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THE EFFECTS OF EXPORTING ON DEFENSE ACQUISITION OUTCOMES: A QUANTITATIVE LOOK AT FMS CONTRACTING

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Abstract

This paper studies how different approaches to security cooperation and varying characteristics of foreign military sales (FMS) recipients influence defense acquisition outcomes. A review of the literature finds that the level of asset specificity of the internationally traded good in question, the nature of the security partnership and quality of partner institutions are all likely influencers of performance. The project has labeled FMS transactions with the federal procurement data system using a machine learning algorithm, integrated multiple data sources to test dataset validity and to study key recipient country variables of interest, and modeled how FMS may change drivers of acquisition performance.

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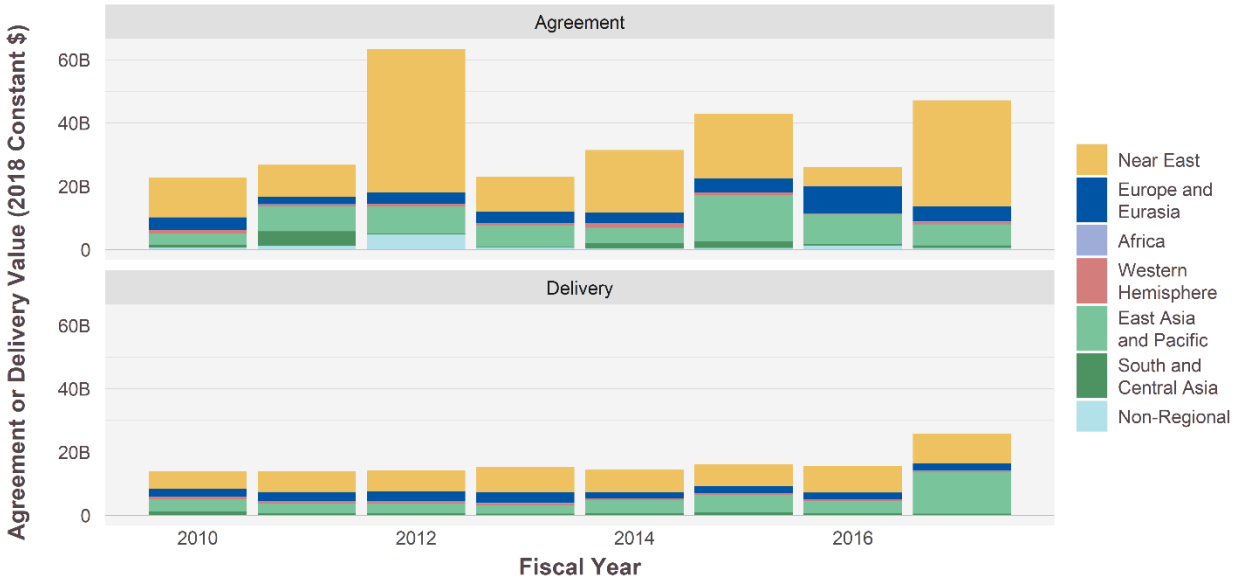
1 Introduction

Foreign Military Sales (FMS) have grown markedly in recent years with major agreements announced during the prior administration, followed by a broad-based push to accelerate and increase FMS by the present administration, which included revisions to the Conventional Arms Transfer (CAT) Policy. This trend, shown in

Figure 1: FMS Agreements and Deliveries by Fiscal Year



Source: DSCA; CSIS analysis.

As shown in Figure 1, FMS agreements have consistently exceeded deliveries across all years observed , in the FY 2010 through FY 2017 window. This suggests that a sizable amount of FMS agreements between the United States and foreign governments do not ultimately result in deliveries of those defense articles and services from the agreements. The FMS process includes strict controls to keep the U.S. government from taking on a debt or making a profit (DSCA). Nonetheless, "FMS customers are not legal participants in the procurement contract" and while the recipient must prepay, if a partner changes their plans, the process leaves room for prioritizing the security relationship over taking a hardline on fulfilling a given sale. Moreover, any funds advanced by the buyer not yet expended could instead be used towards a future agreement.

