed. A turning point was the legislation approved by Congress in 1954: The Atomic Energy Act of 1954 (Law 83-709). In this act, Congress ultimately opened the development of reactors with the purposes of generating electricity for civilian use to commercial firms. This lead the AEC to develop a five-year plan, the Power Reactor Demonstration Program (ALLEN, 1977, p. 36). A Pressurized-Water Reactor began to

be built at Shippingport. Finally, over the next years with a strong government-industry partnership, nuclear reactors came to be utilized for civil purposes[86].

Early during the development of the uses of atomic energy and nuclear reactors, proliferation issues were on the mind of decision makers. As it was argued in Chapter 3, the trade-off between nationalization and internationalization, in this case, the sharing of technology with close allies, is highly controversial. In the first years of the successful achievement of the chain reaction and the following development of atomic bombs, the sharing of this pivotal technology was out of the question. Regarding the generation of electricity for civilian uses, or the military technology for close allies, however, some benefits could be attained. As it was said, R&D costs if allies worked together would diminish. Furthermore, the export of nuclear reactors for civil use could put the United States in an even more competitive position in foreign markets. By the time of President Eisenhower, even though there was put a considerable effort in developing some method of making trade and national security commensurable (ALLEN, 1977), the problems of nuclear proliferation were difficult to overcome. Over the decades, as it is known, and is not in the scope of this study, many diplomatic channels, international organizations and countries were involved in proliferation issues and the possible uses of nuclear technology for peaceful uses.

In terms of usage of nuclear propulsion for Navy's, eventually, other countries had the grasp of the necessary technology. The U.S, after 1959, ceased to construct non-nuclear submarines. Other major powers, however, would continue to combine diesel-electric submarines alongside nuclear vessels in parallel. Great Britain's Royal Navy completed its first nuclear submarine, the HMS Dreadnought, in 1963, and opted by focusing mainly on nuclear submarines, although in the 1980's they built diesel-electric submarines such as the Upholder class (BRITANNICA, 2021). France completed its first nuclear submarine in 1971 and abandoned the diesel-electric fleet for its own force, albeit continuing to produce them for export purposes. In 1968, China began to build nuclear submarines, however continuing to build and purchase nonnuclear submarines (BRITANNICA, 2021). Other nuclear navies opted to employ the pressurized-water and natural-circulation reactors, with the exception of USSR's Alfa-class attack submarines, build with liquid-metal reactors in the 1970's and the 1980's. Brazil has attempting to

[86] For a historical account on the facts that lead to civil-use nuclear reactors, see: (ALLEN, 1977).

develop a nuclear propelled submarine since 1979. This would make the country the first non-nuclear power employing such technology[87]. Recently, what was called Aukus, consists in a project to develop nuclear propelled submarines for Australia, with the jointly effort of the United Kingdom and the United States; in order to contain China in the Pacific scenario. The case of Australia, a non-nuclear power, could open precedents for developing nuclear propelled submarines in countries such as Brazil.

The Soviets, were, of course, US' main concern. Although they continued to add to their fleet diesel submarines, the main part of their focus shifted towards nuclear submarines. The November class nuclear propelled submarines entered service as early as 1958. As it was argued in Chapter 1, threat level directly impacts innovation. The Soviets were not far behind the US, thriving the United States to further develop their Nuclear Navy, including adding nuclear propulsion to their surfaced fleet, develop nuclear propelled attack submarines, carrying weapons such as torpedoes, anti-ship missiles, but mainly focusing on the development of Strategic submarines which would come to carry SLBM's.

The innovative efforts alongside the external threat pressure and domestic political effort that were put into the innovation regarding nuclear reactors continued. This scenario had major military outcomes. As soon as 1957, the first nuclear powered cruiser, the Long Beach, was commissioned (DUNCAN, 1997). By the end of the same year, seven shipyards were working on the surface nuclear powered ships program, with close ties between major industry and the Navy. In Congress, the main committees involved examined closely the proposed budget for the following projects, settled their differences, and finally accepted and passed the legislation for the president's signature (DUNCAN, 1990). This showed a consensual effort within Congress and with the Executive regarding further development of the nuclear propulsion programs. There were, of course, disputes along the process. The costs of nuclear-powered ships were high, and difficult decisions had to be made. Duncan (1990, p. 16), highlights Rickover's leadership in the process: "Strong ties developed between Rickover and key legislators on defense and atomic energy, enabling him to exert unusual and unparalleled influence in the introduction of nuclear propulsion into the fleet".

[87] For more details, see: (DINIZ, 2017). The case of Brazil and the nuclear propelled submarine program is an interesting case for further investigation, within the framework of analysis proposed in this dissertation.

As for nuclear propelled submarines, the US developed, in the following years, the Skipjack and Thresher-Sturgeon attack submarines, the Polaris submarines, the Los Angeles class of fast attack submarines and the Trident-missile submarines. On the surface ships side, by 1967 the Navy had commissioned forty-one ships (DUNCAN, 1990). All these projects would lead to a highly fruitful investigation under the theoretical framework which was developed in this dissertation, especially because of the introduction of the SLBM's, the Cold War's arm-race and the profound involvement of both Congress and the Executive's bureaus and commissions[88]. However, it would require further detailed research and would escape the scope of this study. These developments were briefly pointed, nonetheless, on the one hand, to demonstrate the success of the nuclear propelled submarine program. On the other hand, the variables and hypotheses developed in the theoretical framework regarding the success of a large-scale defense project were positively correlated with the outcome of the project here analyzed.

5.4-Concluding Remarks and Results

The Nuclear Propelled Submarine program was successful. In a short period of time, it was conceptualized, idealized and commissioned. Technological feasibility concerns were surpassed. Even though each bureau, as it has been argued in Chapter 2, maximizes its own interests, there was a close partnership among the actors involved, be them different departments within the Navy, the AEC, Congress's commissions, and so forth. USSR growing threat level also had a crucial role in thriving innovation and making decision-makers accelerate and risk major developments of the nuclear program. Even though some lack of data and sources are here recognized as a problem, due to the time period of the submarine development, the process-tracing of the case, the accounts made by leaders and scholars, provided the sufficient information to obtain solid results. The key-decision makers and stakeholders involved in the project perceived it as necessary. It was delivered before schedule, reveling a smooth acquisition process. Performance goals were achieved and the Nautilus was deployed and served for several decades. Furthermore, summing up with these parameters of success, the nuclear-propelled concept spilled-over to ships, aircraft carriers and so on, as it was outlined.

From the IS' angle, as it was argued in Chapter 1, as the security-dilemma operates, states are expected to balance against threats. Furthermore, external pressure

[88] For a detailed investigation of the "Nuclear Navy", see: (DUNCAN, 1997; CLANCY, GRESHAM, 1993).

can be a source of state behavior, and in this case, internal-balancing measures. The main hypothesis of Chapter 1, that innovative-capable states will military innovate, in a direct proportion to the level of threat, and, hence, in the face of a high level of threat large-scale projects will be more likely to succeed, is corroborated by the evidence of the case treated here. The development of a large submarine fleet by the Soviet Union, the latter loss of monopoly in atomic weapons, the efforts of the USSR to transform its submarine fleet in a nuclear-propelled one, the outbreak of the Korean War, the successful deployment of the Sputnik satellite, were all facts that thrived the United States to mobilize and innovate. The 1950's were marked by a tight competition in the Cold-War. As for the auxiliary hypotheses proposed in Chapter 2, they were also corroborated: i) technological advancement compelled the US to adjust its institutions and doctrine; ii) civilian interference in military decisions were observed, enhancing the capacity of innovation; iii) the pace, scale and timing of the innovation was accelerated by the urgency to balance the threat; iv) the US did not stop innovating when faced with larger threat, on the contrary, it devoted more resources to further enhance the nuclear reactor and Nuclear Navy when external threat build higher and v) at the beginning, there was a lack of external balancing options regarding nuclear propulsion, which did not mitigate innovative efforts.

Chapter 2 developed conclusions and variables from the domestic angle of analysis. The main hypothesis was that the success of a large-scale project will be strongly influenced and positively related to the degree of consensus between and within Congress and the Executive. Some assumptions of BP politics were indeed observed. Parochial interests, especially regarding the control over the atomic program were observed. Furthermore, concerns regarding the cost and budget distribution were at the top of the agenda. Nonetheless, these issues did not generate major disagreements by senior players, attempts to use veto power, or a paralyzing partisan opposition which would dampen the efforts of consensus building. On the contrary, in the Navy, for example, bargaining and interdepartmental arrangements were made to prioritize the Nuclear Propelled Submarine program. The role of Congress and the AEC were supportive, and ultimately, efforts amongst different agencies were orchestrated to the success of the innovation, with civilian participation and oversight. Budget constraints did not seem restraining as well. After USS Nautilus, this collaboration continued, including further institutional

developments, negotiations among Congressional committees and Executive agencies supporting the development of the Nuclear Navy.

Finally, regarding technological feasibility and the economic basis angle of innovation, some comments have to be made. The main hypothesis put forward by Chapter 3 related demand elasticity to technological feasibility as a proxy variable to measure the last. In the case of the USS Nautilus, the data for a better analysis of the proxy variable was unavailable[89]. The budgeting process also could not be entirely traced since this case preceded most of the process outlined in Chapter 4, such as the reforms leaded by Secretary Mcnamara. Nonetheless, Defense Economic premises and the tracing of the project indicate that the technological feasibility matter was early accomplished. Actors coordinated to share the burden of the initial expenditures and as R&D evolved, the project seemed feasible. The schedule and cost issues demonstrated no major demand curve revisions. Efficiency issues were subordinated to national security concerns as actors bared the risk of investment which was soon shown technologically possible. The participation of industry, research facilities and governmental actors reinforced the systemic nature of innovation. Finally, the possibilities of international collaboration regarding innovation were neglected at the time analyzed here, due to national security concerns.

[89] The author of this dissertation contacted CBO attempting to obtain the data. Nonetheless, in their reply, they said that since the project was historically far, they did not have the date available.

CHAPTER 6- A TROUBLED FLIGHT: THE B-2 STEALTH BOMBER

"the B-2's history was one marked by "economic inefficiency, by bureaucratic politics and technological feasibility doubts, and economic calculations" (GRANT, 2012, p. 2).

"the B-2 program, in particular, demonstrates the enormous difficulty of making rational defense spending decisions purely on the basis of U.S national security interests" (STACY, 1996, p. 29).

As it was stated previously, this dissertation presents what is called two positive cases (located in the success spectrum of large-scale defense projects) and two at the failed spectrum. Methodologically, it was argued that necessary, and conjointly conditions are sufficient to explain the phenomena studied. A case in which those conditions are absent (negative case) is important for comparative analysis, since it helps to test the proposed causality and if the hypothesis truly explains the dependent variable. A *small-n* study requires a more in-depth investigation (*process-tracing)* of the phenomena which can make causal links and provide inferences by investigating the sequence of events of the investigated object. The absence or presence of causal relations among the parts that interact is, for this reason, essential to connect the proposed independent and dependent variables.

This Chapter addresses the B-2 stealth bomber project. It is argued that, whilst the project was not a complete failure, given the success/failure parameters presented in this study, by the time the B-2 was canceled it did not meet the criteria to be considered successful. This study classifies the B-2 in the failed spectrum. It is argued that the necessary and positively correlated conditions that would make it a successful program were absent. Process-tracing demonstrates that external threat, decision-making consensus and technological feasibility conditions –as they were defined and developed through chapters 1 through 3– were not met. Diminishing threat level, lack of consensus among specialists and main actors, bureaucratic disputes, and technological feasibility challenges led non-satisfactory results for the project.

The first section addresses the motives and conception to develop the B-2. The perception that the manned bomber leg of the strategic triad was becoming obsolete in terms of countering the Soviet's land-based detection systems led the Air Force to invest in developing a stealth plain capable of infiltrating Soviet defenses. From the beginning, however, there were doubts regarding the need for the program. The section also

investigates possible benefits and problems that the project could face. Section 6.2 focuses on the development of the B-2, highlighting the main events throughout this process, debates raised among specialists and actors, and the stand of decision-makers. The outcomes of the project are briefly pointed out by section 6.3. Finally, the last section is dedicated to confronting the theoretical framework developed in this dissertation and its hypotheses with the results of the B-2 project investigation.

6.1- Conception, Motivations and Prospects

In the late 1970's, US' decision-makers were alert to the eroding defense capabilities of the United States, posing a growing threat by the Soviet Union which was gaining advantage, especially regarding their radar systems, antiaircraft missiles and fighter forces. The general perception of the decision-makers was that the United States' strategic triad –landed based intercontinental missiles, long-range bombers, and submarine-launched missiles – was lagging behind and could become obsolete, especially regarding the manned bomber leg of the triad. According to Scott (1991, p. 21), developments in Soviet defenses were advancing to the "point where aging U.S B-52s would be sitting ducks". The B-52s chances of getting through Soviet defenses and hitting targets was getting smaller. Furthermore, the B-1B, a concurrent program of the B-52, was perceived to be rendered less effective by the 1990's, and would probably be assigned to missions to attack less well-defended targets (WELCH, 1989).

It was in this scenario that leaders, especially in the Air Force, proposed a long-range penetrating bomber, called the B-2, initiated in 1981. The B-2 program was conceived to build a stealth long-range bomber, avoiding detection, denying the enemy's capability of countermeasures and ideally hit the target and return without being detected. This would pressure the USSR economy as well, making them invest further in air defenses.

The Administration's initial plan was to produce 132 B-2 bombers, estimating that it would cost $36.6 billion in 1981 dollars which was readjusted to $70.2 billion in 1990's dollars (GAO, 1990; STACY, GUNZINGER, 1996). The Air Force treated the program with urgency and Northrop Grumman was awarded the contract on Nov. 2, 1981, with the initial plan to ramp up peak production of 30 aircraft per year, after the proposed test deadline of 1987. According to this schedule, the B-2 would reach initial operational capability by 1990 (GRANT, 2012, p. 3). The program moved forward in secrecy.

Achieving a stealth aircraft, however, with many new design components necessary to this end, would pose technological feasibility, cost and schedule challenges, as it will be demonstrated analyzing the program's development.

Given these prospects, it would behoove this study to clarify the conception of a stealth aircraft and the necessary innovations and challenges to achieve this end. From the point of view of the defender, detection of an aircraft "could be accomplished through radar, infrared, visual sighting, acoustic, or electronic emission methods" (SCOTT, 1991, p. 17). An especially troubling challenge was the Soviet's advanced long range radar capability. Radars sent pulses of electromagnetic energy that hit the target and bounce back to the transmitter. "Electronic techniques at the receiver provide information about a target aircraft's presence, speed, direction, and size" (SCOTT, 1991, p. 17). As for infrared sensors, they identify a heat presence that looks different from the air around the supposed attacker. Regarding acoustic sensors, they simply detect the noise coming from the aircraft. Emissions radiated by an invading aircraft can also be detected by electronic sensors, which identify electromagnetic emissions radiated by the aircraft.

In its conception, a stealth aircraft would pass through these defenses without being identified. The first challenges of the development of such aircraft is designing its body to reduce its RCS (Radar Cross Section); the way a radar can identify it. An aircraft is most commonly identified by a radar through "the sharp, angular joints between the fuselage and the wings and tail; flat wing, fuselage, and tail surfaces, engine inlets; the cockpit; and the engine themselves" (BROWN, 1988, p. 354). To minimize the aircraft's RCS, Northrop conceptualized the blend between the wing into the fuselage, making it a "flying wing", a very short and broad wing, with no tail. This conception was similar to Northrop's B-49 of the 1940's. Even though this conception was not new, according to Brown (1988, p. 355) "all-wing aircrafts are not new, but they do not have an established aerodynamic track record at very low altitudes. Any aircraft based on an unproven design faces a long and potentially tumultuous flight testing program". Without horizontal and vertical stabilizers, the aircraft would have to rely on computer-controlled vectoring, which would involve major technological advances. Regarding the engines and the cockpit, the B-2 program would count on hiding the engine and its inlets buried in the body of the aircraft and blending the cockpit within rounded wing surfaces. Stealth advances would have to come, furthermore, from the coating of the aircraft's skin with materials that absorb radar-reflectivity. Another major challenge was the proposed

nuclear mission of the B-2. The designers would face the challenge of developing stealth coatings against radioactive effects. It had to survive the blast from its own nuclear weapons. The blast effects of the detonation would produce gamma-neutron radiation, a thermal wave of great intensity and the electromagnetic pulse, which resulted from gamma rays interacting with the magnetic field (GRANT, 2012). The right materials for this scenario would be a further challenge to the B-2's designers.

Technological feasibility issues would be a central aspect of the problems and disputes that the B-2 program faced through its development. This is due to the highly innovative nature of the program, which entails, as it was argued in Chapter 3, high risks. "Mundane material problems could badly disrupt the overall program" (BROWN, 1988, p. 355). The debate and challenges surrounding the technological advances needed to make the concept of the B-2 feasible will be further discussed, in more detail, in the next section, dedicated to the development of the program. However, as it was argued by Brown (1988, p. 354) that "all the information in the public domain suggests that the B-2 program is an extraordinarily ambitious, even revolutionary, undertaking from a technological standpoint". As it was argued in Chapter 3, technological feasibility is a *sine qua non* condition for the success of a program, and, thus, if, in its development, there are many doubts, cost and schedule revisions and difficult challenges surrounding technological issues, this would affect directly the success or failure of the program.

The prospects and value of achieving a stealth aircraft, given its motivations and initial concepts, had strong incentives and seemed to have many advantages. The B-2 was not the only program which, by the 1980's, the United States announced it had achieved the technical ability to build stealth aircraft (WELCH, 1989). It was part of a "revival" of the country's advantages in its general deterrence strategy, to render Soviet's defense advancing countermeasures ineffective. Since 1980:

> "(…) five air vehicle programs have been identified as having a stealthy nature: 1) the Advanced Cruise Missile (ACM), to be carried by strategic bombers; 2) the Advanced Technology Bomber (ATB); 3) the U.S. Air Force's Advanced Tactical Fighter; 4) the U.S. Navy's Advanced Tactical Aircraft; and 5) the recently announced F-117A fighter" (WELCH, 1989, p. 47).

This study now turns to the seemingly advantages of a successful stealth aircraft program would have, since this technological breakthrough promised major geostrategic importance. As it was already cited, at the time, the Soviets had developed a large number of radars, many more then the West and had continuously improved those radars. Jasper

Welch (1989) accessed the possible value of stealth aircraft alongside the cruise missiles through different angles and possible engagement scenarios, highlighting three main changes generated from the adherence to stealth aircraft. First of all, the stealthy aircraft would likely suffer less attrition, making their losses lower than non-stealthy aircraft. In the second place, non-stealthy aircraft requires more support for identification, countermeasures, escorting, and the needed intelligence to locate, classify, and identify the defensive units. This would increase overall costs of the missions. Finally, the ability to arrive at the target without prompting warning and countermeasures would provide three distinct advantages regarding the targeted unit:

> "a) the unit would be in plain view on the road, aiding detection and identification, and easing the requirement on intelligence assets to predict the unit's exact location; (b) the unit's organic short range defenses would not be alerted and would probably be ineffective; and (c) the unit's physical and psychological vulnerability would be increased, thus increasing the effectiveness of any ordnance delivered. (…) Thus we see in this example that in the areas of penetration, target acquisition, and target vulnerability, large indirect effectiveness increases accrue to the stealthy aircraft; and large indirect cost increases accrue to the non-stealthy aircraft" (WELCH, 1989, p. 50).

