NPS-CM-20-026

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Analysis of Nontraditional Contractors as a Proxy for Innovation through DoD other Transaction Agreements

December 2019

Capt. Alison D. Almonte, USAF

Thesis Advisors: Maj. William A. Muir, Assistant Professor
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Graduate School of Defense Management

Naval Postgraduate School

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Prepared for the Naval Postgraduate School, Monterey, CA 93943.

The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Defense Management at the Naval Postgraduate School.

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ABSTRACT

The 2018 National Defense Strategy highlights the critical importance of leveraging technological advancements in a world with rapidly growing security concerns. For the Department of Defense (DoD) to integrate advancements into military capabilities, the acquisition community will need to innovate its business practices to support the changing character of war. Other Transactions (OTs) provide a tool that offers the flexibility to incorporate business methods similar to commercial industry best practices, thereby supporting faster design and execution. The recent increased use of OTs in federal contracting for research and prototype projects also incentivizes nontraditional defense contractors (NDCs), who would not otherwise overcome obstacles inherent in traditional Federal Acquisition Regulation contracting, to contract with the DoD and serve as proxies to innovation. Three primary techniques are employed. First, a spend analysis is performed on Federal Procurement Data System-Next Generation data. Second, consortium data is matched with the System for Award Management Application Programming Interface to assess the proposed scale using psychometric techniques. Last, a logit model estimates the predictive power of the proposed scale and the relationships between the variables and the current NDC statutory classification. Understanding the characteristics of OT NDCs will help the DoD leverage acquisition policy decisions to access emerging technology solutions.

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LIST OF ACRONYMS AND ABBREVIATIONS

AO	Agreements Officer
API	Application Programming Interface
CAS	Cost Accounting Standards
CFR	Code of Federal Regulations
CRS	Congressional Research Service
DARPA	Defense Advanced Research Projects Agency
DIU	Defense Innovation Unit
DIUx	Defense Innovation Unit Experimental
DoD	Department of Defense
DUNS	Data Universal Numbering System
EEOC	U.S. Equal Employment Opportunity Commission
FAR	Federal Acquisition Regulation
FASA	Federal Acquisition Streamlining Act
FPDS-NG	Federal Procurement Data System—Next Generation
FY	Fiscal Year
GAO	Government Accountability Office
GSA	General Services Administration
IT	Information Technology
NDAA	National Defense Authorization Act
NDC	Nontraditional Defense Contractor
NDS	National Defense Strategy
OPO	Office of Procurement Operations
OT	Other Transaction
SAM	System for Award Management
SBIR	Small Business Innovation Research
SPE	Senior Procurement Executive
TINA	Truth in Negotiations Act
RSGS	Robotic Servicing of Geosynchronous Satellites
UAV	Unmanned Aerial Vehicle
U.S.C.	United States Code

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EXECUTIVE SUMMARY

The 2018 National Defense Strategy highlights the critical importance of leveraging technological advancements in a world with rapidly growing security concerns. For the Department of Defense (DoD) to integrate advancements into military capabilities, the acquisition community will need to innovate its business practices to support the changing character of war. Other Transactions (OTs) provide a nontraditional tool that offers the flexibility to incorporate business methods similar to commercial industry best practices, thereby supporting faster design and execution. The recent increased use of OTs in federal contracting for research, prototype, and production projects also incentivizes nontraditional defense contractors (NDCs), who would not otherwise overcome obstacles inherent in traditional Federal Acquisition Regulation contracting, to contract with the DoD and serve as proxies to innovation.

This research investigates whether the alternative metrics of distance to the nearest tech-hub, membership in a consortium, total DoD obligations, and compound annual growth measure the innovative potential of NDCs and have predictive power for classifying firms under the current binary NDC construct. The research questions provide a narrow view of OT use, however, contribute to the larger scale critical question of whether OTs provide an advantage to innovative technological advancements through NDCs. In addition, this research is an initial step in determining best methods and incentives to encourage NDCs to work with the DoD, since future decisions cannot be made without a clear understanding of the current industrial base for OT agreements. This study integrates data from multiple sources to employ techniques for analysis of innovative potential. The first research objective is to investigate alternative metrics to measure the innovative potential of NDCs through OT agreements. This is conducted through a logit model that empirically tests a multi-item scale that measures the innovative potential of firms and assesses the predictive power for classifying firms under the current binary NDC classification. The logistic regression of nontraditional status on the four dependent variables (distance to a tech-hub, consortium membership, CAGR, and total obligations) fit significantly better to the data than a null model $\chi^2(4) = 32.01, p < .01)$ and correctly predicted nontraditional status for 79.6% of vendors based off pseudo R. The second

research objective is to examine NDCs through a spend analysis of archival Federal Procurement Data System Next Generation data. The DoD’s OT use has increased significantly with the expanded authorities. One of congress’s primary objectives in allowing acquisition flexibility through OTs is to attract NDCs as a proxy for innovative weapons systems.

Understanding the structure and characteristics of OT NDCs will help the DoD in leveraging acquisition policy decisions to access emerging technology solutions. Some areas for future research include researching different metrics for innovative potential, the benefits of OT agreements versus other nontraditional contracting methods through successful prototyping, and analysis of weapon system programs resulting from awards to consortiums. Congress has increased reporting and notification requirements in the FY2019 defense authorization and appropriations legislation; therefore, more data and information will be publicly available for research, which will allow for more in-depth research and understanding of the utilization of OT agreements and access to NDCs. Being able to measure and quantify the innovative potential of firms will help the DoD to access innovation for research and prototyping by being able to tailor the OT special authority towards those firms that might otherwise not partner with the DoD.

I. INTRODUCTION

> The Department of Defense is now in a period during which the time a particular technology is a dominant force on the battlefield is getting increasingly shorter, disruptive technologies are emerging at a faster pace, and these technologies are more widely dispersed. … In a world with rapidly changing technology, time is a valuable resource that must not be taken for granted. It is difficult to predict what capabilities the DoD will need 5 to 10 years from now—biotechnology, nanotechnology, artificial intelligence, robotics, or a new technology area not even known today. It also is unclear on what plane the military will conduct warfare—traditional battlefields, space, cyberspace, or some other domain. The current acquisition system lacks the agility needed to adapt to new paradigms.
>
> —Advisory Panel on Streamlining and Codifying Acquisition Regulations (2017, p. 7)

Until recently, the U.S. military has defended unmatched superiority in all domains—air, land, sea, space, and cyberspace. With the "rapid technological advancements and the changing character of war," the strategic environment requires the United States to rapidly advance, especially due to "the fact that many technological developments will come from the commercial sector … [meaning] that state competitors and non-state actors will also have access to them, a fact that risks eroding the conventional overmatch to which our Nation has grown accustomed" (Office of the President of the United States, 2018, p. 3). The strategic approach in former Secretary Mattis's National Defense Strategy includes three main lines of effort, of which the third is to transform the Department of Defense's (DoD's) business practices (DoD; Office of the President of the United States, 2018). This third line of effort goes hand in hand with the increased attention on nontraditional contracting methods that diverge from the typical procurement procedures under the Federal Acquisition Regulation (FAR), supplements, and statutes and offer unique benefits and risks to the DoD acquisition community (Office of the President of the United States, 2018).

Other Transaction (OT) agreements are a nontraditional contracting method that are exempt from the majority of federal procurement statutes and regulations, allowing for greater acquisition flexibility and private sector–related business practices. Section 10 of United States Code (U.S.C.) 2371 grants the authority for the use of OTs in the DoD. OT agreements are designed for research and development, prototypes, and follow-on production of prototypes, where different contract financing terms and conditions can be utilized, intellectual property rights can be negotiated, and NDCs—who would typically not be incentivized to work with the DoD—can be leveraged. OT agreements originated in 1958 with the enactment of the National Aeronautics and Space Act and creation of the National Aeronautics and Space Administration (NASA) (Schwartz & Peters, 2019). Congress has consistently expanded OT authorities and applicability since OTs have been authorized. OT authority was extended to the DoD through DARPA in 1989 and to the military services for advanced research projects in 1994 (OUSD(A&S), 2018, p. 37). Today, OTs are authorized by all military services and 11 other agencies for research, prototyping, and follow-on production of prototypes. The DoD obligates an estimated $300 billion annually for research and development, mostly under procurement contracts governed through 10 U.S.C., the FAR, DFARS, and agency specific supplements (Schwartz & Peters, 2019). In fiscal year (FY) 2017, the DoD obligated an estimated $2.1 billion to prototype OT agreements, which may seem significant, but only accounts for 1% of its total obligations (Schwartz & Peters, 2019). This amount is predicted to increase significantly with the expanded authorities and threshold levels from Congress and increased attention on OTs in the acquisition community.

As former Secretary of Defense Mattis emphasized,

> Current processes are not responsive to the need; the Department is over-optimized for exceptional performance at the expense of providing timely decisions, policies, and capabilities to the warfighter. Our response will be to prioritize speed of delivery, continuous adaption, and frequent modular upgrades. We must not accept cumbersome approval chains, wasteful applications of resources in uncompetitive space, or overly risk-adverse thinking that impedes change. (Office of the President of the United States, 2018, p. 10)

OTs and other nontraditional contracting methods offer an acquisition path for speed of award, as well as flexibility for adaptation in contract terms and prototyping. Although the increased use of OTs in the DoD is relatively recent—since the addition of OTs for prototypes in the 2016 National Defense Authorization Act (NDAA)—there is already a robust amount of informative literature to understand the intended use, advantages, and disadvantages of OT agreements, including the recent OT Guide, Congressional Research Service (CRS) reports, Government Accountability Office (GAO) decisions, and Congressional hearings. The most recent and informative document for the use of OT agreements in the DoD is the Other Transaction Authority Guide, last updated in November 2018. The guide has undergone significant changes due to the increased use of OTs and increased congressional oversight. The guide includes myths and facts on OTs, case studies, definitions, and guidance for execution of OTs with planning, soliciting, evaluating, reporting, payment information, and legal information (OUSD(A&S), 2018).

Due to the changing nature of warfare and the national emphasis on innovation, new literature is being published on nontraditional contracting methods, including OTs and NDCs. This research topic—examining the DoD's use of OTs and the vendors receiving these agreements—is relevant and provides insight into an area that has not yet been researched. With the recent increased use and expanded thresholds of this special statutory authority, this research provides critical information for near-time policy decisions.

A. PURPOSE STATEMENT

This research furthers the DoD's objectives from the National Security Strategy in support of gaining a technological advantage through an innovative industrial vendor base that provides access to cutting-edge weapons systems (Office of the President of the United States, 2018, p. 4). OTs provide a flexible acquisition tool that supports the intent of the National Defense Strategy to encourage prototyping and experimentation before specifying requirements in order to "allow the Department to more quickly respond to changes in the security environment and make it harder for competitors to offset our systems" (Office of the President of the United States, 2018, p. 11).

This research has three main objectives. The first objective is to investigate alternative metrics to measure the innovative potential of NDCs through OT agreements. This is conducted through empirically testing a multi-item scale that measures the innovative potential of firms and assesses the predictive power for classifying firms under the current binary NDC classification. The second objective is to examine NDCs through a spend analysis of archival Federal Procurement Data System Next Generation data. The

DoD's OT use has increased significantly with the expanded authorities. One of congress's primary objectives in allowing acquisition flexibility through OTs is to attract NDCs as a proxy for innovative weapons systems. Third, this research helps to understand the characteristics of NDCs, which leads to formulating best practices to reach the NDCs for OT research, prototype, and production projects to broaden the DoD's ability to access emerging technology from firms that would otherwise be unwilling to enter into contracts with the DoD, therefore increasing the pace of innovation. Examining whether the current definition of a NDC identifies the innovative characteristics the DoD is targeting is critical to improve the DoD's access to the vendors and oversee the utilization of OT authority. Overall, a multi-item scale was proposed to measure the innovative potential of firms after scrutiny of the binary NDC classification, and this measure of innovative potential has not yet been empirically examined or tested. This research includes a spend analysis and an empirical test of the proposed measurement scale for the innovative potential of contractors.

B. RESEARCH QUESTIONS

Primary Questions: Do the alternative metrics of distance to the nearest tech-hub, membership in a consortium, total DoD obligations, and compound annual growth measure the innovative potential of NDCs and have predictive power for classifying firms under the current binary NDC construct? What is the nature of the relationships between items in the proposed scale and the NDC classification?

Secondary Question: From a spend analysis, what are trends in the DoD's use of OTs? What are common characteristics of DoD OT vendors?

The primary and secondary research questions provide a narrow view of OT use, however, contribute to the larger scale critical question of whether OTs provide an advantage to innovative technological advancements through NDCs. In addition, this research is an initial step in determining best methods and incentives to encourage NDCs to work with the DoD, since future decisions cannot be made without a clear understanding of the current industrial base for OT agreements. Also, this study evaluates four alternative metrics, but opens for discussion other possible metrics for the innovative potential of firms.

OTs are a hot topic in the acquisition community. The advantage for the DoD to adopt business practices similar to the private sector through OTs allows for flexibility to reach those entities whose primary business is not usually with the DoD. NDCs may be a critical tool for turning emerging technologies into military capabilities. This research will influence critical policy implications for the DoD and for the DoD's ability to access innovation through research and development, prototyping and initial production from NDCs.

C. RESEARCH BENEFITS AND LIMITATIONS

This research incorporates data from multiple sources. One of the sources is unclassified FPDS–NG data on OTs from FY2005–2018. The most authoritative contract data source is FPDS–NG for OT prototypes and production; however, research OT obligations along with grants and cooperative agreements are typically recorded in a different system called Defense Assistance Awards Data System (Schwartz & Peters, 2019, pp. 10–11). All data, including data from FPDS–NG, has imperfections, incomplete elements, and certain limitations by nature. FPDS–NG data, in particular, can have a delay up to 90 days in uploading and updating information regardless of fiscal year (Schwartz & Peters, 2019, p. 37). Data was also collected from consortia member lists and from the SAM API for firm-level registration information. Only consortiums that published membership lists were able to be used in the analysis. In addition, firms with clear registration matches to Data Universal Numbering System (DUNS) in SAM API were used in the data fields. Any incomplete data fields were eliminated from analysis.

This research analysis provides insights to answer the research questions on OT vendors and will help determine whether NDCs, with the current statutory definition in OT agreements, are a successful tool in innovative weapon systems acquisition. Understanding whether a contractor has innovative potential is a crucial distinction in acquisition, especially under OT agreements as Congress aims to improve the DoD's access to speedy prototyping and research. The use of OTs and the validity of the classification of an NDC has been criticized and under scrutiny in recent rapid defense acquisition literature. This research advances the DoD acquisition field by assessing the measurement properties of an alternative proposed multi-item scale and its predictive power for classifying firms as NDCs. Since OT use has increased significantly in all DoD agencies and the advantages of contracting with NDCs have received increased attention, this research will provide information for critical policy decisions.

D. ORGANIZATION OF REPORT

This MBA professional report includes the following proposed chapters. First, Chapter I provides the introduction to this research including background information, the purpose, research questions, research benefits and limitations, and the overall organization of the report. Chapter II details the literature review with the OT agreement definition, history of OT use, DoD OT authority and legislative changes, benefits of OTs, risks of OTs, OT innovative potential, AF initiatives to reach NDCs, NDC significance, and measurement validity and reliability. Chapter III introduces the data, sample, variable operationalization, model specification, and methodology. Chapter IV highlights the results of the spend analysis and logistic regression model. Chapter V presents the discussion of the results, research limitations, and areas for future research and Chapter VI details overall conclusions for the research.

E. SUMMARY

OTs are a nontraditional contracting tool noteworthy for being defined by what they are not. OT agreements are not classified as typical FAR-based procurements and thereby are not applicable to the statutes under Title 10, the FAR, and agency-specific supplements. OT agreements do, however, provide a unique acquisition tool with opportunities for private industry business practices that incentivize NDCs to work with the DoD to leverage dual-use commercial technologies and state-of-the-art innovations in prototypes and research. OTs are a hot topic in the acquisition community since Congress has significantly expanded OT authorities and thresholds. The widened latitude of OT authority has the primary objective of providing access to emerging technologies in line with the National Defense Strategy and changing character of war. Since OTs have recently grown in use, especially within the DoD, there is increased literature and research on the benefits and risks of this flexible acquisition tool. This research topic analyzes FPDS–NG data on DoD OT agreements that has not yet been empirically examined. A logistic regression model assesses alternative metrics to measuring innovative potential of nontraditional defense contractors in OT agreements. Understanding the nontraditional defense contractors receiving DoD OT agreements will provide insight into the utilization of OTs and inform decision-makers to make acquisition policy changes.

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II. LITERATURE REVIEW

Chapter II provides relevant literature covering the history of OT use, legislative changes, benefits and risks of OTs, and nontraditional defense contractor significance.

A. OTHER TRANSACTION AGREEMENTS

The majority of DoD acquisitions follow regulations and statutes under U.S. Code 10, the Federal Acquisition Regulation (FAR), the DFARS, and agency-specific regulations. There is an exception, however, where the DoD and other federal agencies are allowed to use a tool called the OT agreement. An OT agreement is notable for being defined by what it is not, providing flexibility and a "gray area" for acquisition professionals. The purpose of the OT agreement is to allow agencies acquisition flexibility to enter into business arrangements similar to the private sector and tailor financing terms, intellectual property agreements, incentives, and other terms and conditions specific and advantageous to the program. This ultimately allows the DoD to incentivize NDCs to work with the government, and allow for access to dual-use commercial technologies and innovative, fast-paced acquisition solutions.