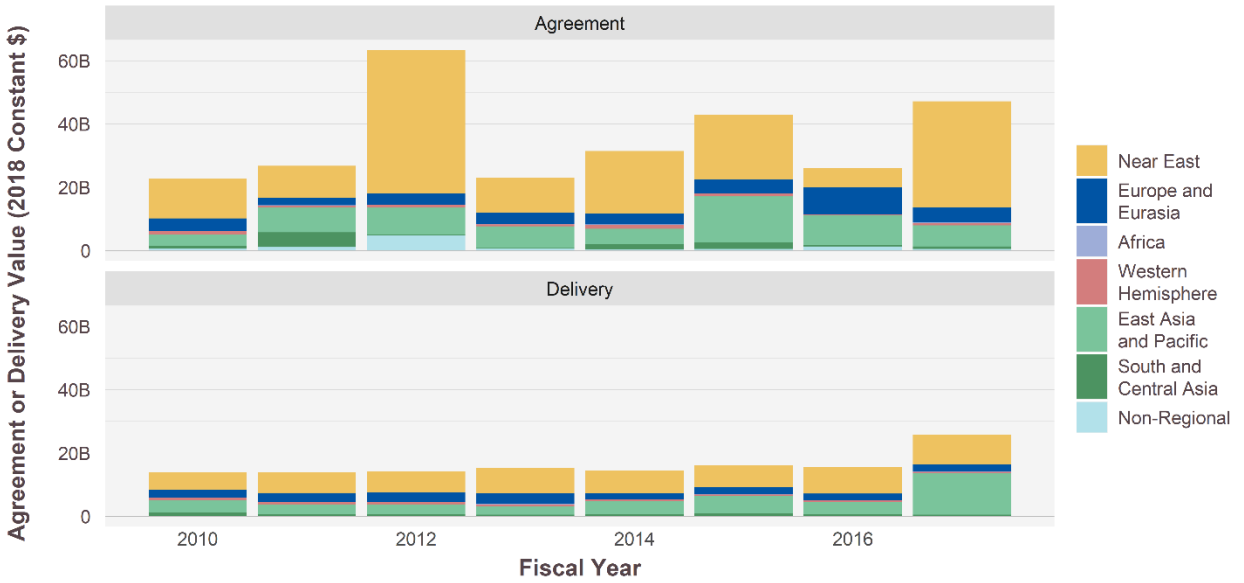
The regional breakdown in Figure 1 suggests that the Near East region consistently has the highest volume of agreements made, when compared to other regions across the globe, for almost all years in the FY 2010 to FY 2017 window. Furthermore, the Near East consistently has a high volume of deliveries as well. This does not automatically follow from the lead agreements as many FMS agreements do not ultimately result in their respective deliveries. This trend can be explained by the fact that multiple administrations have pursued US security and foreign policy priorities in the region by partnering with countries such as Saudi Arabia, United Arab Emirates, and Iraq, the latter being a relationship that continued even after the end of U.S. occupation—among others. As previously mentioned, these FMS partnerships are often scrutinized by the public and policy-makers due factors such as the lack of strong institutions and transparency in many partners nations as well as questions about how the arms are

used. The paper will later provide country-specific breakdowns for some of these key FMS partners, showing the top ten recipients of US exports in 2011 to 2017 in Chapter 5.

Second to the Near East in both FMS agreements and deliveries is the East Asia and Pacific region, with a notable increase in FMS deliveries in FY2017. Although far fewer than those in the Near East and East Asia and Pacific regions, the Europe and Eurasia region also has a substantial and consistent rate of FMS agreements and deliveries, coming in third in both agreements and deliveries. While the lowest rate of FMS agreements and deliveries is observed in the Africa region, the Western Hemisphere, South and Central Asia, and Non-Regional breakdowns also have quite low agreement and delivery rates, especially when compared to the top three regions. To account for classified export agreements and the fact that international organizations are also eligible to participate in FMS programs (DSCA, 2019), international organizations and other unspecified arrangement are captured in the "Non-Regional" category in the data. There is a substantial "Non-Regional" FMS agreement spike for FY2012 attributable to classified agreements.