Stealth aircraft would have high assurance of penetration, and would not have to fly at a breakneck speed, routes or altitudes to avoid defense radars. Cross-targeting could be used between missiles and bombers, with the B-2 being used for back-up assurance or the primary attack. It could also be assigned to attack relocatable targets. What a stealth aircraft provides is effectiveness over a wide range of cases (WELCH, 1989). In conventional operations long-range bombers could cover a large geographical area, giving the advantage of establishing capable and secure bases. Rendering defenses in Soviet "client states" would also enhance U.S' demonstration of military-technical superiority, attacking symbols of Soviet involvement. Attacking fixed installations (political, economic or military) or military forces (ships, aircraft, army vehicles, and personnel) could also open the area to future penetration by non-stealthy aircraft (WELCH, 1989). In theater air operations, strategic bombers with stealth would be hardly engaged by air defense, and thus, they would not be diverted from their primary missions to defend themselves. "In air-to-air combat, surprise is an exceedingly strong factor. Even a small delay in detection can allow one aircraft to obtain a more favorable initial position that will provide dominance in the ensuing engagement" (WELCH, 1989, p. 59).

These possible advantages, however, depended on a number of strategic, cost-effectiveness evaluations and technical development challenges. Welch (1989) poses a

number of questions which demonstrate the uncertainty of achieving the stealthy aircraft benefits. Furthermore, these benefits and its relations to cost concerns were certainly not consensual among experts and different key actors, and the road ahead to developing the B-2 would be hard.

This section aimed at laying out the incentives and first conceptual and value assessment of the B-2 program, stressing its main objectives, design challenges, and possible strategic benefits. The program, however, had enormous challenges from its conceptualization towards its development, testing and acquisition phases. This was a result of bureaucratic and actor disputes, technological challenges, and changes in external threat environment. These problems were intertwined over the following decades and affected the ultimate results of the program. The next section will be dedicated to assessing these issues, tracing the main events and disputes regarding the program.

6.2- Development of the B-2: A Troubled Process

According to Rebecca Grant (2012, p. 2), the B-2's history was marked by "economic inefficiency, by bureaucratic politics and technological feasibility doubts, and economic calculations", which made scale production not occur. The main debates among specialists and the key actors of decision-making, such as the Congress' committees and the Executive bureaus and leaders, were concentrated in the late 1980's and early 1990's. These debates took place on a drastically changing scenario, the end of the Cold War, which would put in question the program's strategic objectives and necessity. Different actors had conflicting stands and interests, cost calculations were constantly modified, and consensus surrounding acquisition was not reached. Since technological feasibility, costs and strategic necessity were at the center of the debate, this topic starts by addressing and reviewing this discussion. It is worth citing that, at the time the main debates took place, there were drastic defense budget reductions, which posed concurrent programs and different interests as an ever greater challenge. Dispute among those which defended their constituencies, alongside with priority debates and disputes within the Armed Forces were intensified.

Jasper Welch (1989) assessed, beyond the possible benefits of successfully developing stealth technology, as it was discussed in the previous section, its main challenges and possible penalties. The core penalties were centered on the question wether the design penalty was too high. That could be manifested in terms of "unit cost,

overall aircraft weight, range-payload, acceleration, climb, maneuver, handling characteristics or perhaps other ways" (WELCH, 1989, p. 50). Unit cost is a decisive criterion for decision-makers, especially evaluating concurrent possibilities. In this sense, cost issues are raised with technological uncertainties. Welch (1989) highlights that at the time, many of the costs of incorporating stealth were not known in a substantial degree. No more than estimates could be made at the time.

The next (after 1988) elected president would face an immense challenge, with cuts in defense budgets, something would have to give (BROWN, 1988). The author argued that "the fate of the B-2, therefore, will probably hinge on cost consideration and seemingly mundane procurement issues" (BROWN, 1988, p. 351). Brown compares the B-2 program with the B-1B, and argues that because the former was so innovative, it should be more problematic than the latter. Brown (1998, p. 351) evaluated that "unfortunately, the B-2 program has the potential to be a legitimate procurement horror story". At the time, the author suggested that the next president would have to decide how to restructure the program. If the deployment decision was made, he suggested in should focus exclusively on engineering development testing, in order to provide him with the necessary information to make an acute decision, with a solid cost-effectiveness evaluation. This would also "release budgetary resources in the near term for other pressing military needs" (BROWN, 1988, p. 351).

Brown (1988) also assessed the strategic necessity of the B-2, arguing that despite the necessity of a land-based, air breathing leg of the strategic triad, the US probably did not need the B-2. Brown (1988) stated that cruise missiles were already tested and reliable and were more effective penetrators than bombers because "the smaller, single-engine cruise missile has a much lower RCS and Infra-Red Signature (IRS) than a manned aircraft" (BROWN, 1988, p. 353). Furthermore, the author argues that penetrating bombers do not perform any unique, critically important strategic mission and raises a technological feasibility issue: "given current sensor and on-board data processing technologies, it will be difficult if not impossible to conduct search-and destroy missions against mobile, camouflaged targets" (BROWN, 1988, p. 353). The author argues that supporters of the B-2 could not uphold the argument that the bomber would be needed by the early 1990's and the rationale for an accelerated procurement program was questionable from a strategic point of view. Furthermore, as a *state of the art* technological ambitious program, Brown (1988) argues that major technological

advances in aerodynamics and materials were not a superficial matter, since problems in these areas had derailed procurement programs in the past.

There were serious technical problems with the aircraft's composite materials and assembly issues had already arouse. Brown (1988) highlighted delays in the B-2 first flight test, increased cost estimations, Northrop's downsizing in production and Congress' steps to slow down the program. These were indicators of technical difficulties and lack of consensus among main actors. An irreversible commitment to the program was, then, inappropriate. "Rushing into production would not guarantee early operational capability" (BROWN, 1998, p. 363). Brown argued for a sequential program and its restructuring instead. According to the author "if the next president fails to restructure the B-2 program, he will face the worst of both worlds: the program will move inexorably towards production even as it accumulates technical problems and costs overruns" (BROWN, 1988, p. 363). Decision-makers should, therefore, be focusing primarily on prototype testing:

> "The prototype testing stage of the process is also vitally important because it confirms that the weapon works as advertised and it allows the engineers to finalize the design of the system before high-rate production begins. Building a prototype also helps to confirm cost and schedule estimates" (BROWN, 1998, p. 357.

The diminishing external threat, Congress' pressure to cut drastically the military spending, technical difficulties and repeated delays, impacted the Air Force's plans for the B-2 by 1990. In April 26, Secretary of Defense Richard Cheney proposed a reduction in the purchase of B-2 stealth bombers. "Instead of buying 132 bombers at an estimated cost of 75$ billion, the Pentagon proposed to buy 75 bombers for 61.1$ billion" (BROWER, 1990, p. 25). It is important to highlight that CBO offered different estimates of the total 132 program at the time. The CBO report suggested that the cost of buying 132 planes in a stretched plan would cost 91.3$ billion, and at a low rate 81.9$ billion. The CBO report, stated, also, that possible cost increases were to be expected, since there were unknowns regarding the program (CBO, 1990).

Even with this reduction, however, Brower (1990) argued that, still, at the time, there was many doubts about the B-2's cost effectiveness: "In fact, none of the advantages the air force claims for the B-2 can withstand careful scrutiny" (BROWN, 1990, p. 25). Brower (1990) held that B-2's would not be effective against mobile targets, since these hidden targets could be jammed, and simple counter measures, such as using decoys, the

number of targets that the penetrating bomber could destroy would diminish significantly. The argument that the B-2's would render Soviet defenses obsolete might be true, although, by the time, Brower (1990, p. 27) stated that "Soviet defenses have already been made largely obsolete by cruise missiles. The Soviet economy is weak and defense expenditures are apparently declining". As for conventional operations, Brower (1990) argued that the B-2 was too costly and that the Air Force already had the B-52, B-1B, FB-111 bombers and F-17, F-15 and F-16 fighters that could be used in these scenarios.

A very important argument, put forward by Brower (1990), was the O&M costs of the program that should be considered in acquisition decisions. The baseline costs projections made by The Air Force were continuously being reassessed. For example, the unit cost estimation went from $530 million in 1989 to $815 million in 1990. Furthermore, operation and support costs, however, including costs-fuel, maintenance, spare parts, personnel tanker aircraft, were estimated to cost another $20 billion over 25 years for a force of 60 active-duty bombers (BROWER, 1990, p. 28). Brower estimated that, adding these factors, the B-2 force would probably cost $103 billion to acquire, operate and support. At the time, Congress had already approved the development of 15 B-2's. Brower (1990, p. 29), thus, proposed that:

> "The United States has an adequate strategic bomber force for the I990s and beyond, without the B-2. Most of the B-2's missions could be handled more effectively by other be weapon systems. Furthermore, the B-2's costs are far higher than current estimates suggest will be at least $ 108 billion. Congress should terminate B-2 production immediately. The I5 aircraft already funded should be used for testing stealth technology and, possibly, special operations. Instead of buying the B-2, Congress should keep the current force of B-IBs and B-52s more or less intact, saving approximately $35 billion in operations and acquisition costs over the next decade, or immediately convert B-IBs to cruise-missile carriers and retire most or all B-52s, for a saving of nearly $49 billion".

In a similar manner, criticizing the strategic necessity and cost-effectiveness issues of the B-2, Brown (1990) made a compelling case for cancelling the B-2 program. The author did not argue against the importance of manned bomber forces and maintaining the U.S strategic triad. He argued that the requirements for maintaining manned aircraft were already met by "stand-off cruise missile carriers, such as the B-52 and, in the future, the B1-B" (BROWN, 1990, p. 130). The author (1990) questioned both the B-2's contributions to deterrence and defense and the procurement and cost estimates of the program, arguing it was strikingly cost-ineffective.

Brown maintained that, strategically, there was no compelling case for the B-2. He stated that the B-1B would be effective as the bomber leg of the triad for 25-40 years

and cruise missile already fulfilled the requirements for the B-2's purposes; ALCM's (Air-Launched Cruise Missiles) and the ACM (advanced cruise missile). As the B-2 uses Short Range Attack Missiles (SRAMs) rather than gravity bombs, it would not have any distinctive kill capabilities. "Instead, it will be the world's most expensive cruise missile carrier" (BROWN, 1990, p. 134). As for conventional conflicts, Chain (apud BROWN, 1990) argues that because of the value of the unit, putting in risk a B-2 was not worth it. These arguments, show that many concurrent options were presented to the decision-makers, and serious doubts around the need for the B-2 were posed. In the light of cutting defense budgets, bureaucratic politics and different stands in Congress, the defense acquisition community would have a difficult time in reaching a consensus that would support the program.

Similar to Brower (1988), Brown (1990) questions the cost calculations of the B-2 program, stating that no one ever said bombers were cheap, but the Air Force tries to make the B-2 appear far less expensive than it really was. BP politics explains the Air Force's insistence in its own programs, since a bureau would act trying to maximize its budget and prestige and monopolizing decisions in its policy area. Brower (1988) demonstrates that the program's estimated costs grew 12% in real terms between 1981 and 1986, and 20% in real terms between 1986 and 1989. Problems with delays in testing, and information available that Northrop was facing serious challenges with the B-2's composite materials, also aggravated the situation (BROWN, 1990). GAO reported that the cost of the B-2's avionics tripled between 1988 and 1989, and was 2 years behind schedule (GAO, 1990). HASC was also questioning the estimates and procurement plans of the Air Force, arguing that, with falling defense budgets, annual funding for the program would drop, raising its overall and unit cost (MORROCCO, 1989). Brown (1990) also reinforces Brower's (1988) of non-baseline costs, stating that O&M costs would substantially increase the program's cost. In conclusion, Brown (1990, p. 153) stated that:

> "In my opinion, the B-2 is not needed, and its capabilities are not worth the tens of billions of dollars the Air Force wants to spend on it in the 1990s and beyond. Building any B-2s above and beyond what the United States is already committed to build is a luxury the country simply cannot afford. Congress should terminate B-2 procurement immediately and minimize American investment in this technologically elegant but strategically superfluous system".

The authors reviewed so far focused on technological, strategic and cost-effectiveness issues. The disputes surrounding the B-2 program intensified with reduced

budgets, and the main actors in the decision-making process, described in Chapters' 2 and 4, were having serious trouble in reaching a consensus regarding the program. Healy (1990, p. 1) said that the controversial stealth bomber could cost as much as 1.95$ billion per unit based on a CBO released study, estimating a total buy of 33 planes at the rate of two per year. If the program was immediately cancelled, that would save $45 billion, although this "would leave a force of 16 bombers with price tags of $2 billion each, the Capitol Hill budget analysts have told lawmakers" (HEALY, 1990, p. 1). This is logical from the point of view that scale saves money, since R&D costs, for example, are fixed. Fewer planes mean a higher unit cost. Nonetheless, what is clear is that cost-estimates were continuously changing and differed among the main actors responsible for them. Furthermore, the Air Force's project of 132 planes for 75$ billion, at a cost of $570 million each (1990 dollars) had already failed, since as it was stated, it has already been abandoned and revised, and ultimately the administration proposed the reduction to 75 bombers. Before the reduction, however, key members of Congress started to oppose each other in procurement options. According to (HEALY, 1990, p. 1), the 1990 Air Force plan could reach a peak funding level of close to $10 billion, which was a "impossible proposition" according to Rep. Les Aspin (D-Wis), chairman of HASC, "when he was presented with the Bush Administration's proposed production schedule for the B-2". The Congressman added "They must be smoking something over there if anybody thinks that we're going to spend $8 billion (to $10 billion) in one year on a single weapons program" (HEALY, 1990, 1). Les Aspin would become Secretary of Defense in Bill Clinton's government. Senator Alan Cranston argued that, "The CBO report confirms what I have been saying all along,". "The only way to stop wasting money on the B-2 program is to kill it outright--not a slice at a time, but once and for all." (HEALY, 1990, p. 1). Proponents of the program, such as the Air Force and Rep. Norm Dicks (D-Wash), argued that there would be large penalties in slowing down the program, stating that the unit cost would go up. The main point is that the lack of consensus and disputes among stands of key players in Congress were quintessential to the administration's decision to cut the program to 75 units in 1990.

There were also disputes within the Executive itself. The Defense Department's former procurement chief, who held the position of undersecretary for acquisitions, said, in 1989, that the B2 program should be killed because of "exorbitant costs, sloppy quality control and poor management by the company building the high-technology aircraft"

(MAY, 1989, p. 1). He argued that the development of the aircraft was at early stages and the Air Force could not calculate its true costs. Furthermore, Castello stated, as Brower (1988) and Brown (1990) did, that the military did not need the new bomber, "since it already had extensive existing strategic arsenal of missiles, submarines and bombers" (MAY, 1989, p. 1). In response, Northrop's CEO, Thomas Jones, defended the bomber arguing that despite it had face some technical challenges, which caused delays, the program had achieved "unprecedented technical success" (MAY, 1989, p.1). Air Force officials said the program represented a "revolutionary aerial warfare" and was needed to carry U.S strategic forces into the 21st century (MAY, 1989, p. 1).

Different and continuously changing cost estimates, opposing decision-makers, technological doubts by specialists and key actors, the diminishing threat level, are all key causes for the outcome of the B-2 project. These facts reinforce the arguments put forward by this dissertation in its theoretical debate (Chapters 1 through 4). Before discussing the results of the program, however, some further comments regarding BP politics will be addressed to better understand the development and acquisition issues the B-2 had through the 1990's. The debate among actors and specialists that were addressed so far took place during the momentum of disputes regarding procurement decisions. What happened afterwards was a consequence of the here demonstrated lack of consensus regarding: i) technological challenges and unknowns ii) cost estimations uncertainties; iii) cost-effectiveness of the program during a reducing budget scenario; iv) the strategical necessity of the B-2; v) diminishing external threat level and, vi) diverging and opposite bureaucratic interests. These facts are certainly interrelated. As it was argued in Chapter 3, innovation has a systemic nature. President Clinton would at the time have to face the challenge of making his stand regarding the future of the B-2 in this troubling scenario.

Jerry Stacy and Mark Guzinger (1996) developed a study investigating specifically the B-2 and Bureaucratic Politics in the mid 1990's. The authors argued that, due to these conflicting interests and in accordance with BP theory, "the B-2 program, in particular, demonstrates the enormous difficulty of making rational defense spending decisions purely on the basis of U.S national security interests" (STACY, GUZINGER, 1996, p. 29). In 1993, the democratic Congress and the Bush administration eventually decided to cap procurement at 20 aircraft at the cost of $44 billion. Decision-makers had agreed to halt the procurement of the B-2 bombers and the Clinton FY 96 defense budget

did not include money for additional bombers. The Air Force's original plans had failed drastically.

Even in the mid-1990's, cost projections and operational feasibility were still a troubling matter. CBO (1993) reported that "the contractor has had difficulty in implementing changes to cost and schedule baselines needed to reflect changes to program schedules". Furthermore, according to CBO (1993), the B-2 proponents had "not adequately describe cost estimates for B-2 development and procurement programs and does not specifically describe cost estimates for elements specified by legislation". GAO (1995) issued a study stating that "after 14 years of development and evolving mission requirements, including 6 years of flight testing, the Air Force has yet to demonstrate that the B-2 will meet some of its most important mission requirements". According to this document "as for May 31, 1995, the B-2 had completed about 44 percent of the flight test hours planned for meeting test objectives" (GAO, 1995). The report concluded that:

> "After 9 years of producing and assembling aircraft, Northrop Grumman, the prime contractor, continues to experience difficulties in delivering B-2s that can meet Air Force operational requirements. For the most part, aircraft have been delivered late and with significant deviations and waivers" (GAO, 1995).

The hard procurement and decision-making process was due to conflicting interests represented in Congress and the Executive. According to Halperin (1974, p. 28), "the dominant view within the Air Force has been that its essence is the flying of combat air planes designed for the delivery of nuclear weapons". In taking stands on policy, budgetary and strategic questions, thus, the Air Force has always "sought to protect its role in the strategic delivery of weapons by air" (HALPERIN, 1974, p. 28). In the mid-1990's, the Air Force was stressing the importance of bomber programs to conventional warfighting strategy. Nonetheless, even within the Air Force, there were those concerned that the B-2 could dampen the efforts of over priorities- such as combat aircraft.

Within Clinton's government, OSD, leaded by Secretary Les Aspin, initiated a campaign to meet the appropriate post-Cold War military strategy and force structure. OSD was very concerned with fiscal matters. In its program, the bomber force structure was limited, including twenty B-2s, perceived as sufficient. With downsizing budgets, a major concern, was conflict among services, since opening the door for more B-2's would result in requests from the services for new and expanded programs (STACY, GUZINGER, 1996). Still, there were strong supporters of the B-2 program in Congress,

the Air Force and naturally, Northrop. The election of a Republican Majority Congress in November 1994, gave hope for those defending the program.

In Congress, defenders of the B-2 also held key-positions at that time. The military procurement subcommittee was chaired by Duncan Hunter of California; the Majority leader of Procurement subcommittee was J.C Watts (Oklahoma). Their stands were highly influenced by constituency issues. In this regard, "Northrop had the advantage of had spread the B-2 production line through 48 states and 383 congressional districts" (STACY, 1996, p. 12) and had contributed to key Congressman campaigns. Job creation and economic boosting, especially in California, Texas and Washington- which benefited disproportionately from B-2 contracts- was a difficult matter that those who opposed the B-2 had to overcome. "Northrop had contracted with almost 8,000 suppliers in 48 states and distributed $14 billion in subcontractors" (STACY, 1996, p. 8). Key members of congress, consequently, stood to preserve the core bomber industrial base.

Nonetheless, there was no consensual support, or a strong majority in Congress of supporters of the B-2, which worked for the advantage of Clinton's administration. The administration directed money not for more bombers, but only to upgrade the existing aircraft (STACY, 1996). While Congress was put in a difficult position of having to choose between additional B-2's and other procurement programs, such as the F-22, or more aircraft carriers for the Navy, the President's decision prevailed, and the 21st B-2 operational heavy bomber was the last to be procured.