OTs are not categorized as FAR-based procurement contracts and thus do not have to comply with common acquisition statutes and regulations. The most impactful of these rules and regulations include the Truth in Negotiations Act, Procurement Integrity Act, Competition in Contracting Act, Cost Accounting Standards, Contract Disputes Act, and Bayh-Dole Act (Schwartz & Peters, 2019). Even though the Competition in Contracting Act is not applicable to OT agreements, competitive practices are to be used to the maximum extent practicable, but do not require sole source justifications and approvals (OUSD(A&S), 2018, p. 38). Requirements related to national security such as the Trade Secrets Act (18 U.S.C. 1905), the Economic Espionage Act (18 U.S.C. 1831–39), specific parts of the Freedom of Information Act (5 U.S.C. 552), and the Anti-Deficiency Act (31 U.S.C. 1341) still apply to OT agreements (Schwartz & Peters, 2019, p. 5). While exemptions from these regulations offer broader discretion to the DoD for acquisition flexibility to access innovative technologies and weapons systems, they also impose a greater risk for checks on responsible stewardship of taxpayer dollars and ethical acquisition practices. Aspects of the tailorable parts of OTs come from the flexibility that the agreements officer (AO) has in determining price reasonableness without restrictions with pricing data, fully negotiable intellectual property rights, contract financing agreements, and follow-on production opportunities (OUSD(A&S), 2018, pp. 17–18).

1. Technology Investment Agreements

The first type of OT agreement is for basic, applied, and advanced research, also referred to as a Technology Investment Agreement (TIA). TIAs are described under 32 CFR 37.100 and authorized for OTs from 10 U.S.C 2371. In order to enter an OT agreement, the research must not duplicate work from another DoD program, half of the total cost should be shared with the contractor, and a grant or cooperative agreement must not be applicable to the situation (OUSD, 2017, p. 12). As seen in Table 1, the DoD Financial Management Regulation provides descriptions of the differences between basic, applied, and advanced research (OUSD, 2017, pp. 4–5).

Table 1. DoD Financial Management Regulation. Adapted from OUSD(C) (2017, pp. 4–5).

BA 1	Basic Research	Basic research is scientific study with the intent of increasing knowledge in the fields of physical, engineering, environmental, and life sciences contributing to national security needs.
BA 2	Applied Research	Study to meet a specific need in effort to program and plan for potential solutions to complex technological problems.
BA 3	Advanced Technology Development	Development of subsystems to incorporate into prototyping ready for field testing.
BA 4	Demonstration and Validation	Evaluation of technology or prototypes in an operating environment.

2. Prototype Other Transaction Agreements

The second type of OT agreement derives authority from 10 U.S.C. 2371b and allows for prototyping, defined as addressing "a proof of concept, model, reverse engineering to address obsolescence, pilot, novel application of commercial technologies for defense purposes, agile development activity, creation, design, development, demonstration of technical or operational utility, or combinations of the foregoing" in the memorandum *Definitions and Requirements for Other Transactions Under Title 10, United States Code, 2371b* from November 2018 (OUSD(A&S), 2018, Appendix). Prototype OTs, if applicable, should include notification of the possibility of a follow-on competitive production OT after successful implementation of the prototype (OUSD(A&S), 2018, p. 6). For a prototype to be considered successful before production, the project should have met specific goals and defined metrics and have provided an overall positive and favorable complete result (OUSD(A&S), 2018, Appendix memo).

Prototype OTs that are compliant with statute 10 U.S.C. 2371b must enhance or improve mission effectiveness of the DoD and have specific participant requirements. The participants in a prototype OT agreement must satisfy at least one of the stipulations of involvement of at least one NDC or non-profit to a significant extent or all vendors small businesses (OUSD(A&S), 2018, p. 13). If the previous two requirements involving participation from NDCs do not apply, then an OT agreement may be awarded to a traditional defense contractor, but the contractor must cost-share at least one-third of the total expense with the government (OUSD(A&S), 2018, p. 13). Lastly, as with most procurement rules and regulations, there is an overarching exception for OT use if there is a justification from the senior procurement executive (SPE) (OUSD(A&S), 2018, p. 13).

Compared to other acquisition vehicles, prototype OTs have minimal clarifying information, shared best practices, and regulations. The main sources of guidance are contained in policy memorandums and the *Other Transaction Guide for Prototype Projects* from the Office of the Under Secretary of Defense for Acquisition and Sustainment.

A NDC is defined by the characteristic of not having been awarded or involved in a DoD contract in the past year. Furthermore, a NDC has not been involved in a DoD acquisition requiring full cost accounting standards (CAS) coverage described in section 1502 of Title 41 and 10 U.S.C. 2302(9) (OUSD(A&S), 2018, p. 31). This definition encompasses a large number of contractors, including almost all small businesses and a large number of large defense contractors that regularly work with the DoD. The wide latitude definition of a nontraditional defense contractor is "in part due to the exemptions to CAS coverage under 41 U.S.C. 1502 and FAR Part 30, which exempt commercial contracts, Firm Fixed Price contracts based on adequate price competition, and any contract or subcontract with a small business concern, amongst other exemptions" (OUSD(A&S), 2018, p. 31). Specifically, the definition of full CAS coverage under 48 CFR 9903.201-2 is pertinent only to CAS-covered contract awards over $50 million or combined CAS-covered contracts valued above $50 million in the past accounting period (OUSD(A&S), 2018, p. 31). This definition intends to capture NDCs by eliminating contractors already with CAS standards. The logic of defining a NDC by not having been subject to full CAS standards is due to the fact that full CAS coverage applies generally to contract awards valued over $50 million. Contracts at this dollar value would most likely be with traditional DoD contractors such as Boeing and Lockheed Martin. Under 48 CFR 9903.201-1, vendors are not subject to CAS if the contract type is sealed bid, subject to FAR Part 15, or below the Truth in Negotiations Act (TINA) threshold. In addition, 48 CFR 9903.201-1 provides exception for CAS to small businesses, contracts with predetermined prices, commercial items, and firm fixed price contracts with competition (CAS Applicability, 2008). These exceptions to full CAS allow a wide latitude of contractors to be classified as NDCs, without truly having unique innovative potential or first time contracting with the DoD.

One common method of executing OT agreements is through the use of a consortium. A consortium is a group formed between industry members, academia, and non-profits with the goal of achieving more as a collective than with individual sources. Consortiums allow collaboration around themed technology areas, and members are allowed to submit white papers for solutions to a complex environment. Ideally consortiums are aimed at benefitting the DoD and other requirement owners by creating a diversified network of experts to encourage advancements and growth in defense sectors (Schwartz & Peters, 2019).

3. Follow-on Production Other Transactions

The third type of OT is for production, also detailed in 10 U.S.C. 2371b. In order to pursue a follow-on production OT, the original OT agreement requires previous mention of the possibility of a follow-on production and must have a complete and successful prototype. In order for a production follow-on OT to be non-competitively awarded, the initial prototype must have been competitively awarded (OUSD(A&S), 2018, Appendix C).

A recent GAO case from 2018 highlights the necessity for both the early notification for a potential follow-on OT production agreement and a completed prototype. In this GAO case, one of the first DoD prototype projects to transition into a production OT agreement was a $65 million dollar agreement for cloud migration services. A competitive vendor, Oracle America, Inc., argued that the DoD did not fulfill 10 U.S.C. 2371b's statutory requirements to notify the potential for a follow-on production contract with the original prototype agreement to REAN Cloud LLC and also did not have a successful prototype at time of award. Overall, Oracle America, Inc.'s protest against the Army's cloud migration services was investigated and upheld (GAO, 2018).

B. HISTORY OF OT USE

The OT authority was created in 1958 under the National Aeronautics and Space Act, which founded the National Aeronautics and Space Administration (NASA) and provided the acquisition flexibility under Section 203(b)(5) to "enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate" (Schwartz & Peters, 2019, p. 21). The National Aeronautics and Space Act was enacted in order to catch up in the space race with the Soviet Union after the launch of Sputnik I (Schwartz & Peters, 2019, p. 21).

The DoD received authority, restricted to only DARPA, in 1989 through the NDAA of FY1990 and FY1991 to use OTs for advanced research projects (Schwartz & Peters, 2019, p. 22). Congress limited appropriated funding for OTs and Cooperative Agreements to $25 million and reviewed a mandatory report detailing the justification of the agreements and the associated benefits provided (Schwartz & Peters, 2019, p. 22).

The NDAA for FY1992 and FY1993 expanded OT authority for advanced research to all military departments in order to develop and leverage dual-use technologies (Schwartz & Peters, 2019, p. 24). The NDAA for FY1994 expanded OT authority even further for military departments to use OT agreements for basic, advanced, and applied research (Schwartz & Peters, 2019, p. 25). The NDAA for FY1994 also approved limited OT authority for three years for DARPA to enter into prototype agreements related to desired DoD weapons systems (Schwartz & Peters, 2019, p. 25). The NDAA for FY1997 expanded prototype OT authorities to military departments and officials designated by the secretary of defense (Schwartz & Peters, 2019, p. 26). The NDAA for FY2001 added the nontraditional defense contractor stipulation for prototype OTs, and the NDAA for FY2002 expanded authority to include the option for follow-on production from a prototype (Schwartz & Peters, 2019, p. 28). The NDAA for FY2004 created a pilot program for prototype projects transitioning into follow-on production and widened the latitude for prototypes to develop or improve weapon systems for the DoD (Schwartz & Peters, 2019, p. 29). The NDAA for FY2016 expanded OT authority further and altered the definition of a nontraditional defense contractor to include more parties, including small businesses (Schwartz & Peters, 2019, p. 32). The NDAA for FY2018 expanded to authorize nonprofits to enter into prototype OT agreements, and the NDAA for FY2019 authorized OTs for enhanced personal protective equipment and research areas under the Explosive Ordnance Disposal Defense Program (Schwartz & Peters, 2019, p. 33).

As evident through the constant expanding of authorities regarding OTs, Congress has given wider latitude and more direction toward encouraging and guiding the increased use of OTs for developing state-of-the-art technologies and weapons systems for the DoD (see Table 2).

Table 2. OT Authority—Legislative History. Adapted from Office of the Under Secretary of Defense (2017, pp. 34–35).

Year	Congressional Authorization
1958	National Aeronautics and Space Act introduces OT authority
1989	DARPA granted OT authority for advanced research projects in the FY1990 NDAA
1993	DARPA temporarily (three years) allowed to use OTs prototypes in FY1994 NDAA
1996	Military departments allowed to use OTs in FY1997
2000	NDC definition and requirement for one-third of total cost-sharing are added in the FY2001 NDAA
2001	Follow-on Production to prototype OT is introduced in FY2002 NDAA. This is limited to a defined number and price for prototypes.
2003	FY2004 NDAA develops the definition of a weapons system
2005	FY2006 NDAA defines monetary threshold levels for approval and adds the applicability of the Procurement Integrity Act
2014	Small businesses are excused from cost sharing requirement in FY2015 NDAA
2015	FY2016 NDAA permanently grants OT authority to 10 U.S.C. 2371b and expands the definition of NDCs and follow-on production agreements
2017	FY2018 NDAA clarifies training requirements regarding OTs, increases approval threshold levels, and allows for follow-on production for sub-awards in a consortium. Also, prototype agreements are authorized for SBIRs and non-profit entities.
2018	FY2019 NDAA changes the highest approval level from the USD(AT&L) to the USD(A&S) or USD(R&E), adds explanations on follow-on production from agreements with consortiums, and expands on the requirements for OT data reporting and collecting.

In the most recent CRS report, FPDS–NG data from FY2017 showed that a total of $2.1 billion was obligated for prototype OT agreements, which seems significant, but actually accounts for less than 1% of the DoD's total contract obligations for that year (Schwartz & Peters, 2019, p. 11). With the expanded OT authority, the use of OTs is predicted to increase even more and has shown a significant increase from 12 to 94 agreements from FY2013 to FY2017 (Schwartz & Peters, 2019, p. 11). See Table 3 and Table 4 for a further breakdown.

Table 3. Annual New DoD Prototype Agreements, FY2013–FY2017, Depicted by Funding Agency. Source: Schwartz and Peters (2019, p. 12).

	2013	2014	2015	2016	2017
DARPA		-	-	-	-
Dept. of Defense	-	-	2	9	27
Dept. of the Air Force	-	-	-	5	16
Dept. of the Army	1	3	-	7	14
Dept. of the Navy	3	5	2	-	2
NSA/CSS	-	-	-	-	1
U.S. Special Operations Command	1	1	1	-	-
U.S. Transportation Command	-	-	-	-	1
Washington Headquarters Services	-	-	-	-	2
Not Indicated	6	7	14	14	31
Total	**12**	**16**	**19**	**35**	**94**

Table 4. Annual New DoD Prototype Agreements, FY2013–FY2017, Depicted by Contracting Agency. Source: Schwartz and Peters (2019, p. 12).

	2013	2014	2015	2016	2017
DARPA	6	6	13	12	23
Dept. of the Air Force	-	-	-	5	5
Dept. of the Army	4	7	5	18	66
Dept. of the Navy	1	1	-	-	-
U.S. Special Operations Command	1	2	1	-	-
Total	**12**	**16**	**19**	**35**	**94**

In 2017, Ellen Lord, the Under Secretary of Defense for Acquisition, Technology, and Logistics, demonstrated her support of increased OT use by stating,

> I will drive expanded use of Other Transaction Authorities (OTA) by focusing on and encouraging those DoD requiring organizations that could benefit from access to nontraditional sources of innovative technology that might be adapted, as in the case of prototypes, to enhance the combat capability of our forces. I believe there are opportunities to judiciously employ these authorities more broadly across the Department. (Senate Armed Services Committee, 2017, p. 18)

This further supports the prediction that OTs will continue to be increasingly used within the DoD.

C. DOD OT AUTHORITY AND LEGISLATIVE CHANGES

There are not designated approval thresholds for TIAs and research OTs; however, prototype OTs have the statutory approval levels from the most recent policy shown in Table 5 (OUSD(A&S), 2018, p. 15). There are also agency-specific rules and regulations for prototype OTs.

Table 5. Authority for Use of OTs for Prototypes, Source: Office of the Under Secretary of Defense for Acquisition and Sustainment (2018, p. 44).

	Transaction Value		
Organization	**Up to $100 Million**	**$100M to $500 Million**	**Over $500 Million**
CCMDs with contracting authority	Commanding officer	USD(R&E) or USD(A&S)	USD(R&E) or USD(A&S)
DAs/FAs with contracting authority/DIU	Director	USD(R&E) or USD(A&S)	USD(R&E) or USD(A&S)
Military Departments	Senior Procurement Executive	Senior Procurement Executive	USD(R&E) or USD(A&S)
DARPA MDA	Director	Director	USD(R&E) or USD(A&S)

As shown in Table 6, other non-DoD agencies also have OT authority. Note that this is not an all-inclusive list since OT authority can also be distributed on a specific program basis (Schwartz & Peters, 2019). Eleven federal agencies and other offices have OT authority (Schwartz & Peters, 2019, p. 36).

Table 6. Selected Non-DoD Federal Agencies with OT or Related Authorities. Source: Schwartz and Peters (2019, p. 36).

Agency	R&D Authority	Prototype Authority	Permanent Authority	Temporary Authority	OT Authority
Advanced Research Project Agency – Energy	Yes	No	Yes	-	*42 U.S.C. 16538*
Dept. of Energy	Yes	No	No	2020	*42 U.S.C 7256*
Dept. of Health and Human Services	Yes	No	Yes	-	*42 U.S.C. 247d-7e*
Dept. of Homeland Security	Yes	Yes	No	2018	*6 U.S.C. 391 and 538*
Dept. of Transportation	Yes	No	Yes	-	*49 U.S.C. 5312*
Domestic Nuclear Detection Office	Yes	Yes	Yes	-	*6 U.S.C. 596*
Federal Aviation Administration	Yes	No	Yes	-	*49 U.S.C. 106(l)*
National Aeronautics and Space Administration	Yes	Yes	Yes	-	*51 U.S.C. 20113(e)*
Transportation Security Administration	Yes	No	Yes	-	*49 U.S.C. 114(m)*

1. Agreements Officer

The government official entrusted with the authority to enter into and administer OTs is the agreements officer (AO). The responsibilities of the AO include negotiating, initiating, and administering OTs, and the AO is not required to be a contracting officer (OUSD(A&S), 2018, p. 29).

The GAO conducted a report titled *Use of "Other Transaction" Agreements Limited and Mostly for Research and Development Activities* to detail the agencies allowed to enter into OTs and to what extent they have executed this authority (GAO, 2016). Out of the agencies authorized to use OTs, the main advantage described is the flexibility to negotiate individualized agreements for intellectual property and cost accounting provisions. The DoD is the only agency with its own individualized guidance for prototype projects in the *Other Transactions (OT) Guide for Prototype Projects* (OUSD(A&S), 2018). Table 7 illustrates the number of active OT agreements for each agency, highlighting the increased use in the DoD and the relatively low number of agreements overall.