Given FMS's utilization of the U.S. defense acquisition system, and in keeping with laws emphasizing foreign policy considerations in all arms exports, those emphasizing economic and industrial base factors tend to also posit that expanding FMS furthers broad U.S. national security goals. Likewise, those emphasizing deliberation and caution point to the risks of poorly considered deals falling apart, and of the possible proliferation of closely held U.S. technological developments, potentially undermining U.S. national security goals. , is more prominent in FMS agreements than in deliveries, although the latter have been increasing. This FMS drive has multiple sources, not the least of which being a greater emphasis on working by, with, and through partner nations, as indicated in the 2018 National Defense Strategy. This partnership goal overlapped with the economic challenges of the global financial crisis and subsequent U.S. spending reductions that reduced defense industry revenues. This mix of motivations and implications is characteristic of the challenges of analyzing FMS. As recognized by U.S. law, are political, in that they are a form of security cooperation intended to aid in pursuit of U.S. foreign policy goals. At the same time, arms exports have economic and acquisition implications. The political challenges of arms exports have been thrown into sharp relief by the ongoing debate over U.S. support for the Saudi-led war in Yemen, as opponents of the war have sought to cut back FMS as a way of adding to the pressure they seek to apply to the Saudi regime while the President emphasized the economic value of the exports.

Figure 1: FMS Agreements and Deliveries by Fiscal Year



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[1] This spike involves roughly $10 billion in record deliveries to the Republic of Korea in a single year recorded in DSCA data. This jump was not replicated in other sources and the DSCA Historical Yearbook does not breakout what items were included in this shipment. Lacking further data on this extraordinary single year feature, the study

Asia and Pacific regions, the Europe and Eurasia region also has a substantial and consistent rate of FMS agreements and deliveries, coming in third in both agreements and deliveries. While the lowest rate of FMS agreements and deliveries is observed in the Africa region, the Western Hemisphere, South and Central Asia, and Non-Regional breakdowns also have quite low agreement and delivery rates, especially when compared to the top three regions. To account for classified export agreements and the fact that international organizations are also eligible to participate in FMS programs (DSCA, 2019), international organizations and other unspecified arrangement are captured in the "Non-Regional" category in the data. There is a substantial "Non-Regional" FMS agreement spike for FY2012 attributable to classified agreements.

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The interaction of these considerations means that when looking at the acquisition effects of FMS specifically, a wide range of potential influences come into play. On the one hand, the effects of sequestration have incentivized industry to look abroad for revenue growth, and program managers have looked to capitalize on budget savings from overseas sales. While industry can directly profit from FMS, the U.S. government does not get these savings from FMS revenue directly but instead from the efficiencies that can result from higher unit counts leading to lower production costs and shared support costs. On the other hand, arms exports are inherently challenging due to the risk of complications when meeting foreign requirements, instability in international demand, blocks by Congress or the Executive branch, organizational complexity from cross-state cooperation, and the risk of adverse technology proliferation.

1.1 Scope

This paper is focused on U.S. acquisition system, which in addition to its role addressing the investment and sustainment needs of the DoD is also charged with fulfilling FMS orders. To guide the research done for this project, the study team posed four research questions:

1. How can contracts that utilize FMS be better identified in FPDS using information from other fields?
2. How does FPDS foreign funding data align with the Defense Security Cooperation Agency's FMS data?
3. Do FMS contracts perform better than non-FMS contracts? This question was subsequently expanded to cover projects incorporating FMS and not just FMS transactions.
4. What variables contribute to the performance of FMS contracts and in what direction and magnitude?

team recommends caution in interpreting this jump in spending and its possible implications, as delivery totals are sometimes subject to revisions in subsequent years.

This project advances understanding of FMS acquisition by studying it from multiple angles: reviewing the literature on FMS; creating and validating a dataset of FMS transaction; modeling the performance of FMS contracts, and identifying key variables to track factors external to the acquisition system that put its performance in context.