Up to this point, this Chapter reviewed the main facts and debates regarding the B-2. In the first section, the conception and initial plans of the program were addressed, alongside with the main advantages and challenges that the program would offer. The second section analyzed the following years focusing on the different positions and stands that would affect the program's outcomes. Difficult technological and doubts about cost-effectiveness and strategic necessity were put forward by the literature reviewed. Bureaus specialized in addressing these problems, such as the GAO and the CBO, also highlighted many difficulties in developing the B-2 which would trouble the procurement process and the Air Force's plans. Congress was divided. Defense budgets were falling. The Soviet Union was ceasing to exist and the Executive was divided and reviewing its priorities. Besides the actors which were expected to defend the program lobbying in its favor, all the issues stated above had more weight in the final result of the program. In the next section, the outcomes of the program are addressed.

6.3- The Outcomes

Four decades later, the results of the B-2 program were substantially different from its conception, purposes and objectives. R&D and constant changing of requirements to develop the aircraft during the process skyrocket the bomber's cost and procurement disputes. In 2009 dollars, the unit cost of the plain turned out to be $ 2 billion. The reduction of the number of bombers acquired, due to the factors outlined in this chapter, further increased the unit cost. At the end of production, the cost of the program totaled $44.2 billion, including sunk costs such as R&D that amounted to more than half of the cost (GRANT, 2012, p. 5). As Bill Scott (1991, p. 23), in accordance to this study's analysis of efficiency, argues: "The defense acquisition process is characterized at every step by three all important elements: cost, schedule, and performance. If any of these varies significantly beyond present limits, the program is in trouble". The actual real cost of the program decreased from the original estimate of $36.6 billion (1981 dollars) to $29.07 billion (1981 dollars) by 1990. However, since the original estimate was based on the projection of 132 planes and the delivery was 21, the original estimate of unit cost was $277 million which increased to a real unit cost of more than $1 billion (1981) dollars. As it was argued, cost estimates were hard to define during the process, since the program was having trouble advancing in its technological challenges. By the mid-1990's it had not proven its performance goals regarding its main mission requirements and was still having trouble estimating costs and schedules (GAO, 1995; CBO, 1993). First flight happened in 1989, and first delivery in 1993. That represents a two-year delay in testing. Initial Operational Capability (IOC) was achieved at 1997, a seven-year delay according to initial projections. Albeit it entered IOC and was ultimately successful at testing, the cancelation decision had already been made. B-2 proponents could not sustain the overruns in cost and schedule and performance problems while convincing decision-makers of its importance.

There were options to the B-2 program, and resources were being harshly disputed, one of the reasons that led to its canceling. The need of the B-2 and benefits to the stakeholders involved in the defense acquisition were not clear. Despite the program's overall failure some remarks have to be made concerning operational successes. The U.S did not get the full return of the B-2 development program. However, the advances in technology, during the process' effort, were substantial and unmatched by other air forces. The plain's mission was readapted, and its B-2's chief role was changed to conventional

weapons delivery (although still maintaining nuclear capability). The B-2 struck targets in Serbia in 1999, Afghanistan in 2001, and Iraq in 2003. Due to its massive investment and cost, however, it can be argued that there was no need for the B-2 in these conventional missions. The Air Force, however, continued to argue that despite the end of the Cold War, strategic warfare was vital and, furthermore, justified the bomber's central role since it was assigned to conventional missions.

The process-tracing in the previous sections already reveal the outcome of the program. Given the parameters of success or failure outlined in this dissertation, the results are clear. The initial goals of the program, and quintessential ones, were not fully met. This is why, the B-2 is rated at the failed-spectrum by this dissertation. Even delivering 21 aircraft that has had operational success and advancing technologically, the program was not efficient (cost, schedule, performance) up to its cancelation and was not viewed as needed by stakeholders and decision-makers. With no efficiency and effectiveness prospects, decision-makers cancelled the project. What does not make it a complete failure is that, ultimately, it proved itself worthy for engagement.

As it will be seen in the next section, the necessary factors which positively impact innovation and large-scale defense projects were not present. The theoretical framework built in this dissertation and the hypotheses put forward in the previous chapters will be now applied to the B-2 case, as it was done on the previous case study (Chapter 5).

6.4- Concluding Remarks and Results

The Stealth B-2 program was not successful. From its conceptualization and idealization until it was commissioned, it had trouble surpassing the main factors that, according to the theoretical framework developed in this dissertation, are crucial to a program's success. Technological feasibility issues were constantly a problem, making cost and schedule projections change constantly. Bureaus had conflicting interests and the main actors involved could not reach a consensus. Congress' commissions, the OSD and specialists were not convinced of the necessity of the expenditure and strategic necessity of the program. Crucial to pressuring innovation– external threat –diminished drastically with the fall of the USSR. The reviewed literature and process-tracing of the project demonstrate its failure in comparison to its initial objective through all three lenses of analysis proposed in this study.

From the IS's angle, the program was conceived to balance the Soviet threat. More specifically, to counter the Soviet air defenses and highly developed radar system. In the beginning of the 1980's, the general perception of military leaders was that the U.S strategic triad– landed based intercontinental missiles, long-range bombers, and submarine launched missiles –was not meeting up to its objective to counter the Soviets. The main concern was with the manned bomber leg of the triad, which led to the conception and motivation to launch the B-2 project, as it is expected, in the sense of internal balancing and state behavior, as argued in Chapter 1. Even though the Cold War continued in the 1980's with a massive military build-up led by Ronald Raegan, the B-2 was not perceived consensually by specialists to be necessary to counter Soviet air defenses. As it was scrutinized, although recognizing the possible advantages of the B-2, scholars and actors objected to the program, proposing other options such as cruise missiles, for example, to achieve the B-2's main mission. With the diminishing threat and economic struggle faced by the USSR at the end of the decade, the program was further challenged in terms of its necessity. Falling defense budgets, readjustment of the US's priorities and concurrent programs put the B-2 even more in question. The external threat motivation for innovation and internal resources mobilization were not met. The main hypothesis of Chapter 1, that innovative-capable states will militarily innovate in a direct proportion to the level of threat, and, hence, in the face of a high level of threat large-scale projects will be more likely to succeed, is corroborated by the analysis made in this Chapter. Diminishing level of threat did not give the sufficient motivation to innovation in the case of the B-2. Furthermore, specialists did not agree that the program was a proper counter measure to the Soviets. As for the auxiliary hypotheses proposed in Chapter 1, they were also corroborated: i) with the fall of the Soviet Union, the US' highly superior military technology compelled them to adjust its institutions and doctrine ii) civilian interference in military decisions, in the face of falling threat, dampened the Air Force's efforts for innovation; iii) the pace, scale and timing of innovation was reduced since there was no urgency to balance the soviets; iv) the US diminished its resources dedicated to innovation as the external threat fell; v) although the U.S, in its purposes for the B-2, did not count of external balancing options, this did not affect their internal-balancing motivations, since external threat did not rise. Finally, it is worth mentioning that external threat variation compelled the readjustment of the aircraft's purposes, changing its main objective from nuclear deterrence to conventional missions.

Chapter 2 outlined the expected domestic factors in order to make a program succeed or fail. The main hypothesis was that success of a large-scale project would be strongly influenced and positively related to the degree of consensus between and within Congress and the Executive. The failure of the project is strongly affected by the lack of consensus observed in the case of the B-2, and thus, the hypothesis was corroborated. While the Air Force, as expected by BP theory, defended its assigned mission, monopoly of information and growing budgets, other players did not go along with them. The fall of defense budgets led other services to bargain for their own priorities. And even within the Air Force, there was doubts and disagreements regarding what projects were priority. Northrop defended the program and there were strong supporters of the B-2 in Congress' commissions, although not sufficient to build a consensus. Defenders of the B-2 were constantly questioned and summoned to hearings. The Pentagon was pressured to cut their plans for the B-2. Clinton's administration and the OSD opposed the program given its Bottom-Up defense review. Consensus was certainly not met and this directly affected the final decision to procure only 21 B-2 stealth bombers.

Regarding technological feasibility, this was certainly another troubled issue. Large schedule and cost revisions reveal that the program faced constant technological challenges. Between totally unfeasible or totally feasible, there are other degrees of technological challenges that impact decision-making and the program's success. This can only be observed by the processing-tracing of the project's development. Delays in flight tests and problems with developing essential materials were some of the factors demonstrated in this Chapter. Specialists and interested actors, as it was reviewed in this Chapter, were constantly concerned regarding technological feasibility issues of the B-2. Over time, even though some of the proposed bombers were procured, the difficulties faced by development certainly discredited the project, raised doubts of its technological feasibility and were a factor of its unsuccessful results.

The proposal of this dissertation to organize the events through the different angles does not mean that they are not interrelated. While external threat variates, technology faces challenges or advances rapidly, actors and decision-making readjust and so on. They are connected. The process-tracing of the B-2 demonstrates this clearly since decision-makers and specialist's stand's overlapped with external threat modifications, the readjustment of the program's purposes and technological challenges. The interaction of

the three proposed angles of analysis will be further treated in the concluding chapter of this dissertation.

CHAPTER 7- THE FUTURE COMBAT SYSTEM LIES IN THE PAST

"FCS is widely regarded as a failure, which has eroded confidence in Army acquisition capabilities from those both inside and outside the Army" (PERNIN et al., 2012, p. 2).

"The program's reliance on immature technology resulted in growing cost estimates and schedule delays. FCS was complicated, and the Army could not provide Congress with a consistent narrative or convincingly demonstrate the return on billions of dollars appropriated for research and development" (BROCKMAN, 2017, p. 175).

The aim of this chapter is to investigate the case of the Future Combat Systems (FCS) and the reasons for its failure. The FCS was conceptualized based on the Army's vision of future threats and their perspective for the need of radical modernization, both technological and doctrinal. The main idea was to build a network of interconnected systems to create situational awareness and rapid deployment of the troops. This would rely on light armory and vehicles, on information technology, Unmanned Aerial Vehicles (UAVs) and precise ammunition. They would be integrated by a digital network to provide all systems instant information and coordination. In its concept, heavy armory would not be needed since the enemy would be engaged without time for a rapid heavy response.

As it was done in the previous two chapters, the process-tracing of the project will begin by analyzing the conception and motivations behind the project towards its development and outcomes. The theoretical framework and proposed methodology will guide the assessment of the program's history, through the lenses of external threat, BP politics and technological feasibility. Another negative case – alongside the B-2 bomber– in terms of failure, is important to infer causality as main features vary and the idiosyncrasies of each program can be treated as *ceteris paribus*, and, thus, the model can be further tested.

During its development, the FCS proved itself technologically unfeasible in the sense that it struggled to demonstrate results in some of its essential technologies while others were also immature. The program began concurring with other priorities in the acquisition community and, furthermore, was not delivering capabilities that could enhance US's performance in the ongoing wars (Iraq and Afghanistan). Some concepts

seemed to be fragile and proved themselves not valid to counter insurgent groups in Afghanistan and Iraq. Schedule and cost delays were constant and both metrics difficult to define, since technology was immature. Despite the Army's efforts engaging with Congress and the defense community, the program lost its support from key decision-makers, actors and specialists. The needed consensus to accomplish the projects objectives could not be formed.

7.1- Conception, Motivations and Prospects

The Future Combat Systems (FCS) was envisioned to be the largest restructuring process and the most ambitious acquisition program in the United States' Army's history. Consistent with the Revolution in Military Affairs (RMA)[90] and the transformation in information technologies, the Army developed the concept of Force XXI, by the mid-1990s, in order to prepare and update its doctrinal and technological features for future threats. The need to innovate was perceived as urgent especially due to the changing IS after the end of the Cold War which generated a "identity crisis" among Army Officials. The Army had taken too much time to mobilize for the Gulf War and its performance in Kosovo was criticized. There was uncertainty about the precise kinds of threats that the Army would encounter (KAESER, 2009). These threats could require action from counterinsurgency, counterterrorism, armed nation building to conventional and nuclear-armed regional competitors. The purpose of the FCS alongside with its reorganization of modular deployable forces was aimed at being flexible enough to assure a well suited performance no matter the threat.

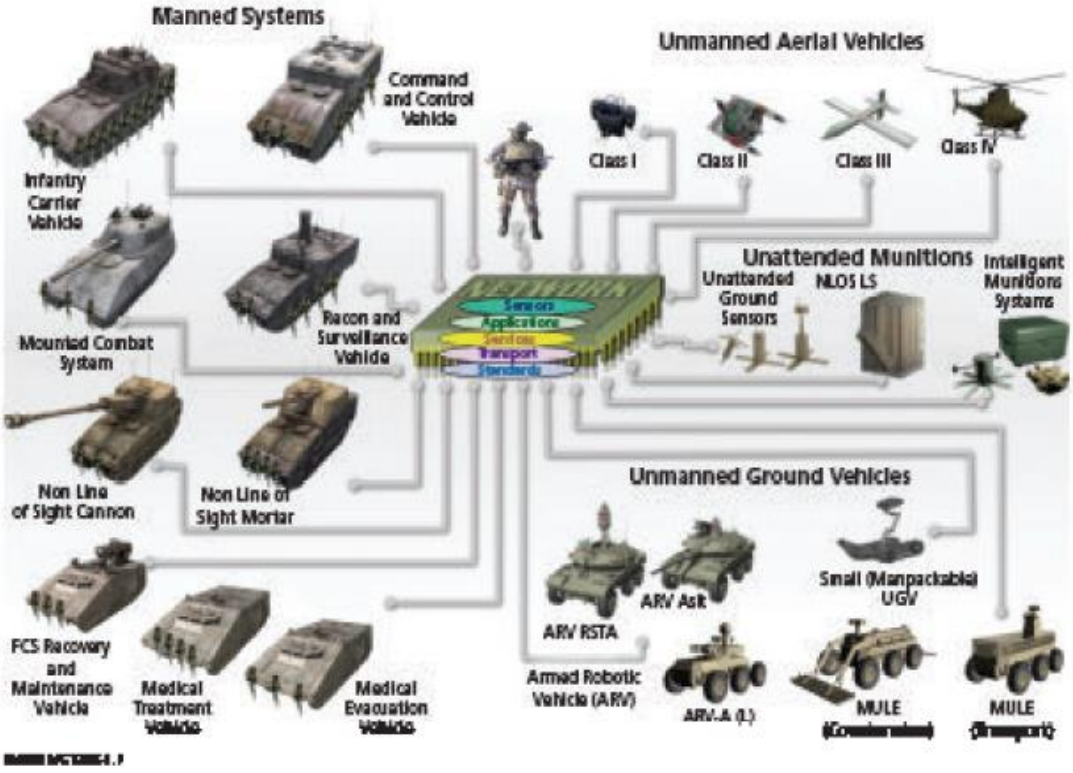
The key aspect of the FCS was to transform the Army into an integrated, rapidly deployable and flexible, quick responsive front. There was a need to a lighter, agile, mobile and modern force. The conceptualization and early requirements of the FCS represented a confluence of several different streams of official thinking within the Army leadership and the DoD, alongside with the Defense Advanced Research Projects Agency (DARPA), and industry partners. These actors were the pioneer supporters and initial sponsors of R&D relative to the FCS. One of the first proponents of the FCS, General Eric Shinseki, Chief of Staff of the Army (1999-2003), was an advocate of the perception that heavy divisions were not holding up to the present challenges (PERNIN *et al.*, 2012). General Shinseki's successor, General Peter Schoomaker, and later General George

[90]On RMA, see: (METZ, STEVEN; KIEVEIT, JAMES, 1995)

Casey, remained supportive of Future Combat Systems and a lighter, more flexible Army (BROCKMAN, 2017, p. 164).

Shinseki decided to reorganize the Army into smaller, self-sufficient and interchangeable Brigade Combat Units of 4,000 soldiers. The goal was to deploy forces globally at a rate of 96 hours for a combat brigade, 120 hours per division and 30 days for five divisions (PERNIN *et al.*, 2012). The FCS Brigade Combat Team (BCT) would be sixty percent more rapidly deployable than the at the time heavy BCT's, outmaneuvering and outsmarting enemy forces (KAESER, 2009; BROCKMAN, 2017, p. 164). This meant situational awareness and the use of advanced information and communication technology. "It was not only a weapon system but the practical implementation of a new doctrine, which emphasizes joint network-centric warfare" (KAESER, 2009, p. 4). For the restructuring of the brigades and achieving the proposed goals, however, major technological challenges needed to be overcome. The acquisition was singular since it was not the traditional process of developing a weapon. Instead, FCS was a combination of multiple programs to equip an entire Brigade. This would require significant advances in technology, program concept, industry interaction and acquisition approach.

Figure 7.1- The Future Combat Systems



Source: (PERNIN *et al.*, 2012, p. 2)

The technological concepts to achieve these objectives were centered around a family of manned and unmanned vehicles, lighter soldier equipment and the network which would integrate the brigade in the battlefield communication architecture (BROCKMAN, 2017). Funds for older "heavy" programs such as the Grizzly Breacher vehicle and the Abrams tank were thus redirected to the FCS and its modular force. More fuel-efficient vehicles, precise and lethal ammunition, lighter armor, lighter armored vehicles were a condition to achieve FCS's objective: "units would be able to assess the situation quickly and engage the enemy with standoff precision fires before the opponent could direct fire from an ambush position" (PERNIN *et al.,* 2012). This would compensate for the volatility of lighter armory since the heavy armor hedge against tactical surprise would not be necessary. Furthermore, "if the FCS vehicles did come under fire, they were to be outfitted with an active protection system that could shoot down incoming anti-tank weapons, along with a new lightweight armor" (ELLMAN, 2009, p. 21).

There was also the transportation matter. The greatly enhanced intercontinental deployability would require means of rapid transport. To achieve the previously mentioned time goals to deploy troops, the FCS' objective was not to surpass the weight of 20 tons per vehicle to be transported by C-130 aircrafts. Another associated idea which would have to be developed was the "air mechanized" concept, which consists of rapidly maneuvering army units in-theater utilizing Vertical Take-Off and Landing (VTOL) aircraft. Armored vehicles, personnel and associated logistics would be moved in the operational area. The "air mechanized" objective was "a significant departure from prior Army schemes of maneuver, and with it came considerable technological, operational, and financial hurdles that would need to be overcome" (PERNIN *et al.*, 2012*).*

Finally, the network – centerpiece of the FCS – would integrate all components keying advanced sensors, gathering information and data from multiple sources and feeding each vehicle, creating situational awareness (ELLMAN, 2009). Sensor and communication technologies spread across the Unmanned Aerial Vehicles (UAVs) and the ground vehicles themselves would enhance logistic readiness. This combination of doctrinal innovation and the family of technologies associated with them would represent the Army's future. According to Pernin *et al.* (2012, p. 14): "Proponents of these concepts claimed that sensor and processor technology was becoming so advanced that in the next

few years the “fog of war” in the complex ground combat environment would largely be lifted, even at the lower tactical levels”. The fog of technological feasibility, acquisition and oversight requirements and political support, however, were a totally different matter.

A very important process that influenced profoundly the concepts behind the FCS were the Army After Next (AAN)/ Objective Force games conducted during the 1990’s. According to Pernin *et al.* (2012, p. 12), however, the games were grounded on the “assumption that the dominant feature of the operational environment would be large-scale conventional combat between nations or what had become known within DoD as major regional conflict operations”. As such, a great part of the early games which had major influence upon the FCS conceptualization and design included a large-scale crossborder invasion by an opponent. Although the discourse, as it was stated earlier, and the FCS documents included the advantages that the project would give the Army in fighting irregular enemies, the assumptions which lead up to the FCS were conceived envisioning a future which would require engaging high-intensity conventional state armies. “Irregular warfare was still largely considered a lesser-included capability” (PERNIN *et al.,* 2012, p. 18). This would largely influence the budgeting and acquisition process over the years, since the United States’ immediate threat were the wars in the Middle East, and, consequently, resources were prioritized to this end. Hence, the FCS had to prove its validity in effectiveness of technological dominance in asymmetric warfare and urban combat.