Table 7. Active OT Agreements, FY2010–FY2014. Source: GAO (2016, p. 27).

Agency	**2010**	**2011**	**2012**	**2013**	**2014**
Advanced Research Projects Agency – Energy	3	3	3	3	0
Dept. of Defense	69	76	88	77	79
Dept. of Energy	2	3	3	3	3
Dept. of Health and Human Services	0	0	0	1	1
Dept. of Homeland Security	19	14	8	4	3
Dept. of Transportation	75	54	30	26	21
Domestic Nuclear Detection Office	0	0	0	0	0
Federal Aviation Administration	44	48	54	60	65
National Aeronautics and Space Administration	2,217	2,611	2,891	3,080	3,223
National Institutes of Health	6	6	6	5	5
Transportation Security Administration	408	435	564	579	637

The *Other Transaction Guide for Prototype Projects* is the most used and referenced source of guidance and lessons learned for prototype OTs issued by the under secretary of defense for acquisition and sustainment (OUSD(A&S), 2018). The guide includes best practices and extensive information, but it is not a mandatory policy. The guide allows for flexibility and sound business judgment with a consolidated source of information and resources. According to the program office's business judgment, prototype OTs are optional to fall under DoD Instruction (DoDI) 5000.02 *Operation of the Defense Acquisition System* if relevant and providing advantage (OUSD(A&S), 2018, p. 5).

2. Bayh-Dole Act

Previously called the Patent and Trademark Law Amendments Act, the Bayh-Dole Act directs intellectual property rights for inventions created with federal government participation under Title 35, Chapter 18 (Sec. 200 et seq.) (Schwartz & Peters, 2019, p. 3). An overall knowledge of this act is relevant in OT execution because OT agreements are not required to abide by the regulations, however, the justification of the act and the corresponding impact on commercial firms will help negotiate favorable intellectual property terms for both parties.

3. Better Buying Power 3.0

Better Buying Power 3.0, titled *Achieving Dominant Capabilities through Technical Excellence and Innovation,* places a "stronger emphasis on innovation, technical excellence, and the quality of our products" (Kendall, 2015, p. 1). Better Buying Power 3.0 builds off the BBP 1.0 and 2.0 directives and advances in technological superiority by reducing unnecessary bureaucratic obstructions and boosting innovation in the government. Specific to OTs, BBP 3.0 directs increased access to modernization and state-of-the-art technology within the security environment by encouraging increased use of OT agreements to incite NDCs, entrepreneurs, and inventors (Kendall, 2016, p. 16).

4. Defense Innovation Unit (DIU)

Former Secretary of Defense Ashton Carter initiated an outreach organization called Defense Innovation Unit Experimental (DIUx) to establish a DoD presence in technology hot spots such as Silicon Valley (GAO, 2017a, pp. 27–29). Initially, in 2015, DIUx did not have the authority to enter into contracts or obligate funds. In 2016, DIUx was granted OT authority, initiating its leadership in prototyping agreements as well as its research and development precedents for the DoD (GAO, 2017a, pp. 27–29). DIUx's main focus areas for innovation are artificial intelligence, human systems, information technology, and space systems (GAO, 2017a, pp. 27–29). From initial creation to March 2017, DIUx issued 25 OT agreements totaling $48.4 million in an average of 59 days (GAO, 2017a, pp. 27–29). For these OT agreements, DIUx preceded the Commercial Solutions Opening process, similar to Broad Agency Announcements, where a requirement topic is publicly posted and vendors can submit solutions in a proposal for commercial technology prototypes and receive OT agreements in a typical timeline of 60 days, significantly faster than the traditional FAR-based contracting process (GAO, 2017a, pp. 7–29).

D. BENEFITS OF OTHER TRANSACTION AGREEMENTS

One of the main benefits of using an OT agreement instead of another acquisition model is the shortened contract award time. Although the flexibility and wide latitude of OT agreements intuitively allows for fast execution, there is not yet research literature or data to prove such claims (Schwartz & Peters, 2019, p. 16). After OT authority was expanded by Congress in 1994, the DoD tasked RAND with researching the OT agreements initiated between 1994 and 1998 in order to assess the benefits, risks, and overall effects of the increased use. The report concluded with three main generalizations: (1) new industrial resources were added into the DoD innovation vendor base due to the increased acquisition flexibility, (2) benefits of OTs are more than just attracting new NDCs, but also better value with cost-sharing, beneficial agreement modifications, and innovative business arrangements, and (3) the benefits outweigh the risks to the DoD with being able to tailor intellectual property and financial plans in OT use with less oversight (Smith, Drezner, & Lachow, 2002, p. ix).

1. Prototyping Advantage

The GAO investigated how prototyping has fueled the DoD in its innovative development of weapons systems (GAO, 2017b, pp. 1–18). Overall, annually the DoD spends $70 billion in weapon system research, which includes, but does not consist entirely of prototyping (GAO, 2017b, pp. 1–18). Researching 22 major defense acquisition programs (MDAPs), 17 of which used prototyping, provides insight into how prototyping aids designs and mature technologies, along with further defining requirements and potential costs, and determining the realism of the desired programs (GAO, 2017b, pp. 1–18). There are barriers for prototyping, especially within the DoD environment due to limited funding discretion from congressional oversight, a risk-adverse bureaucratic structure in the DoD acquisition community, changing priorities, and long budget timelines. The DoD recognizes three different types of prototypes, all with differing purposes and time frames to implement into full weapon system programs. The three types of prototypes in order of increasing capability development are conceptual, development, and operational. Of the programs reviewed in the Army, Navy, and Air Force, program officials found that 16 or 17 prototyping programs had a positive return on investment, especially with those riskier projects, and helped develop solutions, refine requirements, and more accurately estimate costs factors. Twelve of the 17 prototyping programs used competitive prototyping where multiple contractors provided prototypes with different designs and proposed solutions to best meet the DoD's needs (GAO, 2017b, pp. 34–36). Overall, the GAO recommended implementation of department-wide guidance for more strategic prototyping efforts to improve system performance and encourage fast adoption.

2. Engaging with Nontraditional Defense Contractors

The GAO was tasked with conducting a study on 12 innovative companies in the private industry and understanding why those companies did not typically contract with the DoD. This study is especially relevant because research and development investments have consistently been more prevalent in the private industry than in the DoD's R&D spending. Therefore, it is crucial that the DoD can partner with those companies leaning forward in technology advancement and prototyping (GAO, 2017a). An example of how the DoD acquisition process can be especially discouraging for nontraditional defense contractors was highlighted in the report when one innovative nontraditional defense contractor stated that it took "25 full time employees, 12 months and millions of dollars to prepare a proposal for a DoD contract" compared to "3 part time employees, 2 months, and only thousands of dollars to prepare a commercial contract for a similar contract" (GAO, 2017a, p. 1).

The six main challenges that discourage nontraditional defense contractors from engaging in federal contracting are the DoD's widely integrated processes, intellectual property issues, fiscal concerns, DoD unique contracting requirements, lengthy acquisition times, and low experience–level workers (GAO, 2017a). Optimistically, a number of these challenges described by nontraditional innovative companies can be eliminated through OT agreements and the ability to tailor terms and conditions for individual prototypes and research projects. Table 8 illustrates the GAO's findings of the top ranked innovative firms and their overall revenue from DoD contracts. From the study, the companies considered most innovative had a minimal percentage of sales from DoD awards, stressing untapped innovation for the DoD to partner with companies outside the traditional defense sector.

Table 8. Top Innovative U.S. Companies' Revenue from DoD Contracts (2016). Source: GAO (2017a, p. 8).

Company	**Sales ($ billions)**	**Percentage of sales derived from DoD contracts**
Apple	216	< 1
Amazon	136	< 1
General Electric	111	< 2
3M	30	< 1
Google	90	0
Microsoft	85	< 1
IBM	80	< 1
Hewlett Packard	48	< 2
Facebook	28	0
Tesla	7	< 1

3. Cost-Sharing

The *Report to Congress: An Assessment of Cost-Sharing in Other Transaction Agreements for Prototype Projects* was conducted in 2017 to investigate the benefits and risks of cost-sharing within prototype OT agreements and to provide policy recommendations from the findings (OUSD(AT&L), 2017). Under the authority for prototype OTs, 10 U.S.C 2371b allows the DoD to negotiate unique terms and conditions within the agreement but provides stricter guidance on who should receive the OT prototype agreements. The purpose of this specific guidance is to incentivize nontraditional defense contractors through OTs to share state-of-the-art technologies. In research OTs, called TIAs, cost sharing is always required for at least half of the total cost to ensure the contractor also has a vested interest in the research outcomes. In the prototype OTs, however, the flexibility in cost-sharing is intended to draw new vendors into the DoD innovation base by allowing new startups or unincentivized companies to not commit their own funding or financing. Interestingly, this study also found that between FY2013 and FY2016, there was only 4% of an average cost-share rate, supporting that the OT statute as written is promoting the intended vendor pool of nontraditional defense contractors and small businesses (OUSD(AT&L), 2017).

The contractor is required to cost share for one-third of the agreement if a NDC is not involved to a significant extent, all vendors are small businesses or NDCs, or there is an extenuating circumstance justified by the SPE. The definition of a nontraditional defense contractor was changed from whether the vendor had used certified cost or pricing data at all to whether a vendor received a full CAS contract or contract within the past year. This change in definition created a wider latitude of companies that could now be classified as a nontraditional defense contractor, therefore eliminating any required cost-sharing with the federal government. One of the main recommendations of this study was to add nonprofits into the exception for cost-sharing, along with small businesses and nontraditional defense contractors, because nonprofits are unique and do not fit into a specific category of traditional defense contractors or small businesses. Because of this, they could offer innovative and educational solutions to DoD requirements (OUSD(AT&L), 2017).

Although this congressional hearing references the Department of Homeland Security's OT Use, not the DoD's, it emphasizes that OTs provide a unique tool with the flexibility to tailor agreements to bring in nontraditional defense contractors in order to maximize talent and innovation in private sector available technologies. However, there are very unique circumstances where OTs are the appropriate instrument for contractual agreements and present a higher risk for lack of accountability and oversight (U.S. Congress, 2008).

E. RISKS OF OTHER TRANSACTION AGREEMENTS

With the increased flexibility of OTs comes additional risks to the DoD. This section covers OT agreement risks such as oversight issues and improper use and corresponding case study examples.

The Army entered into an OT agreement for a system of systems program with a Lead Systems Integrator for an estimated $108 billion in order to replace an inventory for ground vehicles, aircraft, sensors, and munitions connected on an intertwined network

(GAO, 2005). The OT agreement was awarded to Boeing, a traditional defense contractor, however, due to the "significant involvement" of nontraditional robotics companies in the program, Boeing did not have to cost-share in the agreement or provide any exception (Gansler, Greenwalt, & Lucyshyn, 2013, p. 69). This agreement caught attention two years after initiation due to $4.6 billion already obligated, lack of requirements development, and only one system at mature development. The GAO completed the study in order to investigate and provide recommendations for the cost risks and progress delays (GAO, 2005). The GAO report (2005) saw problems with using FCS program through an OT and highlighted concerns with government financial oversight and protection of intellectual property rights.

While there has not been further research on the risks of OTs and who is receiving the awards, there is the risk of using OTs to circumvent procurement statutes and regulations. One concern highlighted in a DoD Inspector General (DoD IG) report was that from FY1994 to FY2001, traditional defense contractors received 95% of the 209 prototype agreements valued at $5.7 billion (Office of the Inspector General, 2002, p. 11). In addition, a reporter from Federal News Network claimed more recently that from FY2015 to FY2017, NDCs received more of the new OT agreements (66%), but the agreements that went to traditional defense contractors were higher dollar value ($20.8 billion compared to $7.4 billion for NDCs; (Maucione, 2018). This potential risk of OT agreements with traditional defense contractors could show the that flexibility authorized to bring new vendors into the DoD innovation base is not working as intended.

Competition to the maximum extent practicable is encouraged but not mandatory in OTs, which raises concerns over sole source programs; however, FPDS–NG data supports the observation that the DoD competed 89% of new OT prototypes under 10 U.S.C. 2371b (Schwartz & Peters, 2019, p. 16).

Following the congressional discussion regarding the Department of Homeland Security's OT agreements and the expansion of OT authority, the Congressional Research Service published a general report in 2011 overviewing OT authority. Since OTs do not fall under FAR regulations and typical procurement statutes, all aspects of reporting and tracking the agreements proves to be difficult, ranging from contractor performance, functions, and outcomes of OTs. This inevitably leads to challenges in objective evaluation and data collection for other transactions throughout all authorized agencies and the DoD (Halchin, 2011).

A recent GAO decision dismissed a protest on improper evaluation of a proposal from small business MD Helicopters, Inc., on the decision of the Army Futures Command to not use a prototype OT for an acquisition vehicle for a future attack reconnaissance aircraft. Since OTs are not considered procurement contracts, the GAO is not responsible for reviewing protests (GAO, 2019). If an agency has the authority to enter into an agreement under its OT authority, that agreement is not eligible for the Bid Protest Regulations under the Competition in Contracting Act of 1984 (CICA). This means the GAO does not have the discretion to expand its jurisdiction beyond the congressionally-provided CICA limits of "reviewing protests concerning alleged violations of procurement statutes or regulations by federal agencies in the award or proposed award of contracts for the procurement of goods and services, and solicitations leading to such award" (31 U.S.C. 3551(1)).

The GAO does have the authority, however, to review protests on the basis that an agency is "improperly using a non-procurement instrument to procure goods or services," as established through a protest from ACI Technologies in 2019 (GAO, 2019, p.3). In this protest, ACI Technologies, a small business, protested the Navy's solicitation for a consortium for an OT agreement for Strategic & Spectrum Missions Advanced Resilient Trusted Systems on the basis that the solicitation is for a prototype that duplicates existing research (GAO, 2019). The GAO reviewed this case because ACI claimed the Navy was "improperly using a non-procurement instrument to procure goods or services" (GAO, 2019). The S2MARTS OT solicitation was targeted towards innovative prototypes for electromagnetic spectrum, microelectronics, and strategic mission's hardware environments, and ACI already had an indefinite-delivery, indefinite quantity contract for advanced manufacturing technologies in the advanced electronics industrial base (GAO, 2019). Because ACI felt their IDIQ requirements overlapped with the OT solicitation requirements, they protested that the solicitation is not under prototype authority under 10 U.S.C. 2371b and the research under the OT solicitation is duplicative of ACI's already awarded contract. GAO dismissed the protest due to the military departments' authority under 10 U.S.C. 2371 to enter into other transactions and insufficient evidence to prove that the OT solicitation was not for already prototyped projects or for duplicative research (GAO, 2019).

F. OTHER TRANSACTIONS AND INNOVATIVE POTENTIAL

Before Congress expanded OT prototype authority, the DoD's OT obligations increased by 46% between FY2012 and FY2015 (Govini, n.d., p. 4). After the NDAA FY2016 expansion, the DoD OTA obligations increased by 122% (Govini, n.d., p. 4). Overall, the Govini report makes the point that the current definition of an NDC is too broad and does not necessarily correlate to an innovative vendor that is not incentivized to work with the DoD. Instead of accounting for innovation potential for emerging technologies, the Govini report recommends three metrics to assess whether the increased use and authority of OTs is achieving the goal of capitalizing on the best technology in the private sector at a faster pace than in traditional contracting (Govini, n.d.).

The first suggested innovation metric is the innovation force, which compares a company's total obligations to its compound annual growth rate (CAGR) during the same time frame. Ultimately this would show a vendor exhibiting innovation in their business practice. Using this metric, the report determined that 51.7% of DoD OT agreements were with vendors that exhibited at least one of the two components of a "High Innovation Force (high acceleration or high mass), supporting that "OTAs may help the DoD foster a market of vendors with unique technologies or services that could break into the High Innovation Force category and then be contracted with traditionally using FAR contract strategies" (Govini, n.d., p. 8). Innovative force was calculated for RDT&E vendors as well and showed that OTs had a higher proportion of vendors with high acceleration or high mass (51.7% OTA, 43.9% RDT&E).

The second innovative metric was geography and the location of the contract place of performance in order to visualize if there are certain Silicon Valley–type hubs where the OT vendors are concentrated. Essentially, the closer the company is located to a "tech-hub," the higher potential for innovation. The Govini report found that the majority of OTA vendors were concentrated in five cities; however, these cities were not considered high-tech hubs. This was due to the large dollar OT agreements being awarded to consortiums located in non-tech-hub cities, such as Advanced Technology International in Summerville, SC. The consortium masks the location of the companies performing the OTs because the member list can consist of hundreds of innovative companies that may be in Silicon Valley or other technology- rich cities, but the consortium has the agreement and provides the overarching management role (Govini, n.d., p. 9).

The third innovative metric was the use of consortiums. Consortiums allow for business entities, nonprofit, and academics to collaborate on specific technology areas and overall is seen as an advantage for innovative potential. The analysis found that consortiums received 46% of all OTA obligations from FY2012 to FY2018, 34 percentage points more than the share within the RDT&E awards (Govini, n.d., p. 9).