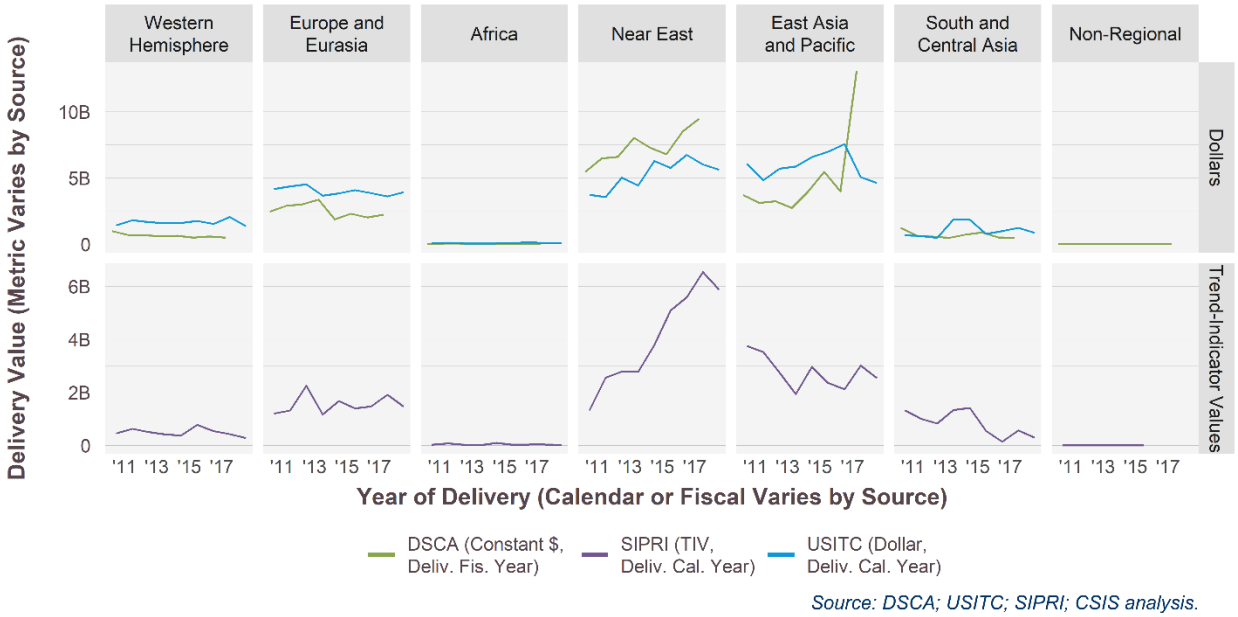
1.2 Background

To evaluate the performance of contracts that utilize FMS, the study team first references the existing body of literature that analyzes contract performance and investigates if any papers specifically looked at contract performance for FMS. While the body of contract performance literature is extensive, the study team found no pieces that empirically analyzed contract performance for FMS contracts. One major obstacle to such research is that the publicly available contracting data from the Federal Procurement Data System (FPDS) is incomplete in indicating whether a transaction was FMS or not. Thus, a large portion of work done for this paper involves curating a dataset using other fields in FPDS to identify FMS transactions that were unlabeled. This labeling effort includes both application of rules based on transaction funding account and labeling using machine learning approaches detailed in section 4.1.2 this paper.

While previous work has not examined FMS contracts in particular, the existing bodies of literature provide guidance on theorizing about and measuring contracting performance. Work on security assistance details some inherent challenges of arms exports in meeting foreign requirements and the risk of adverse technology proliferation. Existing work on transaction cost theory provides a foundation for building models that estimate the effects of FMS contract characteristics on FMS contract performance outcomes. Several authors have found that transaction costs, and in particular asset specificity, are a driving force behind acquisition outcomes for services and products (Williamson, 1981; Brown & Potoski, 2003; Adler, Sherer, Barton, & Katerberg, 1998). Expansion to international markets may reduce asset specificity and create other economies of scale. Other research, however, has examined how transaction costs are exacerbated in the context of international business (Berghuis and Butter, 2017). This paper will draw on these theories to explore contract performance in the context of FMS.

In parallel with creating the contract dataset, this project has integrated three separate sources on arms trade to cross-compare totals from FPDS and to report on and analyze larger trends surrounding FMS.