An acquisition strategy proper fitted to all the mentioned program features and the external threat environment had to be conceived. The size, complexity and technologically revolutionary character of the FCS was very complex to handle and “the near-term focus of what had originally been considered part of the AAN would entail concomitant technical development, engineering, and integration efforts” (PERNIN *et al.*, p. 26). The project was conceived to be delivered by 2010, according to the goal set by Shinseki. Cost and schedule volatility, would, however, be a serious problem. Difficulties in delivering and developing the proposed technologies were constant. The process-tracing of the acquisition process and volatile and multiple cost-estimates will be addressed in further detail in the subsequent section.

FCS acquisition was unique in some senses. It was to be realized through multiple stages and managed in an uncommon way. Prior to reaching Milestone B (see Chapter 4), a Concept and Technology Demonstration (CTD) was divided into two parts. In February

2000, competition started among four industry teams and the subsequent part was the signing of a contract between DARPA, Boeing and SAIC, which was to be referred to as the Lead Systems Integrator (LSI):

> "A Lead Systems Integrator (LSI) is an enhanced prime contractor; while the LSI subcontracts work to other companies, the LSI also acts as an active partner with the government, collaborating and sharing in decisions and program management functions normally conducted solely by defense acquisition officials. The Army decided to partner with Boeing because it 'determined that with its existing acquisition workforce and organizations, it did not have the agility, capability, or capacity to manage the program without an LSI to assist with certain aspects of program management.' The Army did not believe it could successfully manage such a complex set of programs on an aggressive schedule, and so paid Boeing to manage the process. But the LSI arrangement generated additional difficulties. 'We basically handed the whole thing over to Boeing. They knew how all the systems were supposed to integrate, so they were the only ones who really had the big picture," explained one acquisition official" (BROCKMAN, 2017, p. 171).

The LSI alternative for R&D faced criticism on management, as it will be addressed in the next section. The program moved to Milestone B in May 2003. The FCS Selected Acquisition Report (SAR) was prepared annually by the program managers and submitted to Congress in accordance with United States Code § 2432. The SAR is supposed to provide cost, schedule, performance and program unit cost (PERNIN *et al.*, 2012). At Milestone B, the FCS program was estimated at $77 billion (2003 dollars). $18 billion would be directed to R&DT&E (research, development, testing and experimentation), $59.1 billion to procurement and $0.6 billion to military construction (PERNIN *et al.*, 2012, p. 33). The unit cost was the brigade and was estimated at $5.2 billion (2003 dollars). Life-cycle costs of the program, including personnel, O&M and others were estimated at $149 billion at Milestone B. The schedule for delivering Full Operational Capability (FOC) could be met by delivering one fully equipped brigade and the Army proposed to deliver it in December 2012, followed by the Full-rate Production (FRP) decision at June 2013. The Army planned on producing the 14 remaining brigades at a rate of one per year in 2009 and 2010 and two per year until 2017 (PERNIN *et al.*, 2012).

Lacking a sound technical feasibility analysis, a reliance on immature technologies, among other factors, made FCS procurement a turmoil. According to Pernin *et al.* (2012, p. 50): "cost estimation for such a large, complex program was challenging, especially in terms of the software, integration, and life-cycle components". The FCS entered Milestone B with a weak basis in terms of providing the procurement community enough confidence to invest in it and was already target of criticism by important actors,

such as the GAO. The years following Milestone B would be of volatility in cost estimates, technology demonstration and procurement decisions. This process will be further addressed in the next section. However, as it has been already argued in this dissertation, cost and schedule volatility dampen political support and demonstrate technological feasibility problems.

Finally, development and innovation techniques used by the FCS are relevant to explain its outcomes. Evolutionary acquisition and spiral development are strategies, which aim at deploying initial useful capabilities and receiving quick feedbacks from the end-users, and upgrade the technologies incrementally, retaining requirements fluid, thereby avoiding traditional acquisition requirement of demonstrating full capability. Producers would field increments of platforms, while more difficult technological challenges were being working out (ELLMAN, 2009). Anterior successful developments under evolutionary acquisition and spiral development strategy such as the UAV Predator validated this concept among the defense acquisition community. The Predator was utilized in Bosnia eighteen months after the initial contract was awarded and then incrementally improved in various aspects (LOREL *et al.*, 2006). Nonetheless, initial capabilities of the Predator already relied on almost exclusively mature and proven technologies. Evolutionary acquisition and spiral development was formally incorporated to acquisition strategy in 2000, in DoD's Directive 5000.1 and its revised version of 2003, alongside with Directive 5000.2.

This Chapter has, up to this point, outlined the background, motivations and concepts which gave basis to the development of the FCS project. As it was seen, the FCS was highly complex and innovative. War games and a perceived changing role for the Army and its modernization purposes were envisioned as necessary to future military engagements. The main goal was to provide the Army with quick and precise deployment, situational awareness, counting on a set of technologies such as lighter vehicles and armory, a network centric warfare communication system and transport improvement. Technology would field smaller and logistically enhanced brigades. Initial schedule and cost estimates were ambitious but doubtful. Furthermore, continuous improvement and increments of technology during the acquisition process were viewed as the preferred acquisition strategy. The chosen LSI form of contract would also be target of intense debate among the defense community. The next section addresses the FCS by analyzing its years of development through the angles of analysis proposed in this study.

Technological feasibility issues, political disputes and concurrent budgets would be proven hard to overcome.

7.2 – Development of the FCS

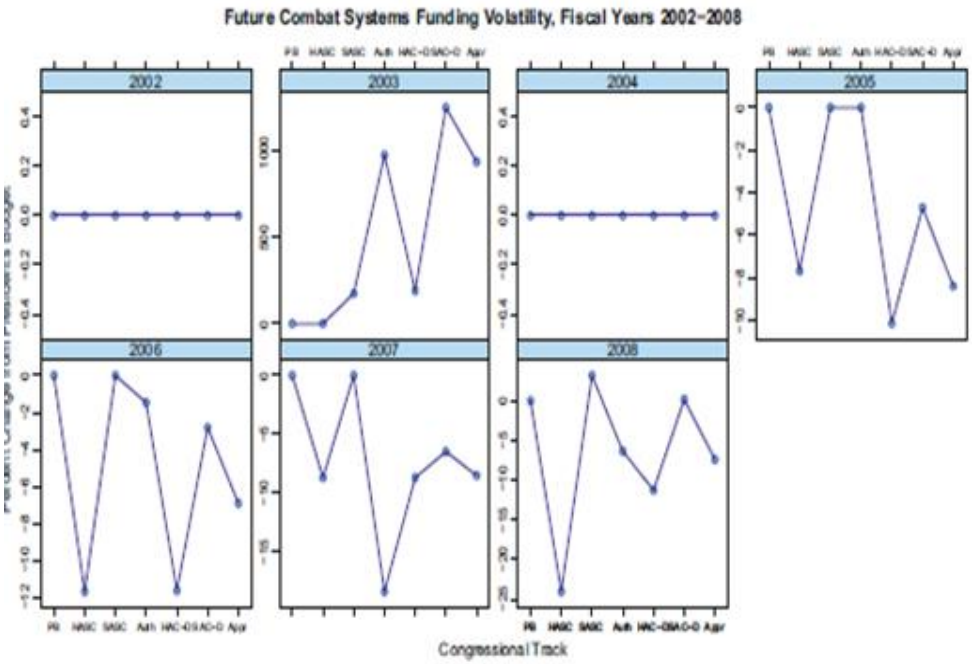
The FCS was conceptualized as a revolutionary program for the Army. Nonetheless, as stated by Heidi Brockman (2017, p. 175) "despite the Army's best, sustained, and incredibly robust efforts to engage with Congress and bolster support for a program identified as top priority, FCS remains firmly in the past". This topic addresses the trajectory of the program from its initial acquisition efforts towards development and, finally, its formal cancellation in June 23, 2009, by the government. Budgetary volatility, immature technologies and doubts surrounding if the program was necessary to engage in present threats will be addressed.

Between FY's 2002 and 2004, Congress granted the Army the amount requested of budget authority for the FCS. However, as it was already argued, there were still many problems when the program entered Milestone B in 2003. After Milestone B, FCS entered SDD (System Design and Development) with a number of items yet to be completed. The incremental acquisition strategy of the FCS proposed the reduction from its original proposal of 18 systems to 14 at Milestone B. Some procurement quantities and training miles were reduced (PERNIN et al., 2012, p. 33). However, the immediate need for mobilizing resources to engage in the fights of Iraq and Afghanistan pressured the program's leaders to restructure the FCS as soon as 2004.

The 2004 restructuring was the inclusion by the Army of spin-outs – spiral technologies – to feed the troops in the field. These included sensors, unmanned air and ground vehicles, unattended munitions and command and communication technologies. Furthermore, in addition to the spin-outs, the Army reincorporated the four technologies plus the network that was decided to be left for a future time at 2003. Thus, spin-outs and the 18 systems were than part of the FCS and the Defense Community expected fast results in the battlefield. The modifications of the program increased costs and lengthened schedule. The new baseline set on November 2, 2005, changed the FCS program costs from the $77.8 billion in 2003 to $120.2 billion. The unit cost climbed (in 2003 dollars) from approximately $4billion per FCS-equipped BCT to $6 billion. The procurement schedule changed from two BCT's per year to 1.5 BCT's per year with this adjustment

(PERNIN *et al.*, 2012, p. 42). The last BCT would be produced by 2023, according to the new schedule.

Figure 7.2- FCS budgetary requests and variation on the amount appropriated



Source: (BROCKMAN, 2017, p. 167)

The restructuring of the program receded support for the FCS from the Capitol Hill. Intense variations, as it can be observed in Figure 7.2, were seen as the budget passed through the different committees. A few years after entering Milestone B, FCS became subject of oversight from Congress. The FY04 National Defense Appropriation Act (NDAA) constrained the program by requiring independent reports and greater detail in the FCS budget justification of the materials submitted. HAC argued that the Army had to substantially improve the reasons for the various elements of the program so it could compete for resources (PERNIN *et al.*, 2012, p. 253). Especially after the restructuring of the program, Congress hardened its demands. The FY05 NDAA required independent analysis of FCS's costs and feasibility to be submitted to Congress and demanded that the Secretary of the Army established and implemented a detailed FCS program strategy.

CBO reported, in February 2005, that the full costs of the program were still not known because the FCS program was still in early stages of developments. The same report called for canceling the FCS, except for R&D to explore promising technologies for later use or the delay of FCS fielding from 2011 to 2015, reducing funding accordingly

(CBO, 2005). In early 2005, the GAO issued an analysis that stated the program was not appropriately applying efforts to maturing its critical technologies. These technologies were still immature and that increased the risk of program cost growth and schedule delays (GAO, 2005). These reports influenced Congress, which was becoming skeptical of the FCS and increased its scrutiny. In FY05, HASC and HAC recommended cuts to the Army's FCS budget, while the Senate committees were still supportive of the program. Nonetheless, by FY06 SAC joined both House committees in recommending funding decrements for the program (PERNIN *et al.,* 2012). FY06 resulted in a $236 million decrement for the FCS.

Increasing pressure was translated in further decrements over FY05 and FY07 and the FCS was, eventually restructured and further schedule changes were made in 2007. According to PERNIN *et al*., (2012, p. 44): "In the years after Milestone B, the FCS program was under increasing scrutiny. Congressional interest, bolstered by GAO and myriad other audits, became more vocal, eventually playing a role in decreasing funding over multiple years". The total program costs were reduced from $120.2 billion (2003 dollars) to $113.2 billion. Nonetheless, Army's estimates were increasingly challenged in the Capitol Hill and by independent agencies. Scrutiny of the FCS by decision-makers further increased in its final years. Disparate estimations make it difficult to determine affordability. This raises uncertainty among developers and the procurement community. In FY07 congressional oversight resulted in funding decrement of $319.1 million. By this time, technologies were not maturing fast enough. Cost estimates by the GAO and the CAIG (Cost Analysis Improvement Group) were far higher than those made by the Army. CAIG projected $300 billion (2003 dollars) it the program's total life cycle and GAO estimated the total cost of the program in $160.7 billion, 73% higher than the Army's initial estimate (PERNIN *et al.,* 2012).

Bureaucratic disputes came highly into the core of the question when the FCS began losing its credibility. First, technological immaturity and the failure to demonstrate success on the ongoing wars made the program fall in priority status. Second, other projects such as Navy shipbuilding and missile defense were constantly being seen as important and, thus, threatening FCS' budget. The Army did not respond to congressional oversight and feedback, even while facing decreasing funding. According to Pernin *et al.*, (2012, p. 260)*:*

> "The congressional interest in FCS and decrements through those years were raised often in interviews with past FCS officials. GAO audits of FCS were described as "self-fulfilling prophecy" and a "death spiral." Audits led to cuts, which led to setbacks within the program, which led to more problems identified in subsequent audits—and so on. The GAO was faulted by some officials as having no strategic incentive to positively review an acquisition program. To some, FCS was simply a good target for cuts because it was large".

At the beginning, it was politically uncontroversial that the Army needed modernization and there was substantial support for technological improvements in warfighting capabilities. There was, in FCS's first years, early interaction among the concept developers, the Army, the industry to formulate an acquisition strategy. As BP politics expects, the Army became increasingly advocative of the FCS's budget maximizing, following the early war games, and disregarded dissenting positions. There was a lack of generation of competing conceptual ideas. This reinforces Janis's (1982, e.g., see Chapter 2) concept and analysis of *groupthink*. Once the Army leadership was convinced of its general guidelines and path, it "closed itself" to other points of view.

Even with the program being apportioned through 41 states and a constant engagement by the Army at The Capitol, Congress did not defend the funding requests for long. Acquisition schedules were complicated, costs estimates were constantly being questioned and changed, core technological systems were immature and operational demonstration appeared far. The program became concurrent with other important programs, and even as "the Army's topline steadily expanded over the lifetime of the FCS, the proportion of resources consumed by the modernization suite restricted the range of funding options available for other programs" (BROCKMAN, 2017, p. 170). Important members of Congress, such as Senator John McCain, as a senior member of the SASC, become vocal and pointed out several problems regarding FCS' oversight difficulties, management problems, climbing costs and uncertain priorities.

When HAC and SAC began adjusting FCS's funding bellow the amount requested the Army reacted by lobbying intensely. According to Brockman (2017, p. 172): "The Army's sustained engagement strategy with Congress about FCS was unlike that of any other acquisition program". The OSD began responding to congressional reticence to fund FCS and "it was just a matter of time until what little backing remained for FCS within the Pentagon and in Congress withered completely" (BROCKMAN, 2017, p. 174). As it was shown in this dissertation, a necessary amount of consensus within Congress and the Executive and among them is needed for a program's success. This was no longer

the case with the FCS. While the Army lobbied, legislators were unaffected by the officers and the case they made defending the FCS and, therefore, did not fully support FCS's funding. According to Brockman (2017, p. 175):

> "The program's reliance on immature technology resulted in growing cost estimates and schedule delays. FCS was complicated, and the Army could not provide Congress with a consistent narrative or convincingly demonstrate the return on billions of dollars appropriated for research and development (…) No matter how often Army officials discussed FCS with members of Congress".

Regarding spiral development and evolutionary acquisition, technologies were too immature to prove themselves valuable enough to generate feedbacks and improvements. In a war, it is of great risk to test immature technologies because lives are in stake. Evolutionary acquisition was officially defined in DoD's Directive 5000.1 (2000, p. 4):

> "Evolutionary acquisition strategies define, develop, and produce/deploy an initial, militarily useful capability ("Block I") based on proven technology, time-phased requirements, projected threat assessments, and demonstrated manufacturing capabilities, and plan for subsequent development and production/deployment of increments beyond the initial capability over time (Blocks II, III, and beyond). The scope, performance capabilities, and timing of subsequent increments shall be based on continuous communications among the requirements, acquisition, intelligence, and budget communities".[91]"

It is crucial that technological feasibility must have sounded readiness in the case of ongoing military engagement. The feedback from the end-user, in this case the soldier, has to already be regarding a technological maturity that is at least partially functional in battle. According to Ellman (2009, p. 16): "The initial increment is supposed to be functional and survivable in its own right, even without the capabilities that are to be integrated in later increments". This was not the case with the FCS. Initial combat vehicles would have to be at least capable enough to safeguard the soldiers. Other essential technologies were far from operational. The innovative strategies of FCS were seemingly not so urgent in terms of counterinsurgency. A report by GAO (2006, p. 18) evaluated that:

> "The FCS intended to be developed using evolutionary acquisition and spiral development, although the FCS is not being developed in proper accordance with the principles of evolutionary acquisition, in large part because of the reliance on immature technologies".

[91] In its revised document of Directive 5000.02 (2003, p. 4-5) the DoD complemented the definition: "In this process, a desired capability is identified, but the end-state requirements are not known at program initiation. Those requirements are refined through demonstration and risk management; there is continuous user feedback; and each increment provides the user the best possible capability. The requirements for future increments depend on feedback from users and technology maturation."

As it is demonstrated in this dissertation, technological feasibility is a *sine qua non* condition for the success of a program. Nonetheless, it is impossible to determine it *ex ante*. As it was argued in Chapter 3, the more the program faces difficulties demonstrating its technological readiness to decision-makers and specialists, the more the program raises doubts regarding its feasibility. A way to track this is cost and schedule rearrangements, which in the case of the FCS, demonstrate clearly that feasibility was a crucial issue. Even if incremental and spiral innovation was the strategy adopted, the initial crucial capabilities for the mere survival of the core technologies regarding the FCS were not demonstrated. As GAO early identified (2005, p. 301):

> "There is not enough knowledge to say whether the FCS is doable, much less doable within a predictable frame of time and money. Yet making confident predictions is a reasonable standard for a major acquisition program given the resource commitments and opportunity costs they entail. Against this standard, the FCS is not yet a good fit as an acquisition program".

The LSI form of contract was target of many criticisms and could have dampened the innovative efforts. As it was argued in Chapter 3, innovation requires incentives and constant interaction among the main actors. Since the Army did not have the capacity to manage the complex FCS family of technologies, Boeing assumed the project with large autonomy. This lack of oversight and precise requirements might have worked in the opposite way of fostering innovation. GAO and Congress grew more concerned about the contract awarded to Boeing and more vocal about the problems that this kind of arrangement could create (BROCKMAN, 2017; PERNIN *et al.*, 2012). The nature of the LSI makes it difficult for oversight, as the company is responsible for almost every aspect of the development process. While the company stated that the technological maturity of some projects were more advanced, reviewers downgraded their technological readiness analysis of these equipment. As stated by Ellman (2009, p. 25): "some critics believe the Army lacked the resources to effectively oversee the contractors managing the program for them". This would undermine the project.

External environment was certainly a decisive issue regarding the FCS's outcome. As it was stated above, the Army envisioned a massive restructuring sounded on concepts and projections about the future threat environment. Nonetheless, it soon became clear that the FCS was unsuited for the counterinsurgency missions the Army was performing in Iraq and Afghanistan. Furthermore, the fog of war was not lifted by technology. The difficult environment and the tactics used by the enemy would sometimes surprise the US' soldiers and make technological asymmetry less important. Immature technologies

were of great danger and other budgetary demands became increasingly more urgent. As argued by (KAESER, 2009, p. 2): “These cost burdens go far beyond the FCS. They interact with other procurement programs, current warfighting needs, the cost to compensate for past wartime wear and losses, and the expansion of its manpower strength”.