Although the GAO has limited oversight and protest review authority since OTs are not considered procurement contracts, the GAO is still responsible for auditing OT prototype agreements higher than $5 million as directed by the NDAA for FY2000 (Schwartz & Peters, 2019).

The *Other Transactions Guide for Prototype Projects* Other Transaction Guide for Prototypes highlighted three case studies of successful implementation of OT agreements and corresponding outcomes and lessons learned (OUSD(A&S), 2018). In 2017, DARPA entered into a prototype OT agreement for Robotic Servicing of Geosynchronous Satellites in order to partner with the private sector to service government and commercial satellites to repair or upgrade the satellites instead of having to discard them (OUSD(A&S), 2018, p. 6). From using a prototype OT, DARPA was able to implement unique cost-sharing arrangements for payloads and special incentive-based payments in order to leverage creation of a new marketplace for space robotics. DIU executed a prototype OT for the Air Operations Center Pathfinder Program for creation of a new web-based software application to schedule air refueling, designed to replace the current system of scheduling by handwritten methods. DIU and AOC were able to successfully partner and integrate an innovative solution for scheduling efficiencies to be used throughout the DoD by having separate agencies hire individual software developers. This prototype OT was competitively awarded by DIU and Army Contracting Command–New Jersey, but the Air Force entered immediately into a sole source production OT (OUSD(A&S), 2018, p. 8). In

1994, DARPA demonstrated immense success of aircraft development and production success through the use of a prototype OT for an unmanned aerial vehicle (UAV) Global Hawk requiring an altitude of 60,000 feet, the ability to stay in flight for a full 24 hours, and a maximum price of $10 million per aircraft. Unusual to traditional contracts, DARPA was able to constrain the price tag of the UAVs, while allowing for industry ingenuity and trade-offs of different performance parameters and capabilities. The UAV, Global Hawk, also allowed for the contractors to collaborate and share ideas. After narrowing it down from eight different UAV prototypes, the selected prototype was sent into production with a budget of $372 million over a period of seven years. Overall, the program was a tremendous success, especially considering a normal timeline for the development of an aerial vehicle spans two decades (OUSD(A&S), 2018, p. 12).

Measuring innovative potential in future business partners is relevant in assessing whether the risk of investing in certain businesses is worth the potential reward. While there are no standardized innovation metrics, commonly used internal metrics correspond to results such as annual research and development budgets, sales of new products, the number of patents, new product generation versus altering existing products, and active innovation projects in a portfolio within a company. In order to create a more accurate innovation measurement, the metrics should be designed based on what the specific company needs to improve on by first assessing the current innovation practices to make sure they correspond to company goals, tailoring and implementing innovation practices (Richtner, Brattstrom, Frishammer, Bjork, & Magnusson, 2017).

G. AIR FORCE INITIATIVES TO REACH NONTRADITIONAL DEFENSE CONTRACTORS

AFWERX was established by a Partnership Intermediary Agreement under 15 U.S.C. 3715 in 2017 by Secretary of the Air Force Heather Wilson and reports directly to the vice chief of staff of the Air Force. The intent behind creating this organization is to encourage innovation hubs to embrace opportunities for the Air Force from Airmen, academia, and nontraditional contractors (AFWERX, n.d.). AFWERX currently has three locations in Washington, DC; Austin, TX; and Las Vegas, NV. For Airmen, AFWERX has created a Spark Tank where Airmen can propose innovative solutions to any Air Force problem in order to encourage entrepreneurship and innovation from those who see the problems first (AFWERX, n.d.). Internally, AFWERX will support bases and entrepreneur Airmen with Squadron Innovation Funds (AFWERX, n.d.). Attracting nontraditional defense contractors, AFWERX hosts Multi-Domain Operation Challenges where outside sources can demonstrate their artificial intelligence, real-time data analysis, data security techniques, and communication through a decentralized network (outside sources include U.S. or allied nations, individuals, teams, academics, research labs, small businesses, start-ups, and traditional or nontraditional defense contractors for an integrated solution) (AFWERX, n.d.). AFWERX also hosts acquisition events for local vendors in order to introduce Small Business Innovative Research areas of interest. The goal of these events is to find collaborative and innovative solutions and discover vendor capabilities for future contract opportunities. Lastly, AFWERX engages nontraditional vendors through commercial solutions openings (CSO), where innovative commercial items, technologies, or services can be put on a DoD contract after competitively selecting proposals from a general solicitation as authorized under the 2017 NDAA (AFWERX, n.d.).

The Air Force has also started hosting themed Pitch Days showcasing Small Business Innovative Research areas of interest where companies can submit short white papers and function more like a venture capital firm (Slaughter, 2019). The Air Force also awards small contracts on site at these events. The Pitch days have been themed on topics such as space, simulators, artificial intelligence, machine learning, data analytics, rapid sustainment, intelligence, surveillance, reconnaissance (ISR), airborne communications, and hypersonic (Slaughter, 2019).

H. NONTRADITIONAL CONTRACTOR SIGNIFICANCE

In order to fully understand the research question addressed in this study, the significance of why the DoD prioritizes innovation and the use of NDCs is discussed. The United States achieved global technological advantage during the Cold War in nuclear capabilities and in the 1970s with critical advances in stealth, precision, and communications (Govini, n.d., p. 2). While the United States still has the military advantage today, the nature of warfare has changed to trends in artificial intelligence, robotics, cyber, space, and electronic warfare. Also, fast-paced emerging technologies are no longer coming from DoD research, but instead from the private sector. Due to this change, the DoD needs to leverage the private sector's cutting-edge technologies by adapting best practices in the acquisition process and integrating them into military capabilities (Govini, n.d., p. 2).

In today's global security environment, China and Russia are the great power competitors with the United States. China, in particular, has a history of capitalizing heavily on integrating foreign and private sector technologies into its military capabilities.

According to a 2019 Defense Intelligence Agency report, China has

> shifted funds and efforts to acquiring technology by any means available…Domestic laws forced foreign partners of Chinese-based foreign joint ventures to release their technology in exchange for entry into China's lucrative market, and China has used other means to secure the needed technology and expertise. The result of this multifaceted approach to technology acquisition is a PLA on the verge of fielding some of the most modern weapon systems in the world. (Defense Intelligence Agency, 2019, p. 5)

With the rising power status of China and its advances in technology and weapon systems, the United States faces a critical need to develop and modernize for long-term military advantage.

The 2013 Gansler report highlights the critical importance of incorporating non-traditional commercial contractors into DoD acquisitions. In the 1960s the United States was the predominant spender for research, responsible for an estimated 67% of all R&D spending, fueling innovation in the economy. Today, the innovative forces have shifted to the private sector providing over 60% of research funding (Gansler et. al., 2013, p. 6). In order to access commercial technologies, the government enacted a number of acquisition reforms including the Federal Acquisition Streamlining Act of 1994 in order to function more in line with the private sector and reduce the typical DoD culture of risk and lengthy bureaucratic acquisition process. If the DoD is not able to access commercial technologies directly, there is likelihood that commercial firms will sell technologies to the DoD through mediators that will result in a higher cost. The Gansler et al. (2013) report stresses the point that the DoD

> risks falling behind technologically in the future, as commercial companies refuse to modify their commercial-off-the-shelf products to avoid complying with government unique oversight requirements, share their intellectual property with the government for fear of having it released, and invest in cutting edge R&D in the United States but rather move this investment overseas to avoid the reach of U.S. export controls and security requirements. (p. 7)

Overall, to access the advantages of the private sector capabilities, the DoD is recommended to optimize NDCs, expand the use of OTs, and improve market research to better understand the commercial capabilities available (Gansler et. al., 2013, p. 8). If the DoD is not able to effectively incorporate private sector commercial technologies into military requirements, there will be duplicative research and wasted time and funding in research and developments where the technology is already available (Gansler et. al., 2013, p. 2).

The Packard Commission of 1986 was significant in the fact that it "ultimately turned to the problems embedded in the acquisition process and the elimination of barriers which had up to this point discouraged the DoD's acquisition of cutting-edge technologies" (Gansler et. al., 2013, p. 8). The commission emphasized commercial practices to be used in the government and reduced dependence on specifications unique to the military. When commercial technologies are not accessed in an efficient manner, commercial companies are faced with the trade-off of whether they can financially support doing business with the government. Typically, as seen with Boeing and other traditional defense contractors, companies have to create separate business lines in order to specialize in the military unique requirements (Gansler et. al., 2013, p. 12).

The DoD gains advantage not only from leveraging the commercial dual-use technologies, but also in manufacturing techniques and best practices that can result in reduced costs and efficiencies. "Commercial business practices in logistics, transportation, inventory tracking, and other aspects of supply chain management can be emulated in the DoD, if it is open to such money- and time-saving ideas" (Gansler et. al., 2013, p. 23).

In order to understate the current definition of a NDC, it is important to understand the characteristics of what a NDC is not. There are a number of ways to classify what the DoD is purchasing through the industrial base by looking at the specific kinds of goods and services, the contracting types, and technology areas (Gansler et. al., 2013, p. 24). When a good or service is purchased through a traditional defense contractor, familiar names such as Lockheed Martin, Boeing, and Northrup Grumman come to mind. Traditional defense contractors tend to be defined by their large weapon system sales with the DoD resulting a large amount of revenue from the DoD versus the private sector revenue (Gansler et. al., 2013, p. 24). This is not always a reliable measurement, however, because large companies can separate into defense-focused entities, for example, Boeing Defense, Space, and Security from Boeing Commercial Airplanes (Gansler et. al., 2013, p. 24). Another flaw in this measure is due to large companies such as United Technologies and Honeywell, which both have large aggregate defense sales (21% and 13.25% respectively), but the sales are minimal compared to the total sales of the company (Gansler et. al., 2013, p.25). Typically, commercial firms that have been successful with DoD contracts separate their commercial side from the defense side rather than undertaking civil–military integration. Rockwell Collins, however, integrated its civil and military requirements and overall, reduced costs for the DoD and increased efficiencies since separate facilities, management, and other resources are uneconomical (Gansler et. al., 2013, p. 27). The types of contracts and regulations are another way to distinguish between traditional and nontraditional defense contractors. As defined in the statute, a NDC is distinguished from not having a full CAS-covered contract in the preceding year. Logically, this would identify a potential NDC because large traditional defense contractors would already have the CAS practices and structure in place for government-specific regulations and requirements (Gansler et. al., 2013, p. 28). OTs provide a flexible and streamlined tool that would enable NDCs to bypass these regulations if determined unnecessary. Of note, the NDC definition in statute also specifies "entity" rather than contractor, which is important in establishing the defense industrial base because it is inclusive of firms, nonprofits, and academic institutions (Gansler et. al., 2013, p. 31). Finding the ideal definition and classification for an innovative NDC is difficult considering how organizations structure in varying ways in culture, practices, and profit centers, depending on their overall goals and expertise (Gansler et. al., 2013, p. 32).

There are various barriers that impede commercial contractors from sharing their technologies, solutions, and products in government contracts, as described by Gansler et al. (2013). The first barrier is the environmental barrier of working with the government and the inherent time-consuming, regulatory requirements, and reputation risk. In DoD contracts, as Gansler et al. describe, there is an uncommonly high risk if there are compliance issues or criminal liability issues. In addition, there are financial barriers that involve risking manpower, capital, and expertise on program, assuming that the rate of return will be worth taking the risk. Lenders consider the DoD market to be generally high risk, low profit, and non-competitive; therefore companies have issues securing the necessary investment funds from venture capitalists, and banks, especially if there is not already a signed contract in hand (Gansler et. al., 2013, p. 45). Gansler et al. describe a report from the Institute for Defense Analysis which states that overall profits for the DoD were lower than private sector. Of note, in order for the DoD to leverage private sector expertise, profits from the DoD will need to be similar to the private sector in critical areas for emerging information technology to incentivize participation. Another barrier to DoD acquisition that Gansler et al. describe is intellectual property rights, especially considering that IP is the backbone of innovation in a market economy: Congress and the DoD have typically introduced strict IP requirements in government contracts that could result in sharing of proprietary information to competitors or requiring delivery of technical data rights as part of source selection criteria, deterring commercial contractor participation. Unique security requirements with export policies and ITAR restrictions also discourages globalized commercial solutions (Gansler et. al., 2013, p. 56). To circumvent these restrictive requirements, Gansler et al. explain that commercial companies are driven to improve their technologies by selling globally for R&D funding and investment first, and then to the government. Last, unique military specifications and oversight are a barrier to NDC participation. Military specific items, cost and pricing data, determinants of price reasonableness, audits, protests, domestic source preferences (Buy American Act and Berry Amendment), billing issues, and socioeconomic programs are all known barriers to nontraditional commercial participation (Gansler et. al., 2013, p. 63).

Tools to encourage NDC participation in government contracts include the streamlined acquisition procedures of commercial items in FAR Part 12, market research to find readily available commercial alternatives, and rapid acquisition authority to “waive any provision of law, policy, directive, or regulation that would unnecessarily impede the rapid acquisition and deployment of needed equipment to prevent combat fatalities" (Gansler et. al., 2013, p. 70). Also,

> OTA authority offers one of the best ways to access non-traditional contractors and was the vehicle that allowed the DoD to harness new technologies that it would not have been able to access through the traditional acquisition process. … The rollback in its use has kept an entire class of commercial contractors and entities from supporting the Department in its attempts to address acquisition challenges. (Gansler, 2013, p. 67)

Another tool to access NDCs is a government venture capital initiative to provide investment funding. For example, the CIA created In-Q-Tel to fund companies in the commercial market for information technology (IT) and security expertise and can then draw solutions into the government (Gansler et. al., 2013, p.74).

I. MEASUREMENT VALIDITY AND RELIABILITY

Measurement validity and reliability provide insight on research design and whether the model meaningfully tests the concepts it is meant to measure. Measurement validity looks at whether the scores depict the idea that the researcher intends to measure (Adcock & Collier, 2001, p. 529). Some common issues with measurement validity include the lack of shared standards, the relation between measurement validity and the disagreement in the meaning of concepts, measurements that vary in different contexts, and confusing language in measurement procedures (Adcock & Collier, 2001, p. 529). Ideally, scores measured should reflect the ideas in the matching concept and measure what it is meant to measure (Adcock & Collier, 2001, p. 530). In order to fully understand measurement validity, the following definitions are relevant:

> Level 1: Background Concept: Broad constellation of meanings and understandings associated with a given concept.
>
> Level 2: Systematized Concept: a specific formulation of a concept used by a given scholar or group of scholars; commonly involves an explicit definition.
>
> Level 3: Indicators: measures, the operational definitions employed in classifying cases.

> Level 4: Scores for the cases: generated by a particular indicator—include both numerical scores and the results of qualitative classification. (Adcock & Collier, 2001, p. 531)

From these definitions, measurement is valid when level 4 scores, resulting from an indicator in level 3, can be meaningfully analyzed through the correct lens of the systematized concept the variable is designed to operationalize (Adcock & Collier, 2001, p. 531).

Alternative types of validation include content validity, criterion validity, and construct validity. Content validity is how much the indicator represents the systematized concept being measured, criterion validity evaluates the scores of an indicator compared to other variable scores, and construct validity is whether the indicators conform to expectations of the interrelationship (Adcock & Collier, 2001, p. 537).

Reliability estimates “evaluate the stability of measures, internal consistency of measurement instruments, and interrater reliability of instrument scores” (Kimerlin & Winterstein, 2008, p. 2276). The basis of reliability is on the assumption that measuring instruments have a true score if the measurement was accurate and the error in between (Kimerlin & Winterstein, 2008, p. 2277). The reliability estimate in this research uses internal consistency with Cronbach’s alpha (Kimerlin & Winterstein, 2008, p. 2277).

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III. METHODOLOGY

The methodology section explains the data collection from multiple sources and overall descriptive statistics of the data sample subset. Additionally, both the variable operationalization and model specification are detailed in this section.

A. DATA AND SAMPLE

This study provides a spend analysis and an empirical test of a proposed measurement scale for the innovative potential of firms under DoD OT agreements. The methodology of this study is designed to answer the research questions of whether the alternative metrics measure the innovative potential of OTs and have predictive power for classifying firms as nontraditional. The research question is investigated using data from multiple sources because there is not one complete source of data that contains all of the information required in this study. The government maintains award data in FPDS-NG, but does not contain all of the information such as consortium membership or firm type to fully utilization of OT agreements.

1. FPDS-NG Data

First, data was collected from FPDS–NG OT agreements from FY2005 to FY2018. FPDS-NG data must be reported by the DoD and federal agencies within thirty days of contract award and includes all post-award data and important pre-award acquisition decisions, such as the extent of competition and contract type. FPDS-NG incorporates business data from Duns & Bradstreet, particularly linking business information to the DUNS number, used to search for vendor information in SAM API. FPDS-NG is the primary source of federal procurement data, reporting to the Office of the Integrated Acquisition Environment (IAE) and functioned by the General Services Administration (GSA). FPDS-NG is the system used to generate reports and analyses for the Executive Branch and Congress (GSA, 2019, p. 2).