Figure 2: U.S. Arms Exports by Region



Source: DSCA; USITC; SIPRI; CSIS analysis.

Figure 2 shows US arms export deliveries by region, using data from DSCA, USITC, and SIPRI. When looking at the regional breakdown of major trends in FMS deliveries, the DSCA and USITC data appear to be largely in close agreement with one another over the years of study, approximately FY11 to FY18. It is important to note that the USITC data includes both FMS and Direct Commercial Sales (DCS). While FMS are a government-to-government transfer, DCS are contractor-to-government transfer. Both are ways that foreign governments can obtain US defense articles, increasing interoperability between the US and its allies and partners around the globe. With DSC, the US contractors are the ones negotiating with foreign governments. In order to do this bidding, US companies are required to have commercial export licenses from the Department of State (DSCA, 2019). The State Department's Bureau of Political-Military Affairs must provide regulatory approvals for all DCS (U.S. Department of State, 2019).

In both the Western Hemisphere and Europe and Eurasia regions, DCS plays a prominent role, and consistently so. This might explain why the USITC data shows a higher dollar value for US arms exports to those regions. The same is true for the East Asia and Pacific region, aside from a sudden increase in FMS in FY17. Figure 2 also shows that FMS deliveries for the Near East region are consistently rising over the years when compared to delivery rates in other regions. In addition, it is noteworthy that the Near East reporting of FMS exceeds the total merchandise trade reported by USITC delivery values, suggesting that FMS is the predominant form of delivery to that region. The next section of this paper is the literature review, which identifies key traits external to the acquisition system that are believed to influence the success of U.S. security assistance. This paper dives deeper into global FMS trends, focusing on characteristics identified in the literature review, in the final portion of the Results, section 5.4.

2 Literature Review

2.1 Security Assistance and Cooperation

FMS is intended as a U.S. foreign policy tool for strengthening the security of the U.S. and promoting global security. FMS is authorized under Section 3 of the Arms Export Control Act (AECA) where it is considered as security assistance. The Department of Defense (DoD) Security Assistance Management Manual (DoD 5105.38-M) has a list of eligible countries and organizations who can participate in FMS. An FMS process begins when a foreign customer determines that its military and security needs require a U.S. defense article or service. That foreign government or organization then alerts the U.S. government of its intent to participate in FMS through submitting a letter of request (LOR). From there, the U.S. government organization that is both relevant to the requirement and authorized to receive and process LORs, otherwise known as the implementing agency, works through an interagency process to determines whether the LOR requestor is an eligible participant of the security assistance process under AECA. If so, the implementing agency moves forward in determining an appropriate letter of offer and acceptance (Defense Security Cooperation Agency, 2012, C5.1).

2.1.1 Export Controls and End Use Monitoring

Assessment, monitoring and evaluation are essential components of any form of security sector assistance. Throughout security assistance relationships, the United States is able to calculate return on investment, identify and prevent abuse of military resources, and enforce forms of positive and negative conditionality on security assistance (Dalton, Shah, Green & Hughes, 2018, p.9). In addition to its strategic importance, monitoring is statutorily required under the Leahy laws, which mandate vetting of individuals and units before they receive training or equipment, thereby preventing security sector assistance from going to foreign security forces that commit gross violations of human rights. Beyond the Leahy requirement for end-use monitoring, the Arms Export Control Act (AECA) and International Traffic in Arms Regulations (ITAR) place substantial restrictions and requirements on both FMS and DCS, including requirements about the eligibility of potential recipient countries and eligibility of platforms and technologies (Gilman, 2014, p.4). Two separate programs exist to provide end-use monitoring for transfers of military equipment: Blue Lantern and Golden Sentry. Blue Lantern operates under the Department of State's Directorate of the Defense Trade Controls and monitors use of equipment from DCS, while the Golden Sentry program is administered by the Defense Security Cooperation Agency and monitors FMS (Fergusson & Kerr, 2017, 6). Golden Sentry provides oversight for recipient security and handling of materials, reports any misuse or illegal transfer of equipment, and performs physical inspections and inventory management in some cases (Little, 2017).