The most decisive factor affecting FCS regarding the external environment was, thus, the ongoing warfighting. Costs and increases in the end lines pressured other procurement programs. The U.S government planned to deploy additional 30,000 troops to Afghanistan by 2009. Active-duty troop personnel would reach 547,000, 65,000 more than before the wars. Furthermore, the Army had adopted a plan to increase its strength in active and reserve soldiers by 100 thousand by FY2013. “Further increase in end strength may be necessary to sustain the current operations and maintain readiness. At an average salary of $120, 000 annually (…) personnel accounts may squeeze funds out of procurement programs” (KAESER, 2009, p. 2).

Innovation, in the case of the FCS, was not stimulated by external threat. FCS was not conceptualized envisioning current threats. And the cutting-edge technology, immature and costly, was not responsive to external threat. FCS was thought for future threats and especially large-scale operations facing powerful state actors or unstable nuclear states, such as Iran, North Korea and Pakistan. Large conventional armies such as China or Russia could justify FCS, as the United States would use its technological advantage to explore asymmetric weaknesses or gaps. Decision-makers did not see the connection between the FCS and the necessities of the time.

The largest and most ambitious acquisition program in the Army’s history seemed, for these reasons, doomed to fail. The FCS was soon to be cancelled on April 6, 2009, after a speech delivered by Secretary of Defense Robert Gates. In his speech he argued that the FCS had many remaining unanswered questions. Gates stated that the lower weight, fuel efficient, and informational awareness which were expected to compensate for less armor did not reflect the lessons of counterinsurgency and close quarters combat in Iraq and Afghanistan (PERNIN *et al.,* 2012). In this sense, according to Sprenger (2016, p. 1), the Army’s moto of: “'see first, decide first, act first–which led to a tradeoff of armor protection for intelligence and decision-making, suggest that the Army did not have a clear grasp of which technologies were feasible and which were necessary and satisfactory to meet the needs of the future."

The FCS failed to respond and to innovate in the face of the ongoing external threat. As it advanced in the procurement stages it could not gather the degree of political consensus necessary for its prioritization among budgetary demands. The FCS failed to demonstrate technological feasibility and to deliver solid future estimates regarding cost, performance and schedule. This topic has addressed these issues along the FCS's development and procurement years. Problems with oversight, immature technology and urgent external threat demands dampened the decision-makers support for the FCS. Its conceptualization, management and procurement strategies were also target of scrutiny among key actors. While the program failed to deliver, it demonstrated that there were also problems in its conceptualization and the Army's prospects regarding its modernization. The next session addresses the outcomes of the program and further explanations for its failure. Finally, the last session confronts the theoretical framework developed in this study with the case of the FCS.

7.3- The Outcomes

Todd Harrison, budget expert of the Center for Strategic and International Studies (CSIS) argued that "the FCS program was such a massive failure and a missed opportunity for Army modernization" (apud SPRENGER, 2016, p. 1). The author stated that the program single-handedly set the Army back a generation in vehicle technology. According the Sprenger (2016, p. 1): "The all-encompassing program was remarkable because there was no mechanism in place to periodically re-evaluate key assumptions, leading officials to charge forward without asking important questions along the way". As stated by Daniel Gouré (2011, p. 1), "the security environment had changed and the FCS program had failed to deliver on its promise".

The formal cancellation came in June 23, 2009. In its end, the FCS had already spent around $15 billion in R&D. Some of the programs remained at the time, although managed as individual programs, most of them cancelled in the following years. For example, The Non-Line-Sight Cannon, which was eventually canceled later in 2009. The Unattended Ground Sensors and the Class 1 Unmanned Air System, both reminiscent programs of the FCS, were cancelled in 2011 (GOURÉ, 2011, p. 1). The Manned Ground Vehicle was rearranged as the Ground Combat Vehicle, which was also canceled in 2014 (BROCKMAN, 2017). "Although some of its components have been transferred to other programs, FCS is widely regarded as a failure, which has eroded confidence in Army

acquisition capabilities from those both inside and outside the Army" (PERNIN *et al.*, 2012, p. 2).

The program was restructured, as it has been addressed, in 2004 and in 2007. The "spin outs" suggested to fulfill ongoing demands and create near-term success and support for the program did not meet their goals and only made the program even more difficult to manage. FCS was large, complex and relied on immature technology. According to Pernin *et al.* (2012), the major shifts through the development process caused turbulence and eroded support for the acquisition. As it argued by Brockman (2017, p. 175), "the sweeping, ambitious, unprecedented scope of Future Combat Systems contributed to its funding difficulties and its eventual termination". It proved itself too large, expensive, unmanageable and complex. Brockman (2017, p. 176) states that:

> "Under other circumstances, each of the eight manned ground systems would be a major defense acquisition program on par with the Army's past major ground systems such as the Abrams tank, the Bradley Fighting Vehicle, and the Crusader Artillery System. As such, each requires a major effort to develop, design, and demonstrate the individual vehicles."

As it was demonstrated through this Chapter, these factors dampened political and budgetary support. Congressional decision-making regarding the FCS started with outcomes which were stable, and key actors supported the program. Through time, resources mobilized to the FCS became erratic. The FCS threatened established programs, relied on immature technology and a problematic contractual arrangement. According to Brockman (2017, p. 175):

> "The program's reliance on immature technology resulted in growing cost estimates and schedule delays. FCS was complicated, and the Army could not provide Congress with a consistent narrative or convincingly demonstrate the return on billions of dollars appropriated for research and development".

Furthermore, as the ongoing wars pressured the budget and decision-makers, information coming back from the operations were at odds with some of the keystone assumptions of the FCS. The fast deployment, light armory and situational awareness were grounded on concepts which did not seem to provide success against that kind of war. Evolutionary acquisition and spiral development was guiding the FCS. However, none of the technologies could provide the necessary feedback for improvement and to foster spiral innovation. FCS's technologies could not meet the warfront demands in time. In his study regarding the FCS and evolutionary acquisition, Ellman (2009, p. 36) concluded that:

> "The FCS experience didn't highlight any major flaws in the theory behind evolutionary acquisition, but this study has shown that there were major problems in its application. At the same time, it seems as though spiral development may not be appropriate for general use in defense acquisitions. The fluid requirements that were supposed to eliminate requirement creep, and the associated cost and schedule problems, actually seemed to make the issues worse. DoD has pulled back on the use of spiral development, and further inquiry will help reveal if the technique has any future in DoD acquisitions".

The FCS failed to realize the Army's ambitious vision of doctrinal and technological modernization. It consumed R&D and acquisition funds and raised profound criticism among the defense acquisition community. Nonetheless, some authors state that the program did enjoy some developments that blazed a path which could lead to the development of important future capabilities (PERNIN *et al.,* 2012). That being said, the last topic, as it was done in the previous two chapters, will analyze the results of the FCS in the light of the theoretical framework developed in this dissertation and the hypotheses constructed. In this sense, it will verify if the proposed hypotheses and their relation to the variables and angles of analysis developed, are suited to explain the outcome of the FCS.

7.4- Concluding Remarks and Results

The Future Combat Systems was a failed program. From its beginning, the concepts drew from war games would prove themselves not capable to meet the urgent needs of US' defense. From its idealization towards Milestone B of the procurement process, the technologically and doctrinal unprecedented modernization of the Army did not mature enough to convince the acquisition community and main decision-makers of its value or current necessity. As severe technological feasibility issues and poor management oversight could not be surpassed over the years, as it was demonstrated in this Chapter, resources appropriated to the FCS started declining. The FCS program was estimated at $77 billion (2003 dollars). It was re-estimated several times. Schedule was also constantly re-estimated. Since it never reached production, it was cancelled with a sunken cost of $15 billion in R&D. Initial Operational Capability (IOC) was never reached and, thus, its operational performance could not even be tested. Other interests and programs became priority, even though initially, there was substantial support for the FCS. The Army became isolated in the defense of the program, which ultimately was cancelled without satisfying any parameter of success.

Scholars and experts reviewed in this work pointed out that the FCS was not delivering in the immediate threat scenario – the ongoing wars– even when proposed

spin-outs in the restructuring of the program were incorporated. The reality of the threat and the urgent need for increasing personnel budget pressured the FCS. Whilst there is no exact precise measure to determine external threat, one can reasonably argue that crossroad tactics by radicalism do not pose a vital threat such as those that come from great power competition or even regional leaders. But, more importantly, the nature of the threat did not properly fit the conception, the high demanding and complex technological advances, and doctrine behind the FCS. Furthermore, during the ongoing wars, the FCS did not prove itself pivotal to the specific threat. Initial technologies could not be proven in battle at time and generate feedbacks as evolutionary acquisition proposes. Furthermore, light armory and intelligence could not compensate the losses, in this specific war scenario, of giving up heavy armory. As such, external threat did not impact innovation positively. The main hypothesis developed from the IS' angle, in Chapter 1, that external threat levels impact innovation positively, was, therefore, corroborated. In the case of the FCS, there was no external threat immediate incentive to the program. As for the auxiliary hypotheses: i) technological advancement was too immature for a precise conclusion about its relation with the doctrinal and institutional arrangements, although they were proposed simultaneously by the Army; ii) civilian interference came at the point where the project could not proof itself feasible and did not deliver to the ongoing threats, and, thus, dampened innovation efforts; iii) the pace, scale and timing of innovation was reduced since the project could not meet the specificities of external threat at the moment; iv) the U.S diminished its resources dedicated to innovation since the necessities of the external environment did not foster further modernization of the Army; v) regarding external balancing options, the ongoing wars were being fought alongside allies. Nonetheless, their impact on the FCS needs further investigation.

The domestic factors expected to impact the success or failure of large-scale high-cost defense projects such as the FCS were outlined in Chapter 2. A project's outcome is strongly impacted by the level of consensus within and among Congress and the Executive. Despite the Army's constant effort at engaging with Congress, in the passing of FY's, FCS lost its support. Besides the project being innovative and promising investments in 41 states, and its initial procurement support, politics is sensitive to uncertain cost and schedule projections. Management and immature technologies became target of criticism by the main actors in Congress and the FCS lost its appeal. The Department of Defense began abandoning the project as well. Concurrent pivotal projects

and wartime costs began competing with the FCS. The Army and the industry could not build a consensus among decision-makers, since the project did not deliver and the perspectives for its benefits became more doubtful. Decision-makers respond to constituencies, and the Army could not justify the resources needed for the FCS. Agencies such as the GAO and the CBO constantly criticized the program, and Congress demanded further oversight as the years passed. The amount appropriated for the project dropped and consensus was definitely not reached.

Technological feasibility was at the core of FCS's failure. The Army rejected alternatives and betted high on a complex and technological immature family of systems. This was based on concepts developed by the Army that were not reviewed or scrutinized. GAO and CBO firmly asserted that technologies were extremely immature. Constant cost and schedule reviews, with disagreements among different auditing agencies and actors' referent to these metrics, demonstrated that technological development of the FCS was facing trouble. Some of the core technologies of the FCS were very far from demonstration, while others were only partially developed. As argued in Chapter 3, technological feasibility is a *sine qua non* condition for the success of a project. It cannot be stated that certainly the FCS was totally unfeasible, but it faced really high challenges in this front. When this happens, doubts are raised among specialists and actors, and the project tends to fail. Even if it was technologically feasible in the long-term, what matters in procurement is the shorter-term and the current needs of defense, especially when budgets are disputed.

This Chapter treated the third case-study proposed to be analyzed in this dissertation. It was a negative case – a case of project failure – and it was investigated through the proposed angles of analysis and theoretical framework developed in previous chapters. As it was stated in Chapter 6, decision-makers stands, BP politics, technological issues and external threat matters overlap and are interrelated. The relations among the variables will be treated in the Conclusion. The process-tracing of the FCS corroborated the main hypotheses proposed by this dissertation. The next chapter will investigate the F-35, which is a case of high-scale large-cost defense project that this study places on the successful spectrum.

CHAPTER 8- THE PROMISING F-35

"It is becoming increasingly obvious that there is no alternative to the F-35 program".

(HLATKY, RICE, 2018, P. 34)

"Threat level made the JSF necessary, especially emerging from China and Russia "will also sustain the JSF even with doubts over its technical capabilities, whether its operational range is sufficient for combat missions, mechanical problems, and cost" (CHAPMAN, 2019, p. 137).

The F-35 is the most recent case-study investigated in this dissertation. It is an ongoing program. However, its matureness alongside with its long lifecycle allow a solid investigation regarding the aims of this work. Since it is not concluded, a final assessment regarding its failure and success is not possible. Nonetheless, the results so far and its relation to the independent variables proposed by this dissertation enables the inference of causality and verification of the hypotheses proposed, in the spectrum of theory-testing and theory-confirming, theory infirming and theory building. The results gathered, furthermore, indicate the future tendencies of the F-35. In agreement to the proposed model of analysis (Introduction), the F-35 is here considered in the successful spectrum as for large-scale defense programs. The aim of this Chapter is, thus, to explain its general success and the reasons for it not to be considered fully successful.

The F-35 was conceptualized as a fifth generation aircraft to substitute an aging fleet and to integrate ongoing projects in an effort to develop a joint project for the Marines, Navy and Air force. Its purpose was economic (as one program was supposed to be cheaper than three separate programs). Furthermore, the present and future challenges of the international system required an innovative effort from the U.S to maintain its air superiority edge. It became a stealthy, data gathering and efficient air plane, with situational awareness and tactical superiority. Throughout its development, the program encountered many challenges regarding cost and schedule overruns, which is the primary reason for its incomplete success. Nonetheless, the F-35 proved itself technologically feasible, gathered political support and became more necessary as threat level advanced. It is, in the most part, viewed as a highly necessary asset for the U.S military.

This Chapter is structured as the previous case studies. The first section is dedicated to analyzing the main motivations which impacted the conception of the JSF (Joint Strike Fighter). In the one hand, it traces the historical background that led towards its conception. On the other hand, first perspectives and objectives are outlined in order to make an assessment regarding its initial objectives and outcomes so far. The second section aims at investigating the evolution of the project, its main problems and advances, with special attention to threat level, key stakeholders and decision-makers stands and influences and technological challenges. The third section delineates and gathers data to create an evaluation of the project's outcomes. These outcomes are compared to the JSF's initial projections and the developments during its lifecycle. Finally, the last section confronts the results gathered here with the theoretical framework constructed in this dissertation.

8.1- Conception, Motivations and Prospects

The current section aims at describing the context in which the F-35 was conceived. Since then, threat level, cost and schedule estimates, BP politics and other issues have substantially affected the program. The three angles of analysis proposed by this dissertation (threat level, technological feasibility, domestic politics) will be further scrutinized in the subsequent section, dedicated to the program's development throughout the years up to the present moment. By comparing its initial goals and its outcomes, throughout the program's lifecycle and its current status, in this chapter the program will be analyzed under the light of the theoretical framework, hypothesis and parameters of success/failure advanced in the first part of this work.

The F-35s are fighter jets with three variants and were conceived to be fifth-generation aircraft, a substitute of former fighter programs of US forces into an integrated major program – the Joint Strike Fighter. A fifth-generation aircraft incorporates highly innovative technology. It combines composite materials, stealth technology, advanced radar and sensor, thrust vectoring and integrated avionics, generating situational awareness. Strike-fighters are dual-role tactical-fighters which are capable of both air-to-ground and air-to-air combat (BEVILAQUA, 2009). As the program developed, other elements and performance goals were incorporated, as it will be discussed in the subsequent section.

In its conception, the JSF (Joint Strike Fighter) was aimed at achieving both economic and warfighting objectives. The US fighter fleet was aging and perceived as becoming obsolete relative to future needs. The Joint Strike Fighter emerged from the Joint Advanced Strike Technology (JAST) program, a result of Clinton's Administration Bottom-Up Review (BUR) of U.S defense policy. JAST was to replace three programs which had been terminated: The A-12 (which intended to provide a stealthy new carrier-based airplane for the Navy), the Multi-Role-Fighter of the Air force and the A/F-X (GERTLER, 2012; BEVILAQUA, 2009). Furthermore, JAST would integrate the ongoing DARPA's STOVL/CTOL (Short Take-Off and Vertical Landing/Conventional Take-Off and Landing) Strike Fighter program. DARPA's project started in the 1980's intended and initially aimed at installing STOVL propulsion system in a supersonic fighter, which became the CALF (Common Affordable Lightweight Fighter) program in the early 1990's.

Figure 8.1- The Integration of Programs into the JSF

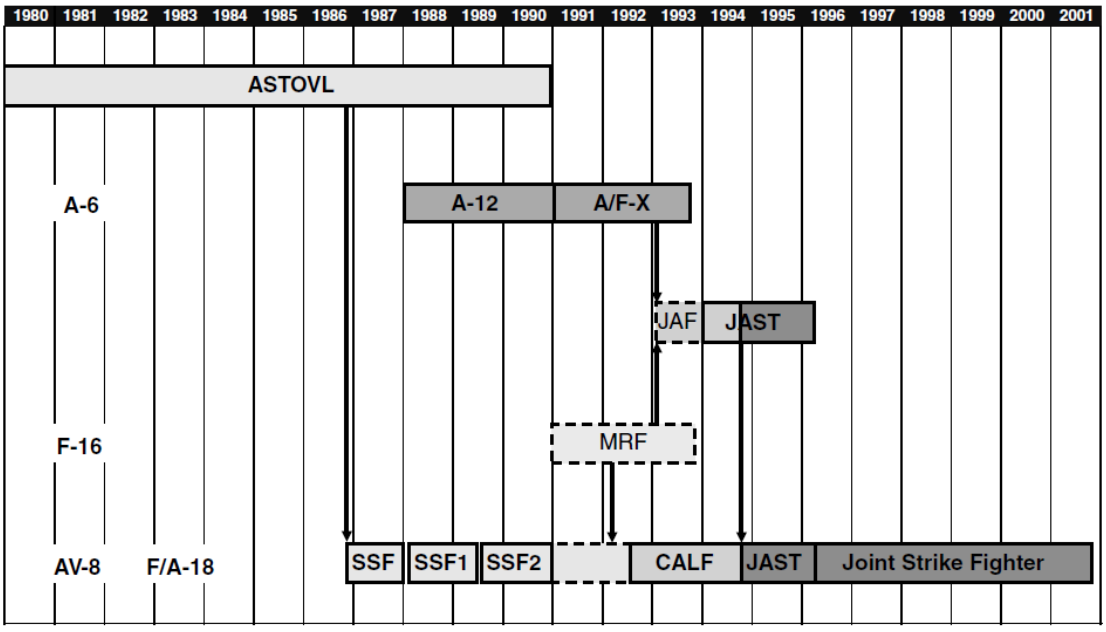


Fig. 17 Timelines of the programs that were integrated into the JSF program (JAF denotes the Joint Attack Fighter).

Source: (BEVILAQUA, 2009, p. 1833).

The JSF was envisioned as an affordable fifth-generation fighter for the Air Force, Marine Corps, and Navy to avoid the development and procurement of three separate programs for these services. The new fighter would satisfy needs in common for all services, by providing variants to these services with increasing commonalities, supposedly reducing the costs of separate development programs. The three versions

were to include a Conventional Take-Off and Landing (CTOL) – the F-35A- for the Air Force, in order to replace the F-15, F-16 and the A-10 aircraft; a Short Take-Off and Vertical Landing (STVOL)- the F-35B- for the Marine Corps, to replace the CTOL F/A-18 and AV-88 strike fighters and; a carrier suitable fighter – F-35C – for the Navy, to replace the F/A-18E/F.

The necessity of replacing the older fleet and Clinton's BUR decision to integrate different programs were the primary rationale for the Joint Strike Fighter. The Navy's F/A-Hornet had a fleet of 328 aircraft and was deployed in 1983, the A-10 Thunderbolt had an inventory of 143 being first deployed in 1977. The F-15 and the F-16 were deployed, respectively, in 1979 and 1978 and the AV-88 fleet of 131 was first deployed in 1985. It was clear that the life-cycle end of these aircraft was approaching[92]. DoD's Defense Science Board urged the program that:

> (…) "contend new military aircraft requirements should include operating with minimum support in theater, operating in small formations or as a single aircraft with minimal or zero close escort or penetrating supporting elements, operating in high-threat areas with minimum attrition, and delivering precision weapons providing high lethality against various targets and also precluding unwanted collateral damage" (CHAPMAN, 2009, p. 93).