2. Consortium Membership Data

From the DoD OT agreements, consortium member lists were researched and the membership lists of companies, nonprofits, and academic institutions were compiled. If there was an OT award to a large consortium, the entire consortium membership list was found online or through personal contact, matched with SAM API, and added to the primary data set. Some of the consortia member lists included the business classifications into large or small business, non-profit, or academic and whether they fit the binary statutory definition of a nontraditional defense contractor.

3. System for Award Management Application Programming Interface

The vendors from FPDS-NG DoD OT agreements were combined with the consortium member list and matched with the System for Award Management (SAM) API with matching DUNS numbers. Any data fields with unclear multiple matches were not used in analysis.

4. Bloomberg Government Data

The Bloomberg Government data used in the discussion chapter was shared from a federal market analyst in their most recent data report dated March 2019 from Bloomberg Government (C. Cornillie, personal communication, August 5, 2019). Bloomberg Government maintains their own proprietary data source on Government awards and firm characteristics for analytic reports and for contractor knowledge. Bloomberg is a global company with the primary capability of data collection and analytics through innovative technology and reports. Bloomberg Government has two markets, one for government affairs and the other for government contracting. The government contracting market provides data and information for the contractor side of federal procurement and analyze current market trends and news from Congress and policy experts (Bloomberg Government, n.d.).

5. Data Sample

In the data sample, there were 437 observations, 355 of which were classified as nontraditional defense contractors under statutory definition. This calculates to 19% traditional and 81% nontraditional vendors. Even using multiple sources of data, it was not reasonable to gain access to all firms involved with OT agreements within the DoD. Over 5,000 firms were identified for this research but after restricting to firms that contained all data fields, the data subset was reduced. The data subset was further reduced to 437 after data fields such as total obligations contained 0s, because calculations such as compound annual growth rate would not have numerical meaning. Even with the restriction of data, the sample subset was large enough to be representative of the general population of firms.

Figure 1 and Figure 2 depict the breakdown of contractor classifications in the data sample, divided by traditional contractor status and nontraditional defense contractor status. From the figures, it is evident that the data sample contains traditional contractors that are primarily academia members and large businesses. Figure 2, on the other hand, shows that the nontraditional defense contractors from the data sample are a majority of small businesses.

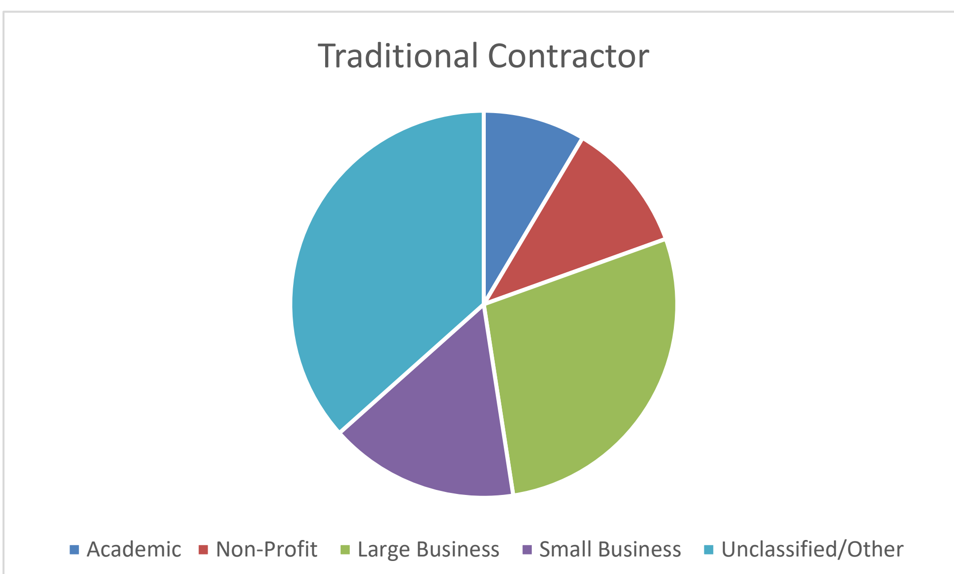

Figure 1. Traditional Contractor Classifications in Data Sample

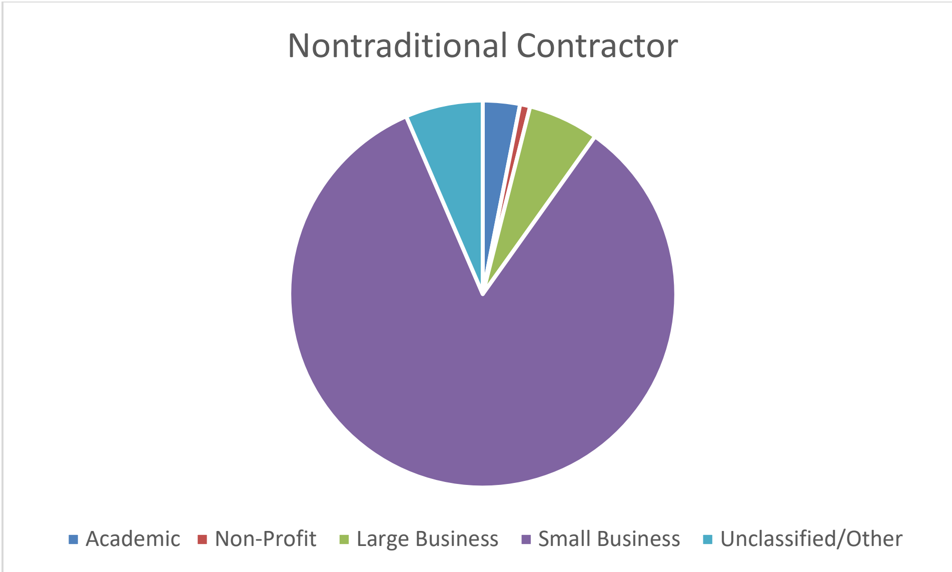

Figure 2. Nontraditional Defense Contractor Classifications in Data Sample

Table 9 highlights the data sample contractor classifications numerically, rather than in pie chart style above. As mentioned, the majority of the data subset contains small businesses classified as nontraditional, 297 of the 437 firms.

Table 9. Data Sample Contractor Classifications

	Nontraditional	**Traditional**
Academic	11	7
Nonprofit	3	9
Large Business	21	23
Small Business	297	13
Unclassified/Other	23	30
Total	355	82

The data sample descriptive statistics are detailed in Table 10. The minimum distance to a tech-hub was calculated in miles, but was also log-transformed for skewness, explaining the corresponding mean and standard deviation. The nontraditional status is a binary variable, therefore the mean of 0.81 reflects that the data sample contained more nontraditional defense contractors (binary value 1), versus traditional contractors. The total

DoD obligations to a firm was calculated in millions, a more reasonable scale for the high dollar values in the data set.

Table 10. Data Sample Descriptive Statistics

Variable	**Mean**	**Std. Dev.**
Nontraditional Status	0.812357	0.3908743
Distance to Tech-hub	4.143765	1.508657
CAGR	-0.0921841	.4982487
Total Obligations	1.10e+08	5.92e+08

B. VARIABLE OPERATIONALIZATION

This research measures the three proposed metrics using FPDS-NG and SAM API data, and conducts a logistic regression model to test how the variables effect the classification of the vendor as traditional or nontraditional. The multi-item scale of these alternative metrics has not been empirically examined. A summary of the operationalization of variables is detailed in this section.

The Govini (n.d.) report investigates alternative ways to measure innovative potential, scrutinizing the current definition of a nontraditional defense contractor as not specific enough and not necessarily correlating to an innovative vendor that is not incentivized to work with the DoD. The Govini report recommends three metrics to assess whether the increased use and authority of OTs is achieving the goal of capitalizing on the best technology firms in the private sector at a faster pace than in traditional contracting.

1. Variables

(1) Nontraditional Defense Contractor: The variable of whether or not an entity is defined as a nontraditional defense contractor is binary

Either the company fits the nontraditional definition under 48 CFR 212.001, or it does not. This research is interested in the factors that influence whether a contractor or company is considered "innovative" or nontraditional—this test will see how variables affect the classification of a company as innovative.

(2) Compound Annual Growth Rate (CAGR)

The DoD is encouraged to repeat research and development business with vendors that demonstrate innovation; therefore more innovative vendors would ideally have an increased sum of total obligations and compound annual growth rate. The compound annual growth rate from DoD contracts was calculated from FPDS-NG and SAM data from obligations FY2012–FY2018. CAGRs from firms with an initial total obligation of 0 in the first year were not able to be calculated and therefore eliminated from the subset.

(3) Sum of Total Obligations

The sum of total obligations was calculated from FY2012–FY2018. The sum of total obligations was scaled to millions of dollars for a more appropriate scale for the high data values.

(4) Distance to the Nearest Tech-Hub

In order to determine the tech-hubs, the U.S. Equal Employment Opportunity Commission researched the high-tech sectors in the United States defined as "industries that employ a high concentration of employees in science, technology, engineering and mathematics occupations and the production of goods and services advancing the use of electronic and computer-based production methods" (EEOC, 2014, p. 1). The top high-tech geographic areas are listed in Table 11.

Table 11. Top High-Tech Geographic Areas. Adapted from EEOC (2014).

Area	Total High-Tech Employment
New York-Newark-Jersey City, NY-NJ-PA	363,444
Los Angeles-Long Beach-Anaheim, CA	269,452
Washington-Arlington-Alexandria, DC-VA-MD-WV	266,378
San Jose-Sunnyvale-Santa Clara, CA	257,349
Boston-Cambridge-Newton, MA-NH	224,533
Seattle-Tacoma-Bellevue, WA	197,046
Dallas-Fort Worth-Arlington, TX	189,615
Chicago-Naperville-Elgin, IL-IN-WI	181,721
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	130,582
Atlanta-Sandy Springs-Roswell, GA	128,296

Latitude and longitudinal coordinates were found for each of the 10 city high-tech-hubs. This list of cities was compared to other non-government sources to find similarities. When compared with CompTIA's 2018 Tech Town Index, which ranked cities with demand for tech workers, cost of living, number of open IT positions, and projected job growth, the majority of cities in the EEOC report matched with the index (CompTIA, 2018).

Since many companies leading in their field of expertise are located in areas surrounded by businesses, universities, and institutions for certain technology, such as Silicon Valley, Boston, or Pittsburgh, the shorter distance to a tech-hub should correlate to a more innovative firm. The place of performance of the contract zip code was a tested assumption to generally equal the same value as the vendor office zip code in SAM. This vendor place of performance location was converted to latitude and longitude coordinate pairs. The coordinate pairs of the 10 cities in the EEOC report table were also found. The distances between each vendor place of performance and each tech-hub city location was found using the Spherical Law of Cosines formula and calculated in miles.

The Spherical Law of Cosines was used to calculate the distance between two pairs of coordinates, from the vendor's place of performance to the nearest tech-hub.

$$d = acos(sin\varphi_1 * \ sin\varphi_2 + cos\varphi_1 * \ cos\varphi_2 * cos\Delta\lambda) * R$$

$$\boldsymbol{\lambda} = \text{longitude of coordinate pairs}$$

$$\varphi_1 = latitude\ of\ coordinate\ pair\ 1$$

In Microsoft Excel, the minimum function was used to find the minimum distance between the place of performance and the closest tech-hub city in the unit of miles. This was the minimum distance to a tech-hub used in analysis. The distance to a tech-hub was log-transformed for skewness.

(5) Membership in a Consortium

Membership in a consortium is seen as an innovative strength since consortiums collaborate with large and small businesses, non-profits, and academic institutions centered around technical areas of expertise. Membership lists of consortiums which the DoD has OT agreements were found online or through personal communication and compiled.

C. MODEL SPECIFICATION

In order to answer the research questions, this study used a logit model—or logistical regression—in order to model dichotomous outcome variables (UCLA, n.d.). Logistic regression uses the log odds modeled as a linear combination of the predictor variables, which in this case are the minimum distance to a tech-hub, compound annual growth rate, and the sum of total obligations (UCLA, n.d.). Logistic regression predicts and explains a binary categorical variable (nontraditional defense contractor: yes or no) and estimates the relationship between the dependent variable and a set of nonmetric independent variables (Hair, Black, Babin, & Anderson, 2010, p. 317). The logistic regression model is widely used because it does not require the assumptions of multivariate normality and equal covariance, as required in discriminant analysis. Also, logistic regression has forthright statistical tests and a range of diagnostics (Hair et al., 2010, p. 320). The objective of logistic regression is to identify the "independent variables that impact group membership in the dependent variable and establish a classification system based on the logistic model for determining group membership" (Hair et al., 2010, p. 320).

The model estimates the variables in the following form:

$$Y_1 = X_1 + X_2 + X_3 + \cdots + X_n$$

(binary nonmetric) (nonmetric and metric).

The resulting outputs of this model are logit values and odds ratios (Hair et al., 2010, p. 320). The model is determined to be statistically significant comparatively to a null model. Once determined to be statistically significant, the confusion matrix quantifies the predictive accuracy (Hair et al., 2010, p. 322).

1. Sample Size

The sample size was considered relevant in this model because if the sample is too small, sampling error would be too high and invalidate the results (Hair et al., 2010, p. 322). With the combined FPDS-NG, consortium member list, and corresponding SAM data, there were over 5,000 data entries; however, some of the entries did not have every data field filled in. Those data entries with missing cells were not included in analysis. In addition, those data entries with clearly inaccurate data, such as misclassifications or all 0s in obligations were eliminated due to being unreliable or useable to calculate compound annual growth rate. Even without the missing value cells, the observed sample size was over 400, which meets the Hosmer–Lemeshow recommended sample sizes for maximum likelihood estimation technique greater than 400. This means the size is appropriate to support estimation of the logistic model (Hair et al., 2010, p. 322). The sample sizes for each dependent variable is recommended to be at least 10 observations per estimated parameter, which is also available in this data set (Hair, 2010, pp.322).

The formula shows the model estimation. The coefficients for the independent variable of nontraditional status are estimated with odds values for the four dependent variables (Hair et al., 2010, p. 326). In this research, the log odds value is displayed in the table of logistic regression results.

$$Logit_i = ln\left(\frac{prob_{event}}{1 - prob_{event}}\right) = b_0 + b_1X_1 + \cdots + b_nX_n$$

The goodness of fit formula for pseudo R^2 is shown. A perfect model fit has a R^2 logit of 1 (Hair et al., 2010, p. 327).

2. Cross Validation

In order to validate the results and ensure external and internal validity, random numbers were assigned to data fields and the logistic model was reapplied to cross-validate the predictive accuracy (Hair et al., 2010, p. 333). Fifteen percent of the data was withheld and used for cross-validation of the logistic regression model to validate performance of the model and assess how it generalizes to the population.

$$R^2_{LOGIT} = \frac{-2LL_{null} - (-2LL_{model})}{-2LL_{null}}$$

3. Interaction Variable

The advantage of adding an interaction variable to a logistic regression model is that it provides more information of the effect of an independent variable on a dependent variable based on different levels of another dependent variable, which if correlated, could demonstrate an amplifying effect as compared to the separated dependent variables. The interaction variable overall is a manipulated variable that assesses the effects of Z at different levels of X from the equation (Spiller, Fitzsimons, Lynch, & McClelland, 2013) For the interaction variable in this model, the sum of obligations and compound annual growth rate were mean centered and were not log-transformed for skewness. The sum of obligations was also scaled to millions per unit for relevance of the data.

$$Y = a + bZ + cX + dZX$$

The Govini (n.d.) study theorizes that CAGR and the sum of obligations from DoD contracts are closely related and if combined into one variable, could have an amplifying effect for "innovative force" (p. 7). Overall, it is hypothesized that if a vendor has both a high compound annual growth rate and a large sum of total obligations, mass and acceleration of the company, then it would be considered to have high innovative potential.

IV. RESULTS

A. LOGISTIC REGRESSION RESULTS

A logistic regression of nontraditional status on four dependent variables (distance to a tech-hub, consortium membership, CAGR, and total obligations) fit significantly better to the data than a null model $\chi^2(4) = 32.01, p < .01)$ and correctly predicted nontraditional status for 79.6% of vendors based off pseudo R. Table 12 displays the estimations of the model. We are unable to conclude, based upon the results of the chi-square testing of distributions that the data subset of 437 firms, traditional and nontraditional differ significantly from those in a larger random sample or generalized population.

Table 12 includes the log odds coefficient and p-values for both model 1 and model 2. Model 1 is the logit model including the original dependent variables of the minimum distance to a tech-hub, mean centered sum of total obligations, and mean centered compound annual growth rates. Model 2 reevaluates the logistic regression including the interaction variable between the sum of total obligations and compound annual growth rate. From the output, Model 2 with the interaction variable was more significant than Model 1 and had a deviance of 23.57 for Model 1 with three degrees of freedom compared to a deviance of 14.39 for Model 2 with one additional degree of freedom. The deviances show the improvement level of the model for prediction nontraditional defense contractor status.

Table 12. Logistic Regression Results

	Model 1		Model 2	
	Estimate (log odds coefficient)	P(>|z|)	Estimate	P(>|z|)
Intercept	1.0170557	0.01545*	0.454834	0.337590
Log Min	0.1469827	0.14769	0.121040	0.246839
Sum centered	-0.0018664	0.00825**	-0.008481	0.000381***
CAGR Centered	0.5771126	0.05739	5.713344	0.001251**
Interaction			0.050195	0.002721**

Note: n = 437; *p < .01, **p < 0.001, ***p< 0.