Golden Sentry and other end-use monitoring are essential to reducing the risks of transfers by "ensuring that they are not misused and remain within the security force to which they are assigned," (Dalton et al., 2018, p.10). Alongside concerns about human rights violations and potential proliferation of weapons beyond intended recipients, FMS can increase the risk of harmful strategic behavior by recipients. Capability transfers and the perception of US support create moral hazards for recipient regimes, leading to opportunistic behavior like coup-proofing and power consolidation, both of which can ultimately degrade military capacity and undermine US goals in security assistance (Boutton, 2018, p.8-10). These risks, and the monitoring needed to mitigate them, can significantly complicate security assistance and impose meaningful transaction costs. Despite an increasing emphasis on the economic

aspects of FMS in current political discourse, it remains the case that "arms transfers are a foreign policy tool and cannot be wholly separated from U.S. security cooperation policy" (Dalton, 2018, p.38).

Defense Institutional Capacity

Defense Institution Building (DIB) is an element of security cooperation which has received increased attention in recent years. It seeks to improve security outcomes and mitigate risk of material misuse by increasing institutional capacity in recipient countries to combat the dangers of instability, weak oversight, and poor governance (Dalton et al. 2018, p19). DIB is stipulated as an integral part of any security cooperation agreement, as part of the FY 2016 NDAA. The growing focus on DIB and on recipient-country institutions more broadly highlights the fundamentally political aspect of successful security assistance, including FMS. While FMS programs may not themselves involve significant DIB activities, the presence (or lack) of institutional capacity in recipient countries remains a central driver of risk.

2.1.2 Interoperability

The 2018 National Defense Strategy expressed a clear desire to increase interoperability, noting that the ability to "act together coherently and effectively to achieve military objectives requires interoperability," (p.9). While interoperability includes elements of communication and operational concepts, material overlap between forces can also be a significant contributor to interoperability. As De Vor argues, "States equipped with the same weapons can support, reinforce, repair, and resupply each other's armed forces without advanced warning," (2011, p.628). Combined with the shared training and logistic integration that can accompany arms transfers, FMS can provide the material foundation for increased interoperability between U.S. forces and recipient-nation forces. This line of reasoning is echoed in the 2018 National Defense Strategy, which includes as part of its plan for increasing interoperability the need to "prioritize requests for U.S. military equipment sales" (p.9).

2.2 Economics for International Cooperation

The rise in foreign military sales observed in Figure 1 has been driven not just by security assistance concerns, but also economic factors. The Great Recession put pressure on defense budgets in the United States and Europe, while expenditures increased for "several countries—particularly in East Asia, South Asia, the Middle East, and South America" (Gilman, 2014, p.1). The present U.S. administration prominently featured economic ends in the April 19, 2018 National Security Presidential Memorandum Regarding U.S. Conventional Arms Transfer (CAT) Policy. That document made it a policy of the executive branch to:

> *increase trade opportunities for United States companies, including by supporting United States industry with appropriate advocacy and trade promotion activities and by simplifying the United States regulatory environment; strengthen the manufacturing and defense industrial base and lower unit costs for the United States and our allies and partners, including by improving financing options and increasing contract flexibility; facilitate ally and partner efforts, through United States sales and security cooperation efforts, to reduce the risk of national or coalition operations causing civilian harm;*

At the announcement briefing Dr. Peter Navarro, Assistant to the President for Trade and Manufacturing Policy, discussed these rationales. When asked about the desire by some buyers for offsets and

technology transfer, Navarro went further to make the case for jobs and industrial promotion saying, "the organizational culture of the Trump administration is: buy American, hire American" (U.S. Department of State, Office of Press Relations, 2018).

With regards to the U.S. industrial base, the most explicit discussion of how economics and industrial issues tie into larger U.S. defense goals is the 2018 Report to the President by the Interagency Task Force in Fulfillment of Executive Order 13805, otherwise known as the Defense Industrial Base Review (IBR). This document points to concerns that prominently feature the first and second order effects from the Budget Control Act (BCA) of 2011 and sequestration (which will be referred to