Competition for the contract started in 1996 with three firms: Lockheed Martin, The McDonnell Douglas/ British Aerospace/Northrop Grumman team, and Boeing. For the Concept Demonstration Phase (CDP), Lockheed Martin and Boeing were selected (SHERIDAN, BURNES, 2018). As for the engine, Congress decided in 1996 to pursue an alternate program to be developed by GE Transportation Aircraft Engines in Rolls-Royce, in addition to the primary F135 primary engine produced by Pratt & Whitney in order to stimulate competition envisioning cost-savings. Another issue for Congress was that, as it was discussed in Chapter 3, awarding a single firm such a large contract would ultimately harm the capacity of other firms and, thus, the industry in general (GERTLER, 2012).

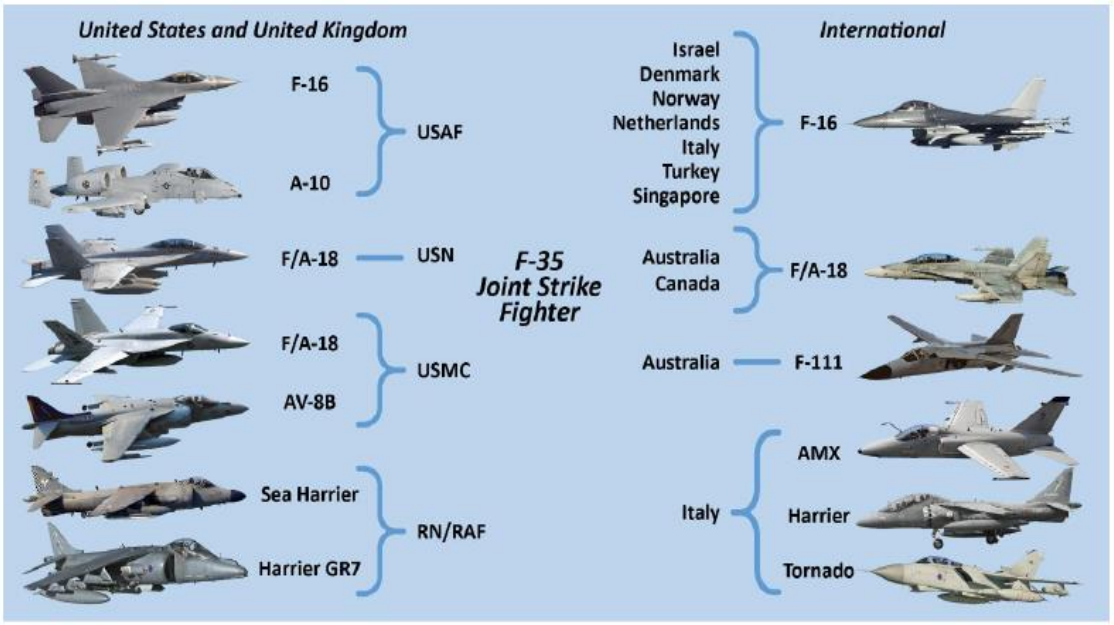
Between October, 2000, and August, 2001, Lockheed successfully demonstrated, through test flights, the program's prototypes with considerable achievements (GERLTER, 2018; CHAPMAN, 2019). Six months before finishing test flights, on October 26, 2001, Lockheed was awarded JSF's SDD (System Design and Development Contract) along with the partnered-up Northrop Grumman and BAE

[92] This data was gathered by: (CHAPMAN, 2019, p. 88).

systems. Lockheed Martin was to be the primary contractor being responsible for research, design, and production. Northrop Grumman was to build the center and aft fuselages and provide expertise in Low-Observable (LO) stealth technology. BAE also was to contribute to advanced lean manufacturing, flight testing and air systems, and sustainment of short takeoff (ABPLANALP, 2017). The alternate engine program ended in 2011 and General Electric/Rolls Royce became a subcontractor of Pratt & Whitney, becoming responsible for developing the vertical lift system for the F-35B.

An interesting feature about the F-35 is its international effort concept. During its development, ten international partners joined development and production efforts, or buyers: Australia, Canada, Denmark, Italy, Israel, Japan, the Netherlands, Norway, South Korea, Turkey, and the United Kingdom. This would entail several issues such as technological transfer matters, commitment to the alliances, impact on national industries and so forth. There are levels of participation in the program, in which depending on the country's status, they can influence design and obtain lucrative sub-contracts for their industrial base (HLATKY, RICE, 2018). Each country would sign bilateral agreements with unique elements. The idea was to benefit from economies of scale, avoid duplicating R&D efforts within the alliance, and strengthen the overall deterrence capacity of the partners, which would have access to cutting edge technology (SHERIDAN, BURNES, 2018; SHIMOOKA, 2018). Furthermore, fighters from other countries would integrate those which the F-35 would eventually replace as it is shown in Figure 8.2. This required convincing from the US that the F-35 was superior to the Eurofighter, the Rafale and the Gripen.

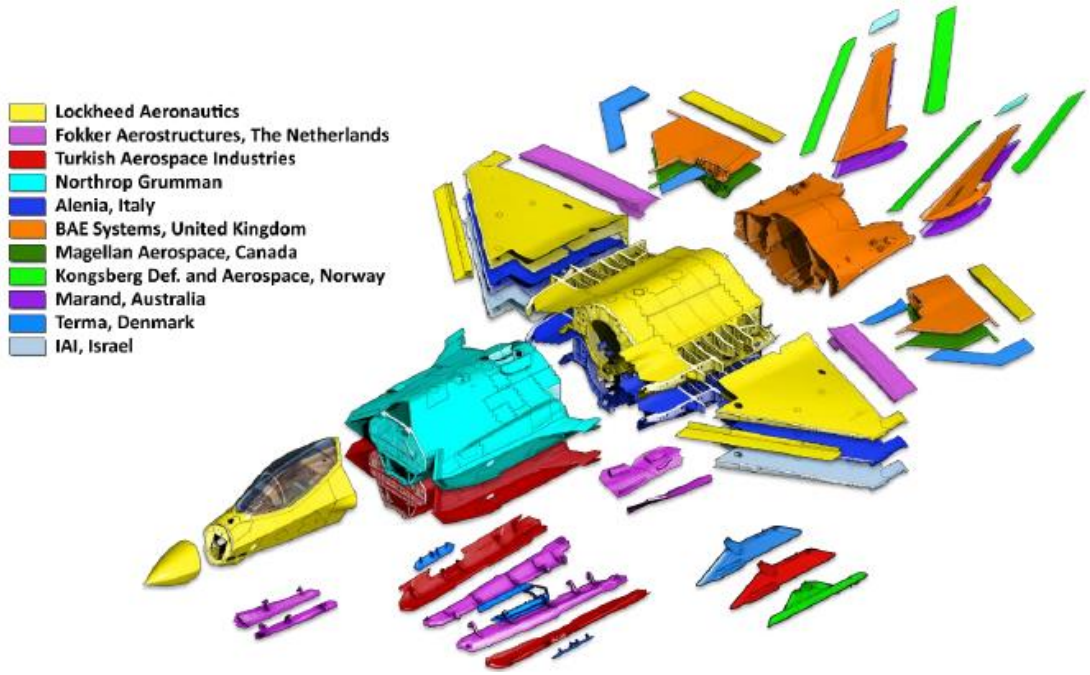
Figure 8.2- Fighters to be Replaced by the F-35



Source: (SHERIDAN, BURNES, 2018, p. 2)

During F-35's development, however, critical issues would be subject to dispute within the international collaboration effort, such as the US' purpose of retaining the core technological features. Problems regarding technology transfer, especially in the case of a defection from the alliance, as it would be the case with Turkey, would also be a matter of scrutiny. The procurement was to be within the United States. Therefore, US' domestic issues and BP politics would also affect other countries.

Figure 8.3- International Supply-Chain of the F-35 (2018)



Source: (SHERIDAN, BURNES, 2018, p. 2)

At this point, this study will outline some of the main technical features of the F-35 at its conception and early development and upcoming challenges regarding feasibility. The main feature of the F-35 architecture was to be the interactivity among the different combat systems, so that the functional outcomes and capabilities were to be generated synergistically. The data from on-board sensors and off-board sources would be integrated to the F-35's central computer, therefore, providing a precise view of the tactical situation. The interactivity among the combat systems creates situational awareness and the automation of possible actions, as the central computer:

> "(…) detects further information needs, prioritizes them and issues new commands to the sensors considered most appropriate to satisfy these needs. Identification and tracking continue automatically in a closed loop fashion as new data from on-board or off-board sensors is acquired. These, in turn, can be either relayed to other platforms in "open transmit" mode or, subject to data bring-back memory capability, manually recorded and stored. The results of the fusion process are provided to the pilot/vehicle interface for display, fire control for weapon support, and electronic warfare for countermeasures support" (PETRELLI, 2021, p. 4).

To this is added stealth capacity, discussed in Chapter 6. The program's goal was to achieve an acceptable level of stealth while securing maneuverability and not exceeding production costs. The "edge treatment" of the aircraft was to be composed with glass fiber honeycomb loaded with carbon, and, in addition to its less disciplined shaped

were to provide very low RCS (PETRELLI, 2021). Moreover “the F-35 features a new LO substance called fiber mat, carbon nanotube-infused fibers that can absorb or reflect radar, which has been built into the composite “skin” of the aircraft” (PETRELLI, 2021, p. 4). The fiber mat also ensures that the electromagnetic properties do not vary with angle. As it was the case with the B-2, this could provide the capacity to penetrate defended adversary space undetected.

During its development, reconciling diverse service requirements into a common design would be a major factor for F-35’s technological challenges and, thus, cost outcomes. Furthermore, the ALIS (Autonomic Logistics Information System) and the HMDS (Helmet Mounted Display System) would be of great technological challenge and would prove themselves a matter of intense debate and criticism of the program among auditing agencies and other key actors.

Up to the current moment, there has been significant debate around specifically F-35’s costs and schedule. Despite its periodic progress, F-35 history, as it will be further addressed in the next section, was “repeatedly plagued by cost overruns, delays, and other setbacks which have made it appear that its completion and successful deployment will never be achieved” (CHAPMAN, 2019, p. 89). From the very beginning, the F-35 seemed to signalize a possible tense procurement story and ultimate failure. Nonetheless, as it will be argued, threat level evolution, congressional support (despite close scrutiny and debate), and the program’s evolution, demonstrated the need to make the project successful. As it is not completed, one cannot argue if it has ultimately failed or succeeded. Although, one can trace the development and evolving stands around the project in order to delineate some general tendencies and arguments of its outcome.

As the program reached Milestone B (2001), at the year the contract was rewarded, the targeted total program cost estimate was $177 billion which increased to $270.5 billion by the end of 2010 (2002 dollars). The DoD planned on delivering 2886 fighters, with Initial Operating Capability (IOC) to be completed at June 2011 and to enter Milestone C (Full Production Rate) by 2012. In the following years, however, the DoD reviewed IOC and Milestone C goals (DoD, 2010). Through 2001 and 2012, while in System Development and Demonstration (SDD), tests and Low Rate Initial Production (LRIP), the program encountered several difficulties in meeting up to its projections, especially due to cost overruns, which will be further addressed in the next section.

DoD's Defense Acquisition (DAE) approved the Program's Acquisition Program Baseline in March 16, 2012, with the re-approval of program's Milestone B. As mandated by Congress, the DoD has to submit SAR's (Selected Acquisition Reports) annually, highlighting cost, schedule and performance updates and projections. After 2012, were targeted total program cost was estimated at $395.7 billion, subsequent SARs and projections were evaluated in terms of the 2012 baseline (DoD, 2011). DoD estimated that the Full Rate Production Decision would be accomplished by April 2019 and Initial Operational Capability (IOC) were yet to be determined for the three variants (DoD, 2012). Furthermore, the plan was to procure 2457 aircrafts, at a Procurement Acquisition Unit Cost (PAUC) of $112.529 million and an Average Procurement Unit Cost of $91.827 million (2012 dollars)[93]. As for performance, it goes beyond the proposal of this dissertation to investigate in detail all technical aspects of the aircraft. Therefore, it will be evaluated in terms of the stands put forward by the key players of the defense acquisition community and specialist's positions. Similar to technological feasibility, performance can be traced in an approximate matter in this way, summing up the stakeholder's positions with other signs such as successful testing and deployment.

8.2- Development of the JSF

As it was done in the previous chapters, this section is dedicated to explaining the development of the program throughout its lifecycle. In the program's history, the three independent variables derived from the angles of analysis (domestic, technological, international) will be analyzed in order to explain the program's outcomes. Differently from the B-2, Congress and other actors remained mostly supportive of the program. Even though they were also demanding further scrutinizing and optimization of costs, the debate centered more around how to make it work rather than canceling it or not. It is argued here that the evolution of threat level, the widespread constituency interests involved in the program, the downsizing of competition for resources among forces since it is a multi-force program and the lack of an alternative program that could satisfy the need for the fighter created a higher level of consensus among political actors. The evolving and augmented threat level in the IS are key to explain the continuing effort to innovate, as it was argued in Chapter 1.

[93] Program Unit Cost (PAUC) consists of the cost of development, procurement and military construction divided by the number of fully configured items slated to be produced for the acquisition program. Average Procurement Unit Cost (APUC) is the government funding of the program divided by the number of units procured.

Throughout the development of the F-35, the need for the strike-fighter was continuously defended by the US' Armed Forces representatives in the light of evolving threats. Congressional hearings revolved around the threat issue and the effectiveness of the F-35 to engage in the international arena. Chapman (2019) investigates the possible scenarios in which the F-35 might be deployed for engaging threats. The author lists that the main threats which would make the F-35 necessary come from terrorism, China, North Korea, Iran and Russia.

As for counterterrorism, F-35' superiority in precision-guided munitions, situational awareness, GPS satellites, intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) and its electronic assets, should facilitate the process of identifying and target hostile targets (CHAPMAN, 2019). Conventional airpower can be used for both intelligence and targeting purposes and it is useful to reduce the necessity of sending conventional or special forces to engage these forces and their infrastructure. Moreover, it reduces the risk of civilian causality that can be a result of UAV operations. Drone strikes, by producing civilian causalities can work to the contrary of the mission, enhancing the ability of recruitment for terrorist causes.

North Korea has held a belligerent position and is developing a nuclear arsenal and ballistic missiles. Its position complicates the ever-growing strategic importance of the Asian-Pacific region. North Korea, despite its size, has an impressive military force. Pyongyang's Air Force "order of battle numbers 110,000 personnel, over 800 combat aircraft, 300 helicopters, and over 300 transportation aircraft" (CHAPMAN, 2019, p. 58). Ground forces are numbered almost a million personnel and are concentrated near South Korea's border. The F-35's probable main mission would be to target North Korea's ballistic missile arsenal while engaging air-to-air combat, as North Korea has Russian MIG-23 and MIG-29 fighters, and disabling and overcoming Pyongyang's air defense systems which include mobile SA-13 SAMs, anti-aircraft artillery, among others. Iran has a more vulnerable defense system to stealth strike fighters. Nonetheless, efforts have been made by Tehran to acquire advanced SAM systems such as Russia's S-300 and more advanced radars and command and control systems (CHAPMAN, 2019). Engaging Iran with the F-35 would involve strikes against military targets, especially Iranian nuclear sites. Iran represents a threat to US' and its allies' interests in the middle-east and has held a combative position in the region.

The most challenging threat, which rose significantly during the F-35 project, is China. Beijing has increasingly transformed its overwhelming economic growth in military power. China has become more assertive and claimed sovereignty of the South China Sea. US' interests and projection on the Pacific arena are in serious threat, making it probably the most important geopolitical front of the moment. China's emphasis on its Anti-Access/Area-Denial (A2/D2) strategy can count on a "broad spectrum of aircraft capabilities including aircraft, command and control, jammers, electronic warfare, and data links" (CHAPMAN, 2019). China can count on its J-10B striker and Russia's SU-35 Flanker, and believes it can deny offensive operational advantages utilizing stealth aircraft and is currently developing the J-20 stealthy aircraft, displayed in 2021 (GIELOW, 2021). There are doubts if it really is a fifth generation fighter as it also happens in the case of Russia's SU-57. Nonetheless, threat level and military capacities of US' adversaries continue to grow. Beijing plans to enhance its air defenses by importing Russia's S-400/Triumph SAM system and developing its own CSA-X-19 (HQ-19) for missile defense. The most urgent and critical matter is China's plan in regaining control of Taiwan. Regarding China, Taiwan and A2/AD, the F-35 can be used, according to Chapman (2018) by a response based on Air-Sea-Battle Concept. According to the author:

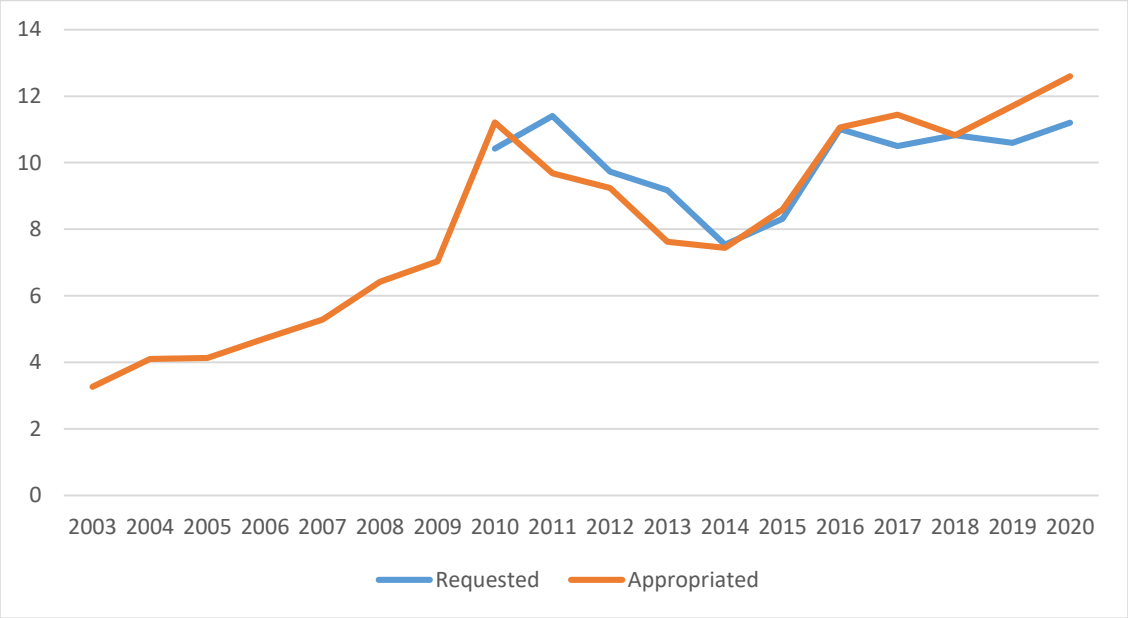
> "A possible US response to China's increasing military power is found in the Air-Sea Battle (ASB) concept. ASB seeks to counter and asymmetrically and symmetrically shape A2/AD environments, and developing integrated forces capable of succeeding in such environments. ASB seeks to respond to A2/AD by developing networked integrated forces capable of attacking in depth to disrupt, defeat, and destroy enemy forces; using air, cyber, land, maritime, and space assets in this regard for friendly joint and coalition forces; providing commanders with ready access to capabilities across these domains regardless of which commander owns them; integrating these forces before entering operational theaters, and attacking in depth to disrupt, defeat, and destroy enemy A2/AD platforms" (CHAPMAN. 2019, p. 53).