Table 13 includes the confusion matrix which quantifies the prediction odds of the logit model. From the results, the model is able to classify a nontraditional defense contractor more effectively than a traditional contractor. The results also show the imbalance of the data sample with the majority of the data samples as nontraditional defense contractors versus traditional.

Table 13. Confusion Matrix

Prediction	Traditional	Nontraditional
Traditional	5	0
Nontraditional	18	65

$$\boldsymbol{\chi^2(3) = 31.49\ p < .01}$$

Table 14 shows the correlation matrix, with the pairwise correlations between variables. Overall, the correlation matrix depicts the relationships between variables, whether they move together and the nature of its linear relationship.

Table 14. Correlation Matrix

	Nontraditional	**Tech-hub**	**Total Oblig.**	**CAGR**
Nontraditional	1.0000			
Tech-hub	0.1703	1.0000		
Total Oblig.	-0.1637	-0.0998	1.0000	
CAGR	0.0559	0.0628	0.04768	1.0000

Figure 3 is the graph of the two-way interaction variable between the total sum of obligations and compound annual growth rate. This shows the amplifying effect of RDT&E obligations on CAGR in predicting the classification of a firm as nontraditional. One standard deviation below and above the mean are included because it shows the higher than average obligations effect and the lower than average obligation effect on CAGR in predicting nontraditional contractor status. The higher the CAGR of a firm, the more likely the firm will be a nontraditional contractor. Firms with high CAGR and total obligations have higher probability of being a nontraditional contractor, conforming with the Govini (n.d.) explanation of a highly innovative force. The lower than average DoD obligations with a low CAGR had a higher probability of classification as a nontraditional defense contractor. Low CAGR combined with high total obligations had a higher probability of being classified a traditional contractor.

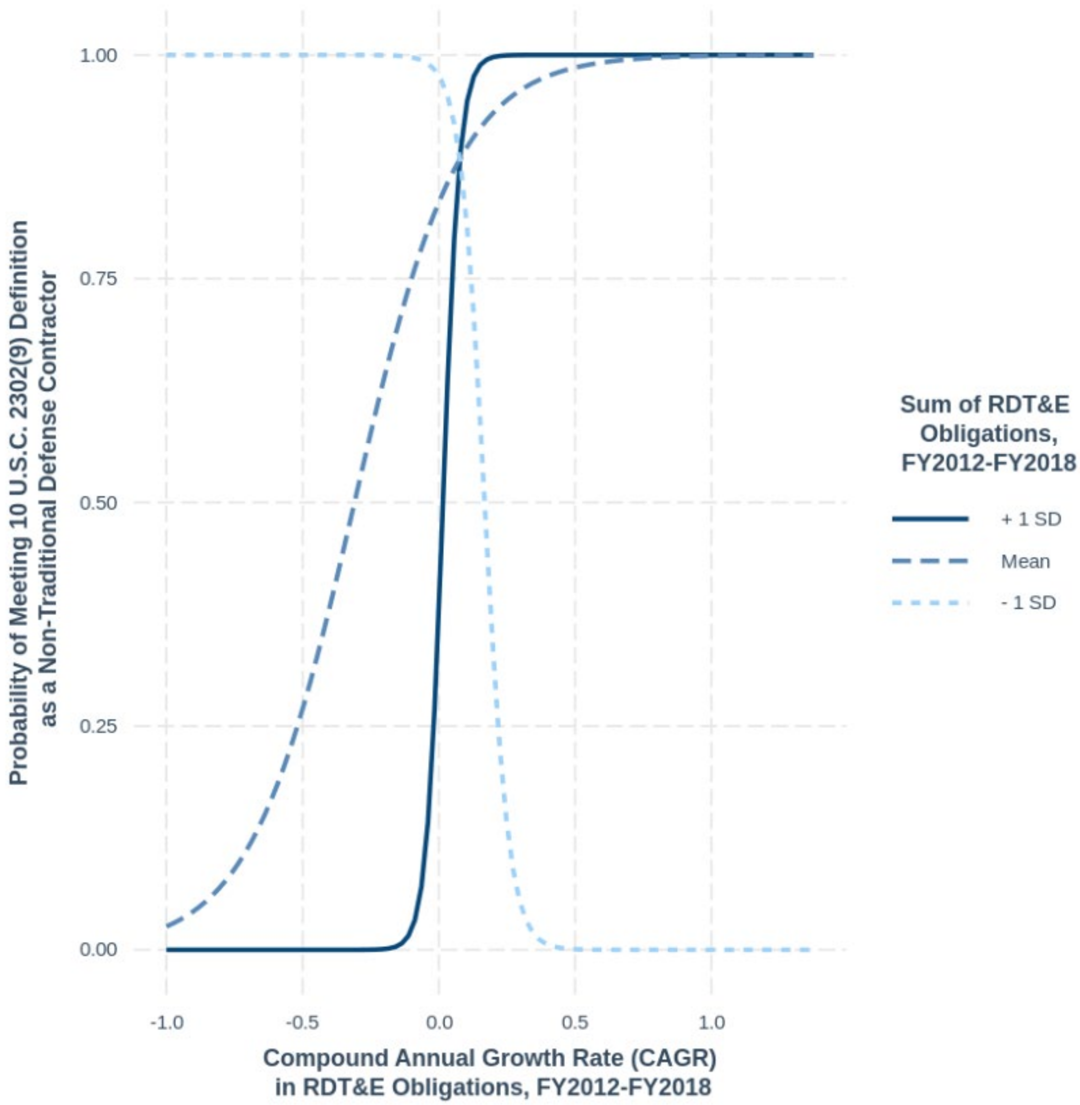

Figure 3. Two-Way Interaction Variable

1. Scale Reliability Coefficient

The scale reliability coefficient, the measure of internal consistency determining how closely related a set of items are as a group was found to be 0.0843. This value is very low, meaning the measure of internal consistency is not a good fit or reliable. With the low scale reliability, it is worth examining the measurement validation of this logistic regression model. It is important to ensure that the model tests the concepts it is meant to measure. There could be issues with measurements that vary in different contexts, such as the compound annual growth of an entity, using only DoD obligations, not the entity's overall financial status. Also, the indicator of distance of a tech-hub, could not be an indicator of innovation of a nontraditional defense contractor due to the increased communication access. Distance to a tech-hub city may no longer be necessary or a valid indicator. There is also the possibility that key elements could be missing or that the indicators fail to capture the full content of the desired systematized concept (Adcock & Collier, 2010, p. 539).

B. SPEND ANALYSIS

The results are from the FPDS-NG OT data spend analysis. The first figure shows that there is a significant increase in OT agreements federally from FY2005–FY2018. This increased use goes hand in hand with the widened latitude of OT authority with the NDAAs, particularly with the NDAA FY2016 allowing prototyping OTs throughout the DoD. In addition, comparing the new awards compared to all actions shows the majority of actions are modifications rather than new awards, similar to in traditional FAR-based procurement FPDS-NG data.

Figure 4 illustrates the significant increase in new OT new agreements (without modifications) in the DoD comparatively to all federal agreements. The main increase of OT use begins with the FY2016 NDAA authorizing prototyping to the DoD.

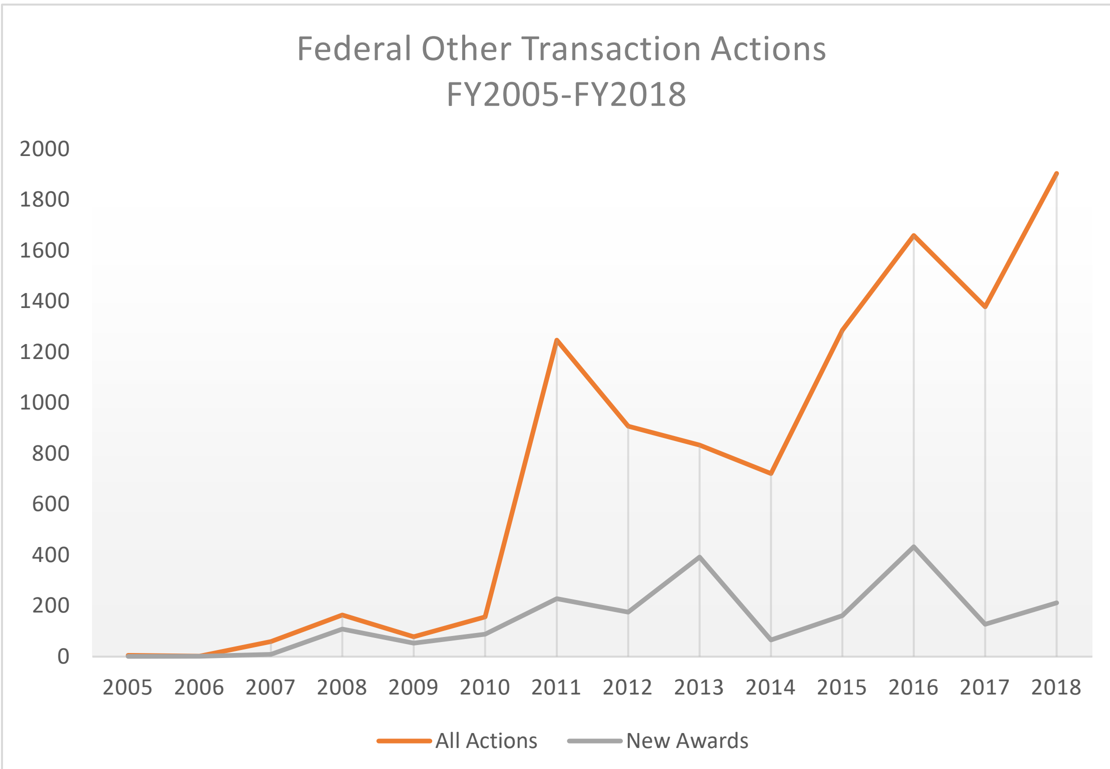

Figure 4. OT Agreements (Awards and Modifications)

Figure 5 shows that the Army has the highest OT obligation amounts, increasing significantly in recent years. From the DoD departments, the Air Force is second in OT obligations, followed by the Navy. The Transportation Security Administration and Office of Procurement Operations (OPO) are included in this figure and have comparable OT spend to the DoD departments.

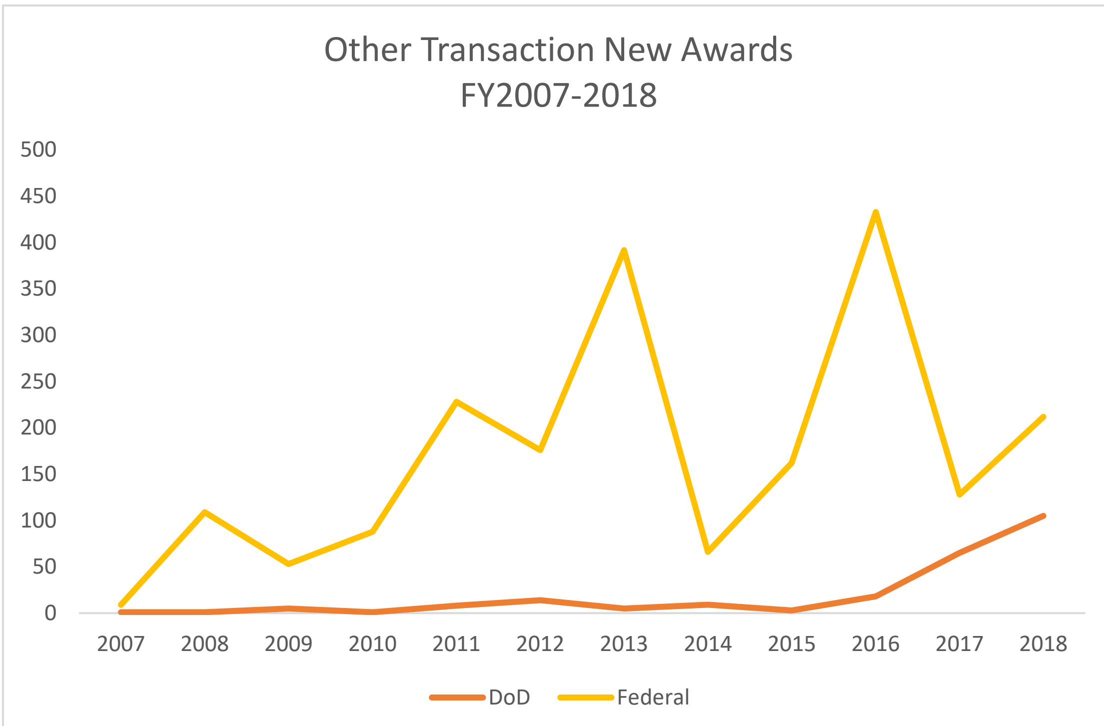

Figure 5. DoD OT New Agreements vs. All Federal Agencies

Figure 7 uses the same OT obligation data as Figure 6 but removes the Army's OT obligations to achieve a better scale for the other agencies. From this graph, there is a general upward trend of OT use. In FY2016, the Air Force awarded a $99 million indefinite delivery indefinite quantity OT agreement for open system initiatives and prototype projects. The OT was issued by the Air Force Research Lab to SOSSEC, Inc., a consortium located in New Hampshire. In FY2016 alone, there were 42 modifications for supplemental agreements for work within scope.

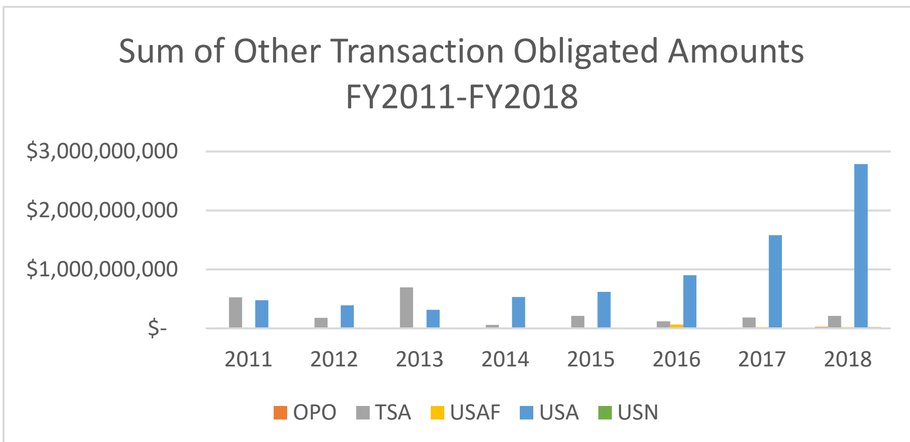

Figure 6. Sum of OT Obligated Amounts

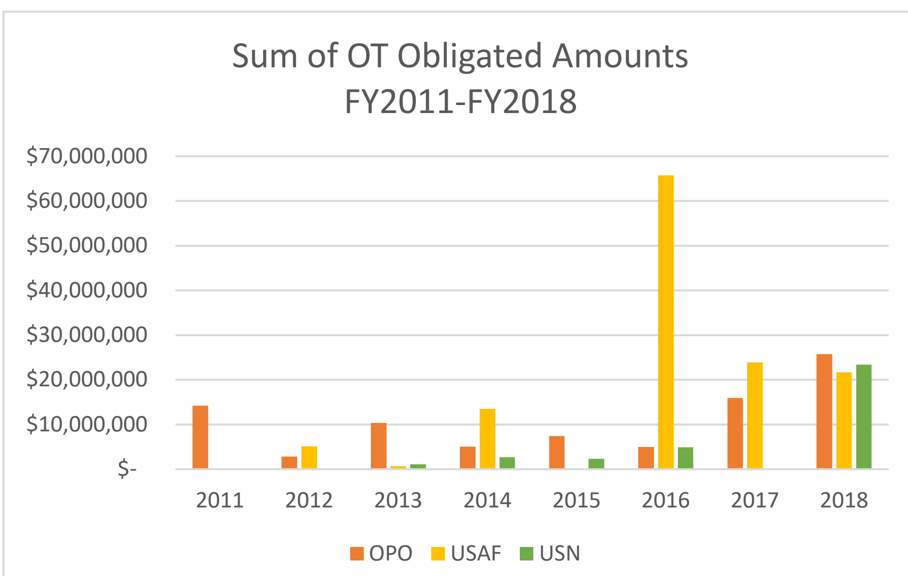

Figure 7. Sum of OT Obligated Amounts

Table 15 identifies the companies with the highest base and option year OT agreements. The table has highest base and all option values and the corresponding vendor names.