In the case of the B-2 (Chapter 6), the threat of great power competition was fading as the program advanced. While facing cost and schedule troubles and Congressional oversight, F-35 advocates could count on the growing great power competition to defend the program. The three forces were able to create a narrative for the need of the F-35 that convinced Congress. From 2001 to 2012 the F-35 faced serious issues, breaching Nunn-McCurdy amendment (explained below) and continuously being criticized by GAO reports on cost and schedule overruns. Furthermore, technical problems in the aircraft's driveshaft and lift-fan summing with cracks discovered in fatigue testing were target of doubts in terms of performance and technological feasibility. This resulted in additional

Congressional oversight. On February 28, 2012, Senator Kelly Ayotte briefed Pacific Command Commander Admiral Robert F. Willard about the importance of the F-35 for the Asia-Pacific region. Admiral Willard answered that in the light of Chinese aircraft development there was no suitable alternatives to the F-35. Chief of Naval Operations (CNO) subscribed to Willard's argument, highlighting the importance of F-35's stealth capacity. Answering to a congressional hearing, Marine Corps Assistant Commandant John M. Paxton stated that the F-35B STOVL triples the number of global airfields that can be used, and combined with the F-35C doubles the number of US capital ships capable of operating the fighter. Paxton highlighted the importance of the fighter in order to counter the threats of state and non-state actors and A2/AD technology, stressing that to reach such targets the U.S would have to successfully develop the F-35 (CHAPMAN, 2019).

As it was stated above, Congress' and other critiques of the cost and schedule delays intensified after the program breaching the Nunn-McCurdy ceiling. In 1981 Senator Sam Nunn and Representative David McCurdy introduced what became known as the Nunn-McCurdy amendment to the 1982 defense spending legislation. The Nunn-McCurdy legislation established congressional oversight of defense acquisition systems whose PAUC and APUC costs growth exceeds 15%. In this case, the Secretary of Defense has an obligation to tell Congress. If cost growth surpasses 25%, the Secretary has to provide Congress with a written declaration providing the legislators with the reasons of the breach. Otherwise, the program would be canceled. In March, 2010, Secretary of Defense Robert Gates announced that the JSF had breached the limits specified in Nunn-McCurdy. In FY 2002 dollars the costs exceeded the original program baseline in 78.21% for the PAUC and 80.66% for the APUC (CHAPMAN, 2019). Especially up to the re-approval of the program into Milestone B and the new Acquisition Program Baseline of that year, the progress of the JSF within the acquisition spectrum was slow. There was criticism and debate over the JSF's funding, cost growth and performance issues. However, despite legislative concerns, program funding remained on course (Figure 8.4).

Figure 8.4- Requested vs Appropriated JSF Funding (Current $ Billions)



Source: Undersecretary of Defense (Comptroller): DoD Budget Request. The Author.

On April 2016, Senator Orrin Hatch spoke in support of the JSF on the floor, emphasizing that despite the frustrations with the acquisition system regarding costs and schedule, the emergence of geopolitical threats such as Russia's annexation of Crimea, China's growing assertiveness and North Korean and Iranian advancing nuclear capabilities, the F-35 was needed to penetrate advanced enemy air defenses and to strike ground targets. Senator Orrin also argued that unit costs were dropping as procurement progressed (CHAPMAN, 2019). General support in Congress remains nowadays. In May 5, 2021 twenty senators from both parties signed a letter urging funding for modernization and sustainment costs of the JSF, in the light of Russia and China's advances in their air defense systems and their own fifth generation fighters. This letter followed a similar one from the House, in which 132 representatives also demonstrated support for the program (STONE, 2021).

The need for the F-35 in face of the growing external threat and the lack of suitable options for the fighter are strong explanations for congressional funding despite schedule and cost overruns. Three forces advocating for the program certainly give it more stability in the bureaucratic arena. Chapman (2019) states that beyond the need to counter existing and growing threats, parochial interests help to explain the support for the program on the Hill. Workforce and subcontractors are spread around the United States with facilities in geographic locations potentially represented by 90 US senators and 424 US

representatives. Furthermore, “another way of understanding the widespread political support JSF receives in Congress is looking at the campaign contributions made to a bipartisan group of legislators by aerospace industry companies and labor unions” (CHAPMAN, 2019, p. 218).

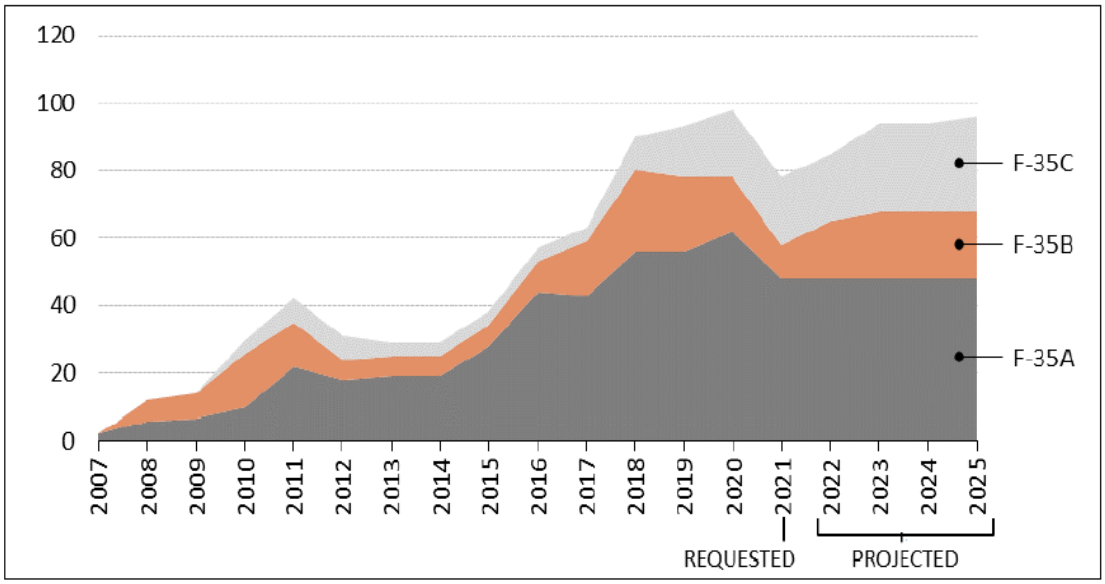
This dissertation contributes to the issue showing that, differently from the FCS (Chapter 7), although highly innovative and still in development as procurement happened, the F-35 demonstrated technological feasibility and performance progressively throughout the years, while the FCS never reached operational capability. The first flight of the F-35A occurred in December, 2007, while F35B and F35C completed their first flight in June, 2008 and June, 2010, respectively. F-35B demonstrated its ability to hover in March, 2010 (CRS, 2020). On March 11, 2015, Department of Defense Inspector General (DODIG) found that JSF had achieved and conformed to quality requirements and demonstrated management performance and improvements in the interim (CHAPMAN, 2019). On June, 2013, GAO Acquisition Sourcing and Management Director Michael Sullivan told SAC defense subcommittee that program performance improved with most management and development test objectives being met. (CHAPMAN, 2019).

DoD’s reformulated goal was to achieve Initial Operational Capability (IOC) by March, 2012 for the F-35B, March, 2013 for the F-35A and March, 2015 for the F-35C. IOC happened in July, 2015 for the F-35B, August, 2016, for the F35-A and February, 2019 for the F-35C (CRS, 2020). By 2013, Lockheed had delivered the 100th JSF. Air Combat Commander General Hawk Carlisle, announced on August 2016 that the F-35A was combat ready, being capable of support, interdiction, partial destruction of enemy air defenses, and the ability to use record missions to conduct and deploy operational missions, therefore, possessing all necessary logistics and operational elements (CHAPMAN, p. 117). Latter in 2016, a Marine JSF detected, tracked and targeted a MQ-170E UAV and passed the information, utilizing its Multifunctional Data Link (MADL) to USS Desert Ship (LLS-1) combat system, which shot down the drown (CHAPMAN, 2018). Delivery, despite delays, progressed through Milestone B and grew substantially over the years.

Despite the JSF demonstrating technological feasibility and performance criteria, this process did not occur smoothly. Compared to the Nautilus (Chapter 5), the F-35 encountered many technical challenges and criticism in this regard, while the former

transited from conceptualization to deployment rapidly, the latter encountered many obstacles. Even though the overall feasibility of the aircraft was present, specific technical challenges accompanied the program through SDD.

Figure 8.5- JSF's Procurement Quantities



Source: CRS, 2020, p. 17)

In its 2017 report regarding the JSF, the GAO found that there were still problems with limited depot repair capacity, spare parts shortages, undefined technical data needs and unfunded intermediate-level maintenance capabilities (GAO, 2017). GAO also estimated that the US had spent almost $400 billion on the program, making it DoD's most expensive program with additional projected $276 billion in procurement and estimating that the overall fleet operational and costs associated with the aircraft's lifetime would exceed 1$ trillion. The JSF "has achieved success during its development and evolution but is seven years behind schedule and $163 billion over budget" (CHAPMAN, 2019, p. 134). While entering the IOT&E (Initial Operational Test and Evaluation) in 2018, and aiming at soon entering Milestone C (Full-Production Decision), the JSF still had many unresolved deficiencies, 13 of them classified by Director of Operational Test and Evaluation (DOT&E) as "must fix" (CRS, 2020).

According to Shimooka (2018, p. 162), "while concerns remain, the program has made significant progress over the last decade, and is on its way to replace a whole inventory of DoD aircraft". In confluence with the argument put forward in this dissertation, the author argues that "between 2012 and 2017 the program development

stabilized, and moved forward roughly as planned" (SHIMOOKA, 2018, p. 166). In this period cost and schedule overruns were attenuated when compared to the initial projections of the program, as it will be seen in the subsequent section. "The program achieved significant successes during this period, including a rapidly declining production cost, and initial operating capacity for the USAF, USMC and the Israeli Air Force" (SHIMOOKA, 2018, p. 166). Chapman (2019, p. 136) evaluates that "despite its repeated delays, technical problems, and cost overruns, the JSF is likely to eventually be deployed by the US even if its numbers are lower than originally planned". The author argues that "technological obsolescence of combat aircraft against military enemies is even more dangerous than an expensive and long-delayed military system" (CHAPMAN, 2019, p. 357).

One the one hand, cost and schedule overruns, as it has been shown throughout this dissertation, are important criteria for evaluating the success or failure of large-scale defense projects. Moreover, during the project's lifecycle, cost and schedule are indicators of possible problems with technological feasibility and different projects are in competition for resources with each other. This can affect stakeholder's and decision makers' support for the project, therefore, making it more prone to fail. On the other hand, as it was demonstrated, the necessity of the project to major stakeholders, its operational success and, hence, what the innovation provides to national defense, have more weight in defining a project successful.

In the case of the F-35, there was cost and schedule overruns, especially at the beginning of the project's lifecycle. Further analysis of its costs and schedule throughout its whole lifecycle is necessary. The subsequent section, dedicated to the "outcomes" of the project, will inquire the efficiency issue (cost, schedule, performance) along with the independent variables and the other criteria of success defined in this dissertation as well. A more holistic view of the project, even if some criteria are considered more important than others, is beneficial for explaining the project as a whole. It should be noted, however, that since the JSF is an ongoing project, this chapter will explain its outcomes through the proposed angles of analysis. The explanations do not intend to be predictive *strictu senso*, although the JSF's lifecycle so far and the tendencies of the independent variables, *ceteris paribus,* can provide a solid scenario for explaining the course and direction the project is moving towards to.

8.3- Outcomes

As the program reached Milestone B (2001), at the year the contract was rewarded, the targeted total program cost estimate was $177 billion which increased to $270.5 billion by the end of 2010 (2002 dollars). This represented a 52.58% increase in the overall development and acquisition estimate. When Milestone B was re-approved in 2012, DoD estimated a total cost of $395.7 billion for the JSF (DoD, 2011). The latest estimate made available at the Selected Acquisition Report of 2020 (DoD, 2019) is that the total program will cost $321.441 billion (2012 dollars), a 18% drop. At 2001 there was no estimate on the PAUC and the APUC. By 2012 the estimate for the PAUC and the APUC was $112.529 million and $91.827 million, respectively. By 2020, the estimated cost dropped to $108.073 in the case of the PAUC and 83.109 in the case of the APUC, an 8.75% and 11.59% respectively. As for quantity, in 2002 the DoD planned on delivering 2886 fighters, number readjusted to 2457 in 2018 (CRS, 2020).

First flight for the F-35A, F35-B and the F-35C was estimated to happen in November 2005, April 2006 and January 2007, respectively. By 2011, the first test estimated were rescheduled to December 2006, June 2008, and June 2010, for respectively the F-35A, F-35B and the F-35C. In 2012, the estimates were maintained. The first flight of the F-35A occurred in December, 2007, while F35B and F35C completed their first flight in June, 2008 and June, 2010, respectively.

In 2002, Initial Operating Capability (IOC) was to be completed by June 2011, IOT&E by March 2012 and to enter Milestone C (Full Rate Production Decision) by April 2012 (DoD, 2010). 2011 and 2012 SARs pointed out that these three milestones were being reanalyzed. IOC happened in July, 2015 for the F-35B, August, 2016, for the F35-A and February, 2019 for the F-35C (CRS, 2020) – eight years behind 2002 schedule, and five years behind DoD's reformulated schedule, as stated above (CHAPMAN, 2019). By the latest estimate the completion of IOT&E, Full Rate Production Decision and Milestone C were to be achieved in September 2020, although it did not. According to the DoD, this milestone rescheduling is due to the delays completing development, verification, validation, and accreditation of the Joint Simulation Environment, which in-turn delays completion of Initial Operational Test & Evaluation (IO&E) (DoD, 2019). IOT&E completion, Full Rate Decision and Milestone C are yet to be achieved while this dissertation is completed (March, 2022).

The F-35 is currently in low-rate initial production, with 753 aircraft delivered as by the end of 2021. According to the Selected Acquisition Report (SAR) issued at the end of 2019, the development of the Joint Simulation Environment is the highest priority risk to the F-35 completion of Milestone C and Full Rate Production Decision Review. Therefore, technical challenges still exist, although general technological feasibility has already been achieved. The F-35 has experienced cost and schedule overruns, especially in its initial years. Between 2012 and 2021, cost estimations fell and the program accelerated its schedule. This dissertation proposes an explanation for the program's survival during the most critical years and its achievements in the subsequent period through the proposed necessary variables of political consensus and technological feasibility and the importance of external threat. This will be further addressed in the last section.

Authors tend to agree that JSF has suffered many problems due to expenditure and delays. Nonetheless, due to external threat and national defense necessities, they evaluate that the program is needed. Engagement in war, as it was stated in the Introduction, is a key criterion to evaluate the program's outcomes. According to Chapman (2019) "combat effectiveness and performance of the JSF is the bottom line indicator of whether the expenditure and delays have been worthwhile". Although the F-35 has not engaged in major combat operations, it was used against Iranian and Hezbollah targets near Beirut and received positive assessment from stakeholders like the IAF (Israeli Air Force).

According to Deptula (2020), the Armed Forces need the fifth-generation fighter as the requirements dictated by the global threat environment demand nothing less. He argues that the F-35 operational performance is "an easy piece of homework to grade" (DEPTULA, 2020, p. 1). The author states that the F-35 is the only fifth generation fighter in production in the Western world. "If you want the attributes of stealth, electronic warfare, sensors, processing power, and real-time teaming all fused into one fighter package, this aircraft is it. F-35s have already gone to war and the results speak for themselves" (DEPTULA, 2020, p. 1). As for costs, Deptula (2020) maintains that any new generation aircraft push innovation forward and this involves challenges. Furthermore, the author argues that fewer F-35 can do more in fewer number that legacy fighters and "That is what cost-per-effect assessment is all about" (DEPTULA, 2020, p. 1). John Venable (2020) states that the F-35 is now the world's most dominant multi-role fighter and provides a significant competitive advantage over peer competitors. Venable

states that the “F-35A’s capabilities and decreasing price tag make it both vital to the nation’s defense and more cost-effective then fourth-generation fighters (VENABLE, 2020, p. 1).

Operational performance relates to need and need relates to available options. Abplanalp (2017) holds that the US and its allies are relying on an older fleet which is shrinking, causing surplus of maintenance and increasing vulnerabilities and, therefore, jeopardizing the U.S air superiority. Hlatky and Rice (2018, p. 34) state that, given its capabilities “it is becoming increasingly obvious that there is no alternative to the F-35 program”. The Pentagon has declared that, despite cost overruns and delays, the F-35 is still a top priority. Chapman (2019, p. 347) argues that “JSF critics need to present economically and militarily credible alternatives to address emerging US and allied jet fighter combat operational needs against emerging threats beyond maintaining existing combat aircraft fleets”.

The need to technologically innovate in defense relates, first and foremost, to external threat (see Chapter 1). According to Chapman (2019), threat level made the JSF necessary, especially emerging from China and Russia “will also sustain the JSF even with doubts over its technical capabilities, whether its operational range is sufficient for combat missions, mechanical problems, and cost” (2019, p. 137). The author also states that the history of developing weapons systems in the United States is full of problems, most of them left with anything less than “significant complexity and uncertainty” (CHAPMEN, 2019). According to Chapman, developing and advancing military jet fighter technology is a never-ending process. Countries such as Russia and China are willing to make financial investments to develop their own fighters based on advancing their national interests. This threatens the US and its allies since these countries continue to perfect their own Fifth Generation fighters “leaving the United States to not assume air superiority as a given” (ABPLANALP, 2017, p. 26).

Developing the F-35 comes also from decision-maker’s perception that domestic scientific and technological agility has to be strengthened due to the proliferation of expertise. According to Chapman (2019) there is a need to develop a jet fighter program capable of meeting the military requirements for the second decade of the twenty-first century. As it was already stated, countries like North Korea, Iran, Russia and China along with terrorism threaten the U.S and the F-35 is pivotal in US’ strategic assessment of possible future combat engagement and to avoid losing air superiority (CHAPMAN,

2019). The U.S and its allies want to ensure "their ability to credibly back up the Asia-Pacific Pivot, European Deterrence Initiative, and deter Russia's pivot to the East" (CHAPMAN, 2019, p. 357)[94]. According to Chapman (2019, p. 115) "the United States will ultimately be more concerned with the geopolitical consequences of potentially losing air superiority to probable enemies than with the protracted problems JSF has experienced over the past two decades".

Some challenges lie ahead for the F-35. Its technical difficulties include limited depot repair capacity, spare parts shortage, undefined technical data needs, unfunded intermediate-level maintenance capabilities and delays in the ALIS system. The most problematic issue is the total life cost of maintaining the fleet, which has been estimated to surpass a $1 trillion dollars (CHAPMAN, 2019). The debate centers around efficiency versus effectiveness. Despite cost matters and delays (efficiency issues), major stakeholders view the F-35 as needed to national security and its performance has been proven effective to fulfill its initial conception purposes.

The investigation of the F-35 case, given the arguments and the parameters of success or failure outlined in this dissertation, place the JSF program in the successful spectrum. It is necessary to state that since it is an ongoing program, it is not possible to give a final statement regarding its success or failure. Nonetheless, it is argued that the analysis demonstrates that the factors which positively impact innovation are being met. Thus, it is argued that the F-35 is on track towards the successful spectrum, despite not meeting some parameters to evaluate success. As it was done in the previous chapters, the theoretical framework developed in this dissertation and the derived hypotheses is confronted with the F-35 case in the subsequent section.

8.4- Concluding Remarks and Results

Up until the present moment, the results of the F-35 are close from its initial conception, purposes and objectives. Initial cost and schedule overruns were attenuated, although in this regard the F-35 did not, and is not, keeping up with its initial estimates. Despite that, F-35 performance and main stakeholder's and decision maker's need for the F-35, given external threat and lack of more effective options, place the F-35 in the successful spectrum of large-scale defense projects. The F-35 is viewed as needed for

[94] Recently, after Russia's invasion of Ukraine, Germany decided to buy thirty-five F-35's (REUTERS, 2022).

United States defense by the main actors of the defense acquisition community. Furthermore, up until now, it is operating well. The reviewed literature, data and process-tracing of the project explain its relative success regarding its initial objectives through the three lenses of analysis proposed in this study.

From the IS' angle, threat level substantially increased during the development of the program. The U.S forces needed a new fighter program due to the aging fleet and the conception of future combat. Although in the 1990's, the United States had a substantial military, political and economic advantage in the IS due to the victory of the Cold War, the twenty first century, especially after its first decade, pushed the U.S to the need to balance. As it was argued in Chapter 1, technology, doctrine, and organization are the three internal-balancing main spheres. With external threat rising, with specific emphasis to the pacific pivot and Russia's capabilities, including developing their own fifth generation fighter, the F-35 became even more important. After the second decade of the twenty-first century, the competitive pressure and the US' need to maintain its air superiority, the F-35 received more support by decision-makers. This is a result of, as it was argued in Chapter 2, resource mobilization and innovation are positively related to external threat rise. This coincides with the greater progress of the program in its diverse aspects after 2012 reformulation. The main hypothesis regarding the external threat angle of analysis was, therefore, corroborated. As for the auxiliary hypotheses: i) technological advancement appears to have precedence over doctrinal and organizational arrangements, since, during the increase in external threat, the tactical and organizational aspects of the military are accompanying the program's development; ii) civilian interference, in the face of growing level of threat, pressured the project towards its success, by keeping close scrutiny of the developments; iii) external threat, especially after the second decade of the twenty first century, made innovation assume greater speed, scale and urgency; iv) the US did not stop innovating while faced with greater threat, by the contrary, it fostered its efforts in a direct relation to the growing level of threat; v) As for external threat balancing options, the US transferred to its allies some of the responsibilities, but the effect on innovation cannot be conclusive without further analysis.

Congress is more concerned with deficit levels and fiscal austerity. It has to attend to a number of interests and disputing resources. Nonetheless, as it was argued, Congress was firmly backed with a large consensual regard to parochial interests regarding the F-35, related to job creation and campaign support. However, this

dissertation argues that this is not enough. The program has to prove itself worth the possible efficiency flaws experienced, in the case of the F-35, in its costs and schedule delays. The F-35 gathered consensus in Congress and the Executive because of its need, promising operational value and the lack of cost-effectiveness options. The three forces acting together to protect the program certainly gives it more bureaucratic power, and, thus, the ability to obtain resources and develop the program. As it was stated, differently from the B-2, Congress and other key decision-makers were more concerned on making it work than searching for available options. This reflects itself on the amount requested by the Executive and the amount appropriated by Congress (Figure 8.5), demonstrating a consensus between the two branches of government. The tendency is continuous support, since the variables applied here remain.

In the case of technological feasibility, the elasticity of the demand, although higher, was lower than the case of the B-2. Especially since, with the lack of substitutes, demand tends towards an inelastic demand. Cost and schedule revisions were higher than the Nautilus. This indicates a middle-rage technological feasibility status for the F-35. As it was shown, despite the technical problems already outlined, the general technological feasibility of the aircraft progressed and demonstrated itself to be successful. Challenges were put forward by GAO and other analysis, but advancements were constantly recognized. Technological feasibility proved itself through tests and operations during Milestone B, which, by consequence, did not weaken the project as much as the case of the FCS and the B-2. The project was not greatly modified (in technological terms) throughout its development relative to its initial goals. This places the future tendency of the JSF in the successful spectrum of high-scale defense projects, as conceptualized by this dissertation.

This Chapter reviewed the F-35 conceptions, motives and main goals. It than traced the development of the program in order to analyze empirically the reasons for its outcomes so far. Finally, as it was done in the other case studies, the theoretical framework built in the first part of this dissertation was confronted to the results of the empirical investigation. The results corroborate the main hypotheses outlined in this dissertation. The subsequent part – the concluding one– will review the main results found in this dissertation and further compare the case-studies and confront it with the model and methodology proposed by this study, in order to outline its main contributions and

further research challenges which arouse by studying the success and failure of large-scale projects.

CONCLUDING REMARKS

This dissertation's aim was to explain why some innovative large-scale defense projects succeed in accomplishing its objectives while others do not. In order achieve such goal, the introductory pages set the central concepts, the methodology, the general hypothesis and the structure to address this problematic.

Firstly, the dependent variable (success or failure of large-scale defense projects) was defined. The parameters by which a project is considered successful were outlined. It was argued that projects were usually evaluated regarding mainly its efficiency results (cost, schedule, and performance). Given the complexity of defense, its numerous variables and the implications of such expensive and highly innovative projects, other parameters were drawn from project management literature to address the effectiveness results of the cases. Summing up efficiency and effectiveness can provide the researcher a more holistic and precise analysis of the project's results. It was maintained that a project will be effective if the main stakeholders and decision-makers are satisfied with the employment of the innovation and, mainly, if the innovation was necessary to achieve its main objective: the mobilization of resources for a successful military engagement and, hence, to fulfill national security demands. Efficiency matters were considered subordinate to effectiveness in the case of national defense. While analyzing the empirical data, effectiveness was indeed more important in the decision-making scenario.

Secondly, the objectives of this dissertation were outlined alongside a proposed framework of analysis and general hypothesis that guided the research. This study proposed the construction of a theoretical framework built upon three angles of analysis: domestic; economic/technological and international. The framework incorporates the structure, actors, processes and issue that were investigated. Each of these angles of analysis would result in an independent variable. Scrutinizing the independent variables, as it was done with the dependent variable, established parameters and indicators for a comparative analysis among different cases of large-scale innovative defense projects. By doing such, a general hypothesis was presented. It was sustained that the domestic variable (level of consensus among and within the Executive and Congress) and the economic/technological variable (level of technological feasibility) were necessary and conjointly sufficient conditions to explain the success or failure of large-scale defense

projects. As for the variable derived the International System (level of external threat), it was argued that it is a non-necessary condition, although with a high level of impact and positively related to the dependent variable.

Finally, in order to test this study's general hypothesis and successfully accomplish its objectives, a methodology and research techniques were proposed. The methodological approach was qualitative and the main strategy of investigation was the Historical-Comparative Method (HMC). This method allows the research to infer causality among variables by establishing relations among variables while others are kept constant. This work chose four case-studies to test its hypothesis and its framework of analysis. The choice of cases was based on the methodology, as the phenomena was studied, by selecting cases in which the proposed explanatory conditions were either present or negative. Two of the large-scale defense projects studied were negative cases (failed or in the defined failed spectrum) and two were positive (successful or in the defined successful spectrum). To investigate thoroughly the proposed case-studies, the main research technique employed was *Process-tracing,* which aims at connecting hypothetical variables X to a Y dependent variable through the identification of the absence or presence of causal interactions among relations between the parts that interact. By conducting the investigation in this manner, the dissertation is epistemologically placed in a Middle Range Theory, neither idiographic, nor nomothetic. Nonetheless, as it will be further argued, *theory-construction* and *theory-testing*, which can result from HMC, can contribute to build more generalizable model.

The work was organized in two parts in order to develop the theoretical framework in the first part and test it in the investigation of the case-studies in the second part. Part I – Structure, Actors, Processes, and Issues – built the theoretical framework and established the parameters within the variables that would be addressed in the second part. Chapters 1,2 and 3 engaged in literature review and theoretical debate, drawing from a critical engagement with the specialized literature the definition of the variables, parameters and indicators that would explain the dependent variable. In each of these chapters, a main hypothesis was put forward. Furthermore, main inferences and conclusions regarding their angle of analysis were identified, which would guide what structural characteristics, main actors and data were to be observed. Chapter 4 gave emphasis to the process in which these are embedded, highlighting the typical lifecycle of a large-scale defense project. Part II – High Stakes and High Risk: An Analysis of

large-scale, high-cost and long-term defense projects – was dedicated at the comparative analysis of the four cases proposed. The cases were addressed from its conception and motivations towards its development and outcomes in order to confront them with the theoretical framework and hypotheses.

From the International System (Chapter 1) perspective, the success of large-scale defense projects is positively and directly related to the level of threat. It was argued that the greater the level of threat, the higher the chance of success. In its development, the chapter discussed the relation among the international system and the State's response. The argument was built on the premise that states are embedded in an anarchic system. Their response to this threat can be to balance externally (built alliances) or internally. Internal balancing can be realized by enhancing the doctrinal, organizational and technological spheres in order to best mobilize to the purpose of military engagement. It was demonstrated that the domestic level is highly impacted by the international system and its stimuli pressure. A state can choose to maintain its present strategy, emulate successful practices or innovate. The focus of the dissertation was on innovation and the technological sphere of internal-balancing. Being the United States an innovative-capable state, external threat will pressure the country to innovate technologically. Threat is assessed by observing the countries relative position in the International System, since there is no precise measure available for such variable.

As for Chapter 2, the domestic level and its decision-making process was unraveled. It was demonstrated that decision-making is fragmented and divided among key actors, which maximize their own interests. In order to a large-scale project succeed, there is a necessary level of consensus to be achieved. Self-interested bureaus, elected leaders –among other key actors– are continuously disputing resources, protecting their supposed roles and aiming at maximizing prestige. This creates a scenario in which decisions are suboptimal. The chapter reviews Public Policy's and Political Science's main perspectives in order to construct its variable: level of consensus among and within the Executive and Congress. It is argued that, given the decision-making process, key congressional committees, auditing agencies, the OSD, the Military and the President, are the main actors who's stands and decisions impact large-scale projects. Other possible actors are already represented in this variable (e.g., public opinion, interest groups). When a minimum level of consensus cannot be reached, the project will start to fade and ultimately fail.

Large-scale defense projects are expensive. Mobilizing resources and innovation were addressed in Chapter 3. A Defense Industrial Base and its composition impacts directly the manner the project is conducted. Defense Economics themes such as efficiency, procurement and incentives are analyzed and the chapter engages with the trade-offs involved in these matters, as well as the internationalization *versus* nationalization problem. The defense market is characterized by a monopsonic demand side with idiosyncratic features and security concerns; hence, these issues must be engaged differently from regular market analysis. This entails into a specific scenario for innovation, including intellectual property issues and technological transfer matters. Propositions, actors, and particular processes are drawn from this debate. Furthermore, building upon the cited discussion, Chapter 3 contends as its main variable that technological feasibility is a necessary condition for the success of a project. Measuring it *ex ante,* nevertheless, is not possible since the projects are highly innovative. However, it can be analyzed through the lifecycle of the project, observing challenges highlighted by specialists and decision-makers. When there are many doubts regarding the technological feasibility of the project it loses strength and, by consequence, budgetary support. Moreover, the elasticity of the demand can work as a *proxy* measurement for technological feasibility since the difference from the projected costs and the real ones are a sign of problems regarding developing technology.

The politics of budget is at the center of conflicting interests. The power of the purse dictates the future of large-scale projects. By observing the budgetary process, one can identify the supporters and opponents of the project and their stands. Chapter 4 delineates the "rules of the game" and sets the stage for analyzing the projects. Legislation and pivotal political positions are scrutinized as the chapter explains how a project lifecycle works, the DoD's and Congressional role in defense procurement, and theoretical insights regarding budgeting.

As stated, Part II of this dissertation engaged in the comparative analysis of the four proposed case-studies. In order to summarize the empirical results of the analysis done in each chapter, Table 9.1 and 9.2 will be presented below. Table 9.1 recapitulates the results of testing the theoretical framework confronted with the empirical cases, demonstrating the causal relation between the independent variables and the Dependent variable. Table 9.2 delineates the relation between the cases and the dependent variable, decomposed in the SC presented in the Introduction and investigated in the case-studies.

The proposed qualitative indicators (High, Medium and Low) are assigned given the project's lifecycle as a whole. The SC in Table 9.2 are divided among the efficiency criteria (blue) and effectiveness criteria (red).

Table 9.1- Results Analyzed Through the Proposed Model of Causality

	External Threat	Political Consensus	Technological Feasibility	Success or Failure
USS Nautilus	High	High	High	**Successful**
B-2	High->Low	Medium-> Low	Low-> High	**Failed Spectrum**
FCS	Low	Medium-> Low	Low	**Unsuccessful**
F-35	Low-> High	Medium-> High	Medium-> High	**Successful Spectrum**

Source: The Author.

Table 9.2- Results Analyzed Through the Success Criteria (SC)

	Cost Overruns	Schedule Overruns	Performance	Stakeholder's Need	Operational Success	Success or Failure
USS Nautilus	N/A	None	High	High	High	**Successful**
B-2	High	Medium	Medium	Low	Medium	**Failed Spectrum**
FCS	High	High	Low	Low	Low	**Unsuccessful**
F-35	Medium	High	High	High	Medium	**Successful Spectrum**

Source: The Author.

Chapter 6 analyzed the USS-Nautilus, the world's first Nuclear Propelled Submarine. With the end of the World War II, the United States enjoyed the monopoly over atomic weapons due to the success of the Manhattan Project. Nonetheless, the Soviet Union was rapidly emerging as a major threat and quickly catching-up with the United States in many fronts. Especially threatening was USSR's large and growing fleet of submarines and its own attempt to develop nuclear propelled submarines. The technology for the USS-Nautilus was drawn from scientific revolution in physics and chemistry that culminated in the Manhattan Project. Different prototypes were developed. Bureaus and Congress worked together. Under the leadership of Admiral Rickover, the Nautilus was commissioned in 1954, before schedule. Technological feasibility issues were rapidly overcome. Continuing growth of external threat impacted on innovation. The Nautilus was deployed with success and gave genesis to a nuclear propelled Navy. Other matters, such as the development of nuclear propelled submarines by other countries and atomic energy for civil use were addressed. Nautilus proved itself extremely necessary and an operational success. In this dissertation, under all SC suggested in the Introduction (Table 9.2), Nautilus was successful. As for the cost efficiency criteria, the author of this dissertation could not have access to data. Nevertheless, since the procurement process ran smoothly and as the reviewed literature did not point out problems in this regard, it can be assumed that it did not impact the other SC. The three proposed independent variables correlated in a precise matter with the Dependent variable. Nautilus is an outstanding case of project success.

In 1981, there was a perception among the Military that the manned-bomber leg of the strategic triad of the United States was lagging behind due to increasing developed air defenses and radar systems by the Soviets. The aim was to build a bomber which could penetrate the defenses with an advanced stealth technology. The three independent variables impacted conjointly the fate of the bomber. As the B-2 was conceptualized and developed, external threat diminished, hard criticism came from Congress, auditing agencies and specialists doubted its need. This resulted in the program's loss of political support. With the end of the Cold War, the B-2 was cancelled with 21 already being delivered, with an extremely high unit cost. Concurrent programs and defense budget cuts further intensified the B-2's proponents' support. Feasibility grew during the 1980s and, despite schedule and cost delays, the B-2 was commissioned and employed in service. That is why the program is not considered a failure by this dissertation. It fits the "failed

spectrum", especially due to the fact that decision-makers did not support the project, it was not a priority. Effectiveness and efficiency had bad results, given the initial goals of the project. The program, due to falling threat levels, technological feasibility doubts and immense challenges and continuous loss of political support led it to be cancelled. The B-2 did not meet the necessary conditions for success and falling threat levels seriously dampened innovative effort.

The Future Combat Systems (FCS) was addressed in Chapter 7. A highly innovative project envisioned by Army leaders promised to revolutionize combat, with agile modular brigades, situational awareness, lighter equipment and a centralized network coordinating engagement. The FCS proposed an organizational, doctrinal and technological revolution for the Army, which was concerned regarding its effectiveness. The idea was conceptualized in the 1990's based on the results of war games and promised to "lift the fog of war". As it was argued during the investigation of the FCS, the proposed form of acquisition and management failed. Core technological systems could not be successfully developed. At the very beginning of the project the FCS enjoyed enthusiasm among decision-makers. Nonetheless, it continuously lost political support, and decision-makers became critical of diverse aspects of the program. The FCS was envisioned in a low threat scenario promising to revolutionize high intensity competition, such as engagement with regional nuclear powers. The nature of the external environment (the wars of Iraq and Afghanistan) was priority to decision-makers and the FCS could not deliver in this front. Immature development regarding technology and the concurring costs (especially from the wars) made the FCS lose its political support rapidly. Demand elasticity grew, budgets were constrained, and the FCS was cancelled. Remaining projects of the FCS were also cancelled. The three independent variables correlated accurately with the project's results. The FCS certainly did not lift the "fog of war" and was a failure. What remained was sunken costs and a bad reputation for the Army.

The final chapter thoroughly investigated the Joint Strike Fighter program, from its initial ideas and prospects towards its conceptualization and lifecycle. President Clinton's bottom-up review, in the face of an aging fleet of strike fighters, incorporated different projects into the development of the F-35, to be used by three forces: The Marines; Navy and the Air Force. One of the goals was economic, as developing one fighter with similar technology between its three proposed models was argued to be cheaper than developing a fighter for all three forces. The F-35 is a fifth generation

aircraft, with a complex informational system connected with other weapon systems and the tactical scenario, data-processing and other innovative features scrutinized at Chapter 8. Its technological feasibility, however, was not so troubling as was the case with the B-2. This gave decision-makers confidence. It had support in Congress, and the three forces working together diminished resource disputes. The main issue was cost and schedule. Albeit, even with a low threat scenario, the project moved on since the necessary conditions were being met. The project was scrutinized by Congress mainly due to its costs. The second decade of the twenty-first century was characterized by growing great power competition. The U.S could not afford to lose its air preponderance, as China, Russia and other threats were continuously rising. This increased innovative effort and diminished the weight of costs in decision-maker's assessment of the project, since national security was at stake. Congress remained supportive of the program, as it also fulfilled constituency and other interests. The necessary consensus, in the case of the F-35, was met. Pace and scope of production rapidly increased diminishing the aircraft's unit cost. The F-35 was commissioned and successfully employed in operations. In this dissertation, it is classified as in the "successful spectrum" because of efficiency matters. The early costs and delays were detrimental to the program. However, as it was argued, efficiency is subordinated to security issues. The program is necessary in terms of national defense. As it is an ongoing project, no final conclusion can be put forward. Nonetheless, the assertiveness of the analysis made so far can confidently place it in a "successful spectrum" scenario. Main SC were met and the relation among the theoretical framework and the results were confirmed.

After reviewing the cases, the methodological approach was considered appropriate for analysis. The small-n comparative study enabled theoretical building and testing by identifying the causality mechanisms regarding decision-making and the success or failure of large-scale innovative projects. The causality mechanisms identified provided a successful explanation for the dependent variable and, hence, the general objective of this dissertation was accomplished. The construction of the model provided a solid explanation of the key-actors in defense decision-making, the impact of external threat in the technological dimension of internal-balancing and innovation in the idiosyncratic defense market. These mechanisms were clearly observed in the empirical chapters. Theory accomplished its goal by reaching an equilibrium between parsimony and excessive factual reconstruction, as the epistemological approach of this study

proposed. The general hypothesis and proposed model were corroborated by empirical analysis.

The work developed here opens new opportunities for future research in many ways. Firstly, as it was intended, the theoretical framework can be further developed encompassing other defense and foreign policy issues, with the adequate adaptations. Theoretical development regarding external threat, domestic decision-making and innovation can be advanced based on the advances made in this study. Secondly, the research can be expanded geographically for studying specific countries such as Brazil or proposing comparative analysis amongst different countries. Thirdly, more precise measurement parameters for the given variables can enhance analysis and allows large-n studies. Finally, the relation between variables and its components can be further investigated enabling a more profound explanation of the mechanisms addressed.

The author hopes to have contributed, in this study, towards explaining defense-decision making and what makes a large-scale innovative defense project succeed or fail.

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