Table 15. DoD FPDS-NG data FY2014–FY2018: New OT Agreements—Highest Base and All Options Values

Company	Vendor Location	Contract Requirement	FY	Base & all options	Department
Advanced Technology International	Summerville, SC	Medical Countermeasure Systems – R&D into medical, pharmaceuticals, and diagnostic technologies	2016	$10 billion	Army
Advanced Technology International	Summerville, SC	Countering Weapons of Mass Destruction OTA	2018	$10 billion	Army
Advanced Technology International	Summerville, SC	DOTC OTA Base agreement	2018	$10 billion	Army
Consortium Management Group, Inc.	Washington, DC	Masked	2017	$2 billion	Army
Consortium Management Group, Inc.	Washington, DC	Masked	2017	$2 billion	Army
National Center for Manufacturing Sciences, Inc.	Ann Arbor, MI	New Competed Ground Vehicle System (GVS)	2017	$2 billion	Army
Advanced Technology International	Summerville, SC	Spectrum OTA Base Agreement	2018	$2 billion	Army
Advanced Technology International	Summerville, SC	Prototype	2015	$1.2 billion	Army
United Launch Services, LLC	Centennial, CO	Agile Systems Development	2025	$967 million	AF
Rean Cloud, LLC	Herndon, VA	Prototype	2018	$950 million	Army

Since the majority of the highest value OT agreements are issued by the Army, the Air Force and Navy OT agreements are shown in Tables 16 and 17.

Table 16. Air Force OT Base and All Options, FY2014–FY2018

Company	Vendor Location	Contract Requirement	Fiscal Year	Base and All options	Department
United Launch Services, LLC	Centennial, CO	Prototype	2025	$967 million	AF
Orbital Sciences Corporation	Chandler, AZ	Prototype	2025	$792 million	AF
Blue Origin, LLC	Kent, WA	Prototype	2025	$500 million	AF
Aerojet Rocketdyne of DE, Inc	Canoga Park, CA	AR1 Rocket Propulsion System Prototypes for EELV (Evolved Expendable Launch Vehicle) Program	2020	$115 million	AF
Advanced Technology International	Summerville, SC	Applied Research/ Exploratory Development	2022	$100 million	AF

Table 17. Navy OT Base and All Options, FY2014–FY2018

Company	Vendor Location	Contract Requirement	Fiscal Year	Base and All options	Department
Advanced Technology International	Summerville, SC	Information Warfare Research Project	2018	$100 million	Navy
Elemental Excelerator, Inc.	Honolulu, HI	Infrastructure and Energy Technology Commercialization	2018	$30 million	Navy
Honeywell International, Inc.	Plymouth, MN	Compact MEMS precision azimuth system	2014	$15.3 million	Navy
George J. Kostas Research Institute	Burlington, MA	Advancing Warfighter Technologies in the Area of Expeditionary Cyber	2018	$12.3 million	Navy
Advanced Technology International	Summerville, SC	Persistent Acoustic Detection through Reef Ecological Soundscapes (Padres)	2018	$750,000	Navy

The Army, Navy, and Air Force all have OT participation from Advanced Technology International. The Air Force's OTs are primarily for rocket propulsion system prototypes. The Navy has the lowest dollar value OT agreements overall.

Tables 18 through 20 are created from the same FPDS-NG data from FY2014–FY2019 but are based on the total obligated amounts not the base and option years. This shows the actual amount of funding placed on the agreements and the requirement. There is a difference with the obligated amounts because where the Army had the largest indefinite vehicle OTs for use, the Air Force has actually obligated more money on the OT agreements.

Table 18. OTs Highest Obligations, FY2014–FY2018

Company	Vendor Location	Contract Requirement	Fiscal Year	Obligated Amount	Department
Aerojet Rocketdyne of DE, Inc	Canoga Park, CA	AR1 Rocket Propulsion System Prototypes for EELV (Evolved Expendable Launch Vehicle) Program	2020	$115.3 million	AF
United Launch Services, LLC	Centennial, CO	Prototype	2025	$109 million	AF
Orbital Sciences Corporation	Chandler, AZ	Prototype	2025	$109 million	AF
Blue Origin, LLC	Kent, WA	Prototype	2025	$109 million	AF
AT&T Corp.	Oakton, VA	Network as a Service Experiment – Risk Reduction Effort	2020	$74.6 million	AF
ATK Launch Systems, Inc.	Magna, UT	Common Booster Segment, BE-3U Extendable Nozzle, and GEM 63L Rocket Propulsion Systems Prototypes for the Evolved Expendable Launch Vehicle	2019	$47 million	AF

Company	Vendor Location	Contract Requirement	Fiscal Year	Obligated Amount	Department
Space Exploration Technologies Corp	Hawthorne, CA	Raptor Rocket Propulsion System	2019	$33.7 million	AF
Microsoft Corporation Sitz in Redmond	Redmond, WA	Network as a Service Experiment – Risk Reduction Effort	2020	$33.3 million	AF
United Launch Services, LLC	Centennial, CO	AR1 Rocket Propulsion Systems Prototypes for EELV	2019	$26.3 million	AF
Rean Cloud, LLC	Herndon, VA	Agile Systems Development	2018	$14.1 million	Army

Since the majority of the highest OT obligations are from the Air Force, the Army and Navy's OTs are detailed in Tables 19 and 20.

Table 19. Army OT Obligations, FY2014–FY2018

Vendor	Vendor Location	Requirement	Fiscal Year	Obligated Amount	Department
Rean Cloud, LLC	Herndon, VA	Agile Systems Development	2018	$14.1 million	Army
Dynetics, Inc.	Huntsville, AL	Award Under DIUx AOI Hardware to Software Transformation	2018	$13.0 million	Army
World Wide Technology, Inc	Maryland, MO	Tanium Enterprise Endpoint Management Software	2016	$12.7 million	Army

Table 20. Navy OT Obligations, FY2014–FY2018

Vendor	Vendor Location	Requirement	Fiscal Year	Obligated Amount	Department
George J. Kostas Research Institute	Burlington, MA	Advancing Warfighter Technologies in the Area of Expeditionary Cyber	2018	$12.3 million	Navy
Elemental Excelerator Inc.	Honolulu, HI	Infrastructure and Energy Technology Commercialization	2018	$2.0 million	Navy
Honeywell International Inc.	Plymouth, MN	Compact MEMS precision azimuth system	2014	$964,000	Navy

Consortiums demonstrate innovative potential for the DoD due to the collaboration of businesses, nonprofits and academic institutions in specified technology areas.

Figure 8 shows the distribution of the 39 new OT agreements to consortiums in FY2014–FY2018. There were a total of 215 new OT agreements, 18% of which were to consortiums rather than individual firms. Although the number of agreements to consortiums was in the minority, the values of the OT agreements were among the highest. With the multiyear base and all options values from FY2014–FY2018, OT agreements to consortiums account for $42.2 billion out of $47.1 billion. This is 89% of the base and option year funding to consortiums. Using the actual obligations, $56.5 million of obligations out of $954 million were to consortiums, only 6%. This data reflects that large indefinite vehicle OT agreements were given to consortiums, but the majority of OTs with products are to individual entities.

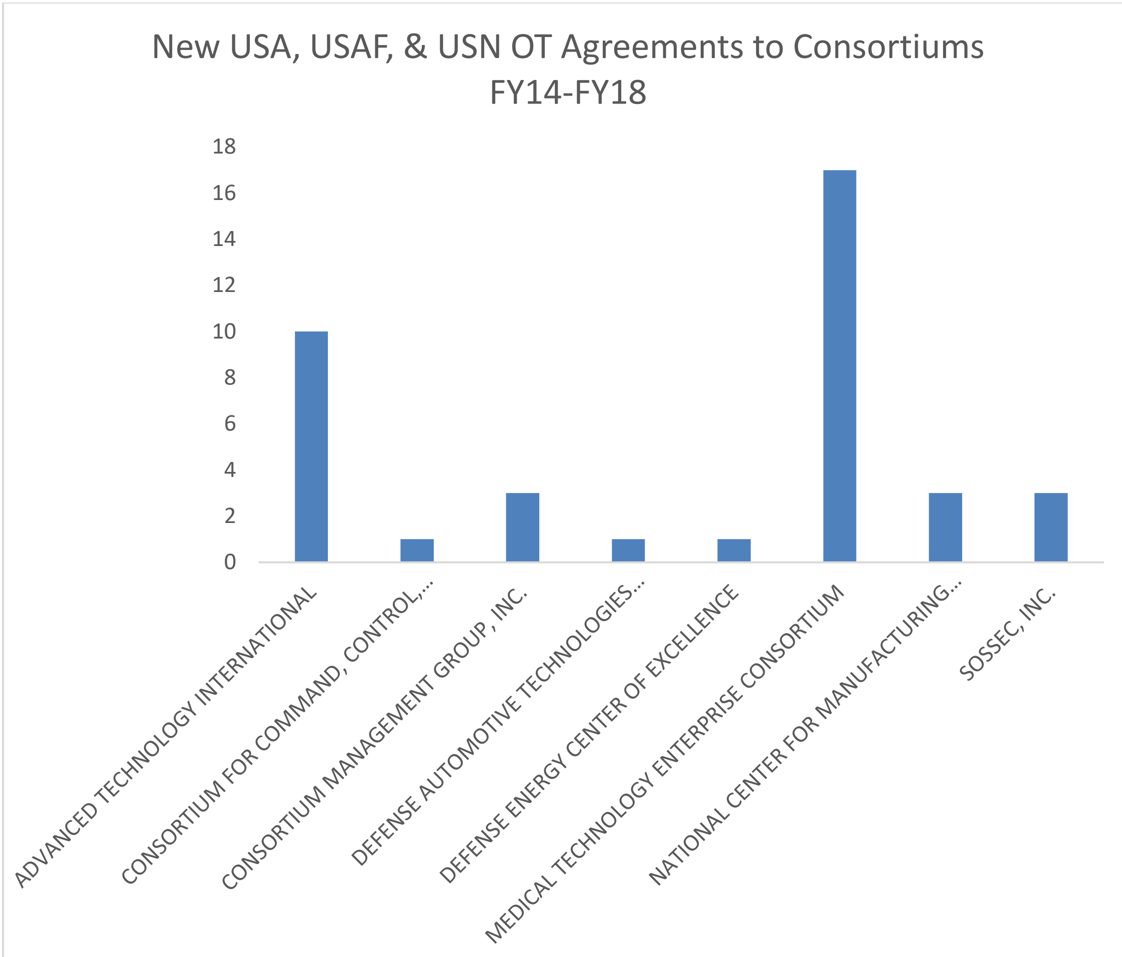

Figure 8. OT Agreements to Consortiums

V. DISCUSSION

Analyzing multiple sources of OT data helps policy-makers in making informed and educated decisions and illustrates trends for the increasingly utilized acquisition tool of an OT. Being able to measure innovative potential of companies is critical to the DoD's ability to advance with innovation through prototyping and follow-on production with companies with expertise and knowledge not currently being tapped into by the DoD. If the current binary statutory definition of a NDC does not correctly classify those companies the DoD aims to leverage, then the DoD is missing out on opportunities to fully leverage the special authority of an OT. In addition, this study helps provide initial information on the firms receiving DoD OT agreements in order to identify the best methods and incentives to encourage NDCs to work with the government utilizing OTs and the common characteristics and organizational structure of the contractors receiving DoD OT agreements. In today's complex security environment of rapid technological change, companies that are postured for fast technological adoption and innovative prototypes are most relevant and critical in DoD acquisition.

The minimum distance to a tech-hub resulted in a relatively low positive relationship, meaning the closer to a tech-hub location, the more likely the vendor to be classified as a nontraditional defense contractor. The relationship may not have been a strong of a predictor of innovation because the minimum distance to a tech-hub may not be a reliable measure for innovation due to modern communications and ease of travel. As supported by the Gansler et al. (2013) report as well,

> for many companies, location matters less to their increasingly virtual and global workforce…This is equally true for small startups without the time or money to pursue work permits, but that do have access to shared virtual workspaces and overnight shipping…Many companies have found they can maintain around the clock progress on critical discoveries by handing off results across time zones as one shift leaves the lab and another arrives for work. (p. 17)

In addition, the Govini report (n.d.) found that OTAs were focused in five cities, none of which were tech-hubs, because they were the consortium office location. Because of this, this metric was not useful in the Govini report, but in this analysis, instead of using the consortium locations, the membership companies and their locations were used to assess distances to the nearest tech-hub. There was a negative relationship between the sum of total obligations and the probability of being classified as a nontraditional contractor. This means the higher the DoD obligations to the firm, the less likely the firm would be a nontraditional. If a firm has a high amount of DoD obligations, there is a higher likelihood they would be subject to higher CAS covered contracts and be a traditional contractor.

From the FPDS-NG spend analysis of consortiums, the data mirrored the Bloomberg Government results with the top consortium management firms of ATI, Consortium Management Group, Inc., and the U.S. National Center for Manufacturing Sciences. Of note, however, is that the obligation rate is significantly lower than the base and option years for DoD OT agreements, showing that consortiums are more likely to be involved in indefinite vehicle OT agreements.

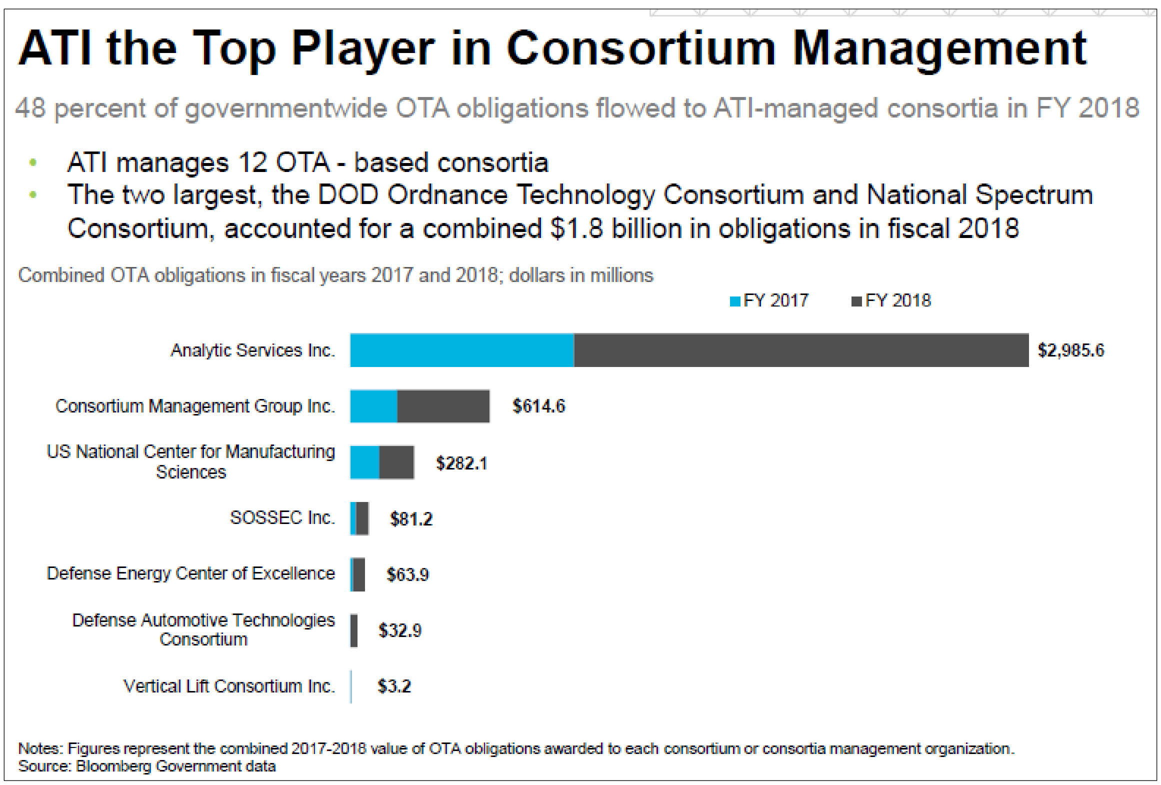

Figure 9. ATI Consortium. Source: C. Cornillie (email to author, August 5, 2019).

In addition, the only consortium webpage to include more than just membership information was the National Spectrum Consortium. As shown in Figure 9, Bloomberg Government chart, the National Spectrum Consortium publishes which member company, nonprofit, or institution received the OT agreement and the associated dollar value. The majority of OT awards went to their members classified as NDCs, which emphasizes the importance of ensuring that vendors are being correctly classified as NDCs to utilize their innovative potential.

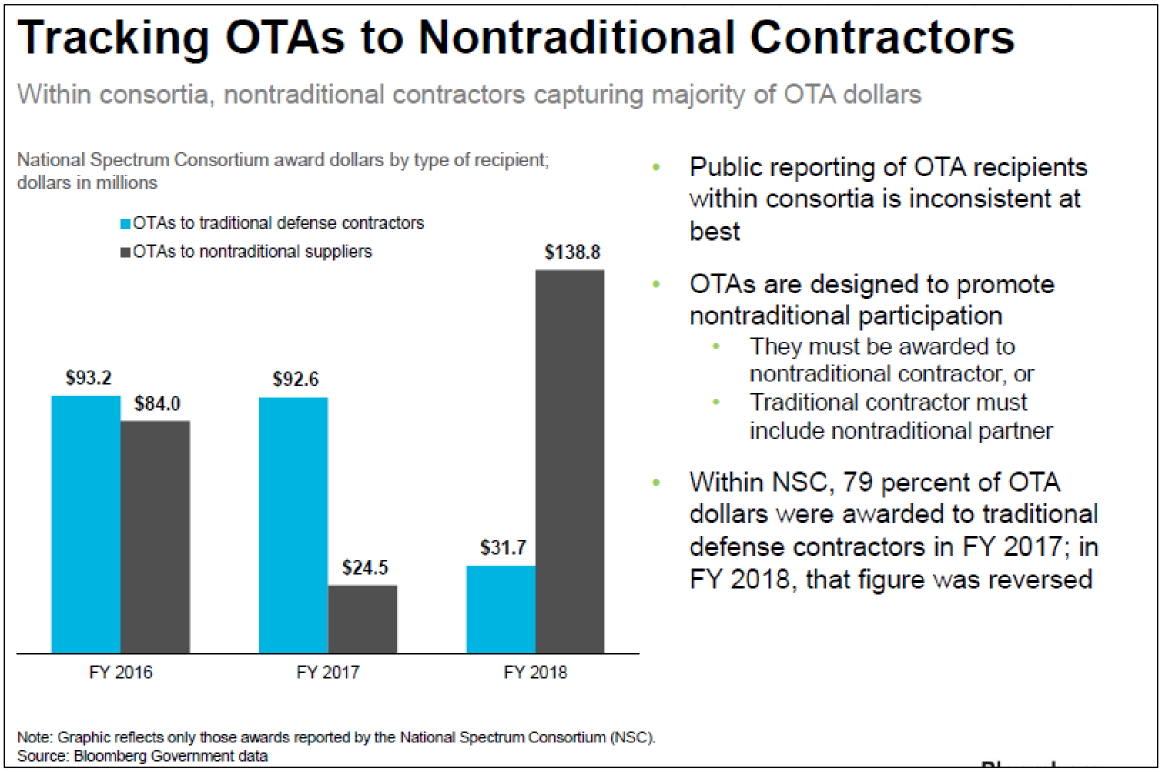

Figure 10. OTs to Nontraditional Defense Contractors, Source: C. Cornillie (email to author, August 5, 2019)

While a large amount of OT funding is going to large defense contractors, it is important to note that they could have the OT agreements if they have participation from a nontraditional contractor or subcontractor to a significant extent, again showing the importance of appropriate definitions and metrics for nontraditional vendors and innovation potential.

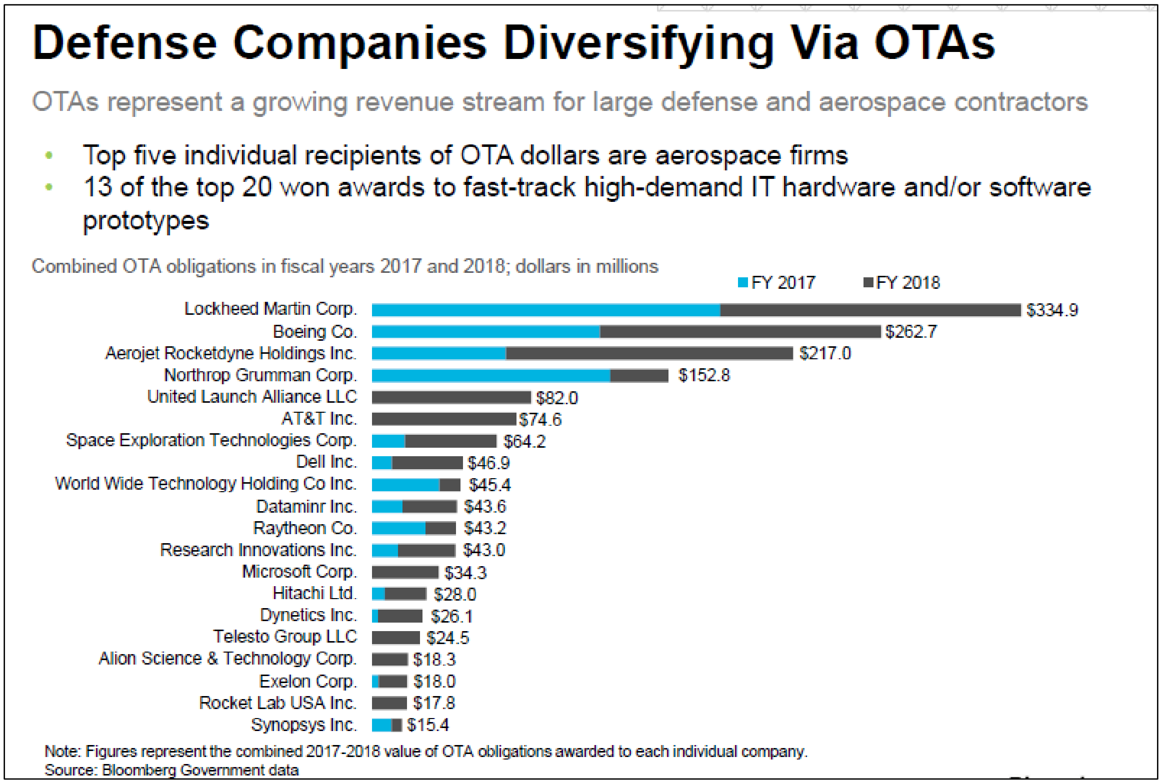

Figure 11. Defense Companies in OTs, Source: C. Cornillie (email to author, August 5, 2019).

The innovation metrics proposed by Govini (n.d.) are alternatives that could correlate to whether the definition of a nontraditional contractor is measuring the innovative potential aimed for in OT agreements. In the Innovation Management Measurement article, measuring innovation tends to focus on output measures and research and development measurement (Adams, Bessant, & Phelps, 2006, p. 38). The article recommends developing innovation metrics by evaluating seven innovation management processes including "inputs management, knowledge management, innovation strategy, organizational culture and structure, portfolio management, project management, and commercialization" (Adams et al., 2006, p. 21). There are currently no standardized innovation metrics, however commonly used internal metrics correspond to results such as annual research and development budgets, sales of new products, the number of patents, new product generation versus altering existing products, and active innovation projects in a portfolio within a company.

Other metrics for innovation could be market share in the science technology markets, which is publicly available information. Of note, it is important to consider that the characteristics that make a firm innovative are not necessarily the same characteristics that make a firm successful. The intent behind prototyping and research is to try new ideas. There needs to be a way to assess and identify firms with the innovative potential and to not consider them failure if a company enters into an OT agreement and does not reach the entirety of goals or mission requirements but could still add value to partnering with the DoD in the future.

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VI. CONCLUSION

The research question aimed to answer if four alternative metrics—of compound annual growth rate, total DoD obligations, distance to a tech-hub, and membership in a consortium—measure the innovative potential of NDCs and have predictive power for classifying firms under the current binary NDC classification. This question was answered through conducing a logistic regression model on archival FPDS-NG data and producing a model more statistically significant than a null. The model was not considered particularly reliable in the definition sense of Kimerlin and Winterstein's (2008) explanation of the consistency of a measure to be reproduced, reflected by the low value of the scale reliability coefficient, however the model did assess the predictive power of the proposed scale and the relationships between the items in the scale. Being able to measure and quantify the innovative potential of firms will help the DoD to access innovation for research and prototyping by being able to tailor the OT special authority towards those firms that might otherwise not partner with the DoD. The research questions are specific and narrow in view, but provide an initial understanding of the broader question of whether OTs provide an advantage to innovative technological advancements through NDCs and the best methods to reach and encourage these contractors to partner with the DoD.

Overall, background and initial information is provided to understand how OTs provide an advantage to innovative technological advancements through nontraditional defense contractors. The DoD prioritizes leveraging rapid technological advancements by integrating emerging commercial technology solutions into military capabilities. The data used in this research is unclassified FPDS-NG data on OTs from FY2005 through FY2018. From the CRS report, the most authoritative contract data source is FPDS-NG for OT prototypes and production; however, research OT obligations along with grants and cooperative agreements are typically recorded in a different system called Defense Assistance Awards Data System (Schwartz & Peters, 2019, pp. 10–11). The CRS report also highlights that all OT data will be reported in FPDS-NG in late 2019, which will provide for a more accurate analysis of OT use (Schwartz & Peters, 2019, p. 11). This research does not include any data from the Defense Assistance Awards Data System. All data, including FPDS-NG data, has imperfections, incomplete elements, and certain limitations by nature. FPDS-NG data in particular can have up to a 90-day delay in uploading and updating information regardless of fiscal year (Schwartz & Peters, 2019, p. 37). In the Prototype OT FPDS-NG data, there are inconsistencies and conflicting data inputs due to two related fields, one titled "Fiscal Year" and the other "Contract Fiscal Year" to identify when an agreement was signed or modified (Schwartz & Peters, 2019, p. 37). These two similar data inputs could result in differing analyses in drawing conclusions in prototype OT data. Another limitation of the data is that the compound annual growth rate could not be calculated for any of the vendors with the initial obligation of 0. One last limitation of the data is that during the SAM API process, there were firms with multiple matches, and therefore could not be confidently retrieved with the correct data fields for analysis. All of the SAM multiple matches were removed from the data sample. Initially the data sample consisted of over 5000 firms, but after scrubbing the data for missing fields, incomplete or inaccurate data, the sample was reduced to 437. This data sample is large enough to be considered representative of firms in the general population.

Some areas for future research include researching different metrics for innovative potential, the benefits of OT agreements versus other nontraditional contracting methods through successful prototyping, and analysis of weapon system programs resulting from awards to consortiums. Congress has increased reporting and notification requirements in the FY2019 defense authorization and appropriations legislation; therefore, more data and information will be publicly available for research, which will allow for more in-depth research and understanding of the utilization of OT agreements and access to NDCs (Govini, n.d., p. 14).

LIST OF REFERENCES

Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International Journal of Management Reviews*, *8*(1): 21–47. Retrieved from https://doi.org/10.1111/j.1468-2370.2006.00119.x

Adcock, R., & Collier, D. (2001). Measurement validity: A shared standard for qualitative and quantitative research. *American Political Science Review*, *95*, 529–546. Retrieved from https://www-cambridge-org.libproxy.nps.edu

Advisory Panel on Streamlining and Codifying Acquisition Regulations. (2017). *Section 809 Panel Interim Report*. Retrieved from https://section809panel.org/

AFWERX. (n.d.). Retrieved May 1, 2019, from https://www.afwerx.af.mil/

Bloomberg Government. (n.d.). From intelligence to influence. Retrieved November 27, 2019, from https://about.bgov.com/

CompTIA. (2018, October 23). Tech Town, USA: 20 cities IT pros will want to call home [Blog post]. Retrieved from https://www.aitp.org/blog/aitp-blog/2018/10/23/tech-town-usa-20-cities-it-pros-will-want-to-call-home/

Defense Intelligence Agency. (2019). *China military power: Modernizing a force to fight and win*. Retrieved from https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf

Equal Employment Opportunity Commission (EEOC). (2014). *Diversity in high tech.* Washington, DC: EEOC. Retrieved from https://www.eeoc.gov/eeoc/statistics/reports/hightech/

Gansler, J.S., Greenwalt, W.C., & Lucyshyn, W. (2013). *Non-traditional commercial defense contractors.* Retrieved from https://apps.dtic.mil/dtic/tr/fulltext/u2/a613239.pdf

General Services Administration (GSA). (2019). *FPDS-NG Government User's Manual* Retrieved from: https://www.fpds.gov/downloads/Manuals/FPDS_NG_Users_Manual_V1.4.pdf

Government Accountability Office. (2005). *Future combat systems challenges and prospects for success* (GAO-05-442T). Retrieved from https://www.gao.gov/products/GAO-05-442T

Government Accountability Office. (2016). Federal acquisitions: Use of 'Other Transaction' agreements limited and mostly for research and development activities (GAO 16–209). Retrieved from https://www.gao.gov/assets/680/674534.pdf

Government Accountability Office. (2017a). *DoD is taking steps to address challenges faced by certain companies.* Retrieved from https://www.gao.gov/assets/680/674534.pdf

Government Accountability Office. (2017b). *Weapon systems: Prototyping has benefited acquisition programs, but more can be done to support innovation initiatives* (GAO-17-309). Retrieved from https://www.gao.gov/assets/690/685478.pdf

Government Accountability Office. (2018, May 31). *Decision—Matter of Oracle America, Inc.* (GAO B-416061). Retrieved from https://www.gao.gov/products/B-416061

Government Accountability Office. (2019, April 4). *Decision—Matter of MD Helicopters, Inc.* (GAO-B-417379). Retrieved from https://www.gao.gov/products/B-417379

Govini. (n.d.). Evaluating the innovative potential of other transaction authority investments. Retrieved March 27, 2019, from https://www.govini.com/home/insights/

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate data analysis* (7th ed). Upper Saddle River, NJ: Pearson Prentice Hall.

Halchin, L. E. (2011). *Other Transaction (OT) Authority* (CRS Report RL34760). Washington, DC: Congressional Research Service.

Kendall, F. (2015, April 9). *Implementation directive for Better Buying Power 3.0—Achieving dominant capabilities through technical excellence and innovation.* Washington, DC: Under Secretary of Defense for Acquisition, Technology, & Logistics (USD[AT&L]).

Kimerlin, C.L., & Winterstein, A.G. (2008). Validity and reliability of measurement instruments used in research: Research fundamentals. *American Society of Health System Pharmacists, Inc., 65*(1), 2276–2284.

Maucione, S. (2018, July 17). As OTAs grow, traditional contractors are reaping the benefits. Retrieved from https://federalnewsnetwork.com/contracting/2018/07/as-otas-grow-prime-contractors-are-reaping-the-benefits/

Office of the Inspector General. (2002). *Statement for the record, Robert J. Lieberman, Deputy inspector general, Department of Defense, to the Subcommittee on Technology and Procurement Policy House Committee on Government Reform on the Services Acquisition Reform Act (SARA) of 2002* [Memorandum]. Retrieved from http://www.dodig.mil/reports.html/Article/1116572/statement-for-the-record-robert-j-lieberman-deputy-inspector-general-department/

Office of the President of the United States. (2018). *National defense strategy.* Retrieved from https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

Office of the Under Secretary of Defense for Acquisition & Sustainment. (n.d.). Other Transactions Authority (OTA) statutory timeline. Retrieved July 1, 2019, from http://www.acq.osd.mil/dpap/cpic/cp/docs/OTA Statutory Timeline.docx

Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L). (2017). *Report to Congress: An assessment of cost-sharing in other transactions agreements for prototype projects*. Washington, DC: Department of Defense. Retrieved from https://www.acq.osd.mil/dpap/cpic/cp/docs/Assessment%20of%20Cost-Sharing%20in%20Other%20Transactions%20Agreements%20for%20Prototype%20Projects.pdf
Pandit, K., & Marmanis, H. (2008). *Spend analysis: The window into strategic sourcing.* Ft. Lauderdale, FL: J. Ross Publishing.

Richtner, A., Brattstrom, A., Frishammer, J., Bjork, J., & Magnusson, M. (2017, September 12). Creating better innovation measurement practices. *MIT Sloan Management Review.* Retrieved from https://sloanreview.mit.edu/article/creating-better-innovation-measurement-practices/

Schwartz, M., & Peters, H. M. (2019). *Department of Defense use of other transaction authority: Background, analysis, and issues for Congress* (CRS Report R45521). Washington, DC: Congressional Research Service. Retrieved from https://crsreports.congress.gov/product/pdf/R/R45521

Senate Armed Services Committee. (2017). Advanced policy questions for Ellen Lord: Nominee for Under Secretary of Defense for Acquisition, Technology, and Logistics. Retrieved from https://www.armed-services.senate.gov/imo/media/doc/Lord_APQs_07-18-17.pdf

Slaughter, R. (2019). Space Pitch Day—And the other 11 upcoming Air Force Pitch events. Retrieved from https://www.linkedin.com/pulse/space-pitch-day-other-11-upcoming-air-force-events-robert-slaughter/

Smith, G., Drezner, J., & Lachow, I. (2002). *Assessing the use of "other transactions" authority for prototype projects.* Santa Monica, CA: RAND. Retrieved from https://www.rand.org/pubs/documented_briefings/DB375.html

Spiller, S.A., Fitzsimons, G.J., Lynch, J.G. & McClelland, G. H., (2013). Spotlights, floodlights, and the magic number zero: Simple effects tests in moderated regression. *Journal of Marketing Research*, *50* (2), 277-288. Retrieved from https://www.jstor.org/stable/42002773

UCLA. (n.d.). Introduction to SAS. New Test: Command to compute new test. Retrieved October 1, 2019, from https://stats.idre.ucla.edu/stata/dae/logistic-regression/

Under Secretary of Defense. (2017). *Department of Defense financial management regulation volume 2B: "Budget formulation and presentation."* Washington, DC: Department of Defense.

Under Secretary of Defense for Acquisition and Sustainment (OUSD(A&S)). (2018). *Other Transactions (OT) guide for prototype projects*. Washington, DC: Department of Defense. Retrieved from https://aaf.dau.edu/ot-guide/

U.S. Congress. (2008). *Other transaction authority: Flexibility at the expense of accountability? Hearing before the House Committee on Homeland Security, Subcommittee on Emerging Threats, Cybersecurity and Science and Technology*. Washington DC: Government Printing Office. Retrieved from https://www.gpo.gov/fdsys/pkg/CHRG-110hhrg44511/pdf/CHRG-110hhrg44511.pdf

CAS Applicability, 48 C.F.R. § 9903.201-1 (2018). Retrieved from https://www.law.cornell.edu/cfr/text/48/9903.201-1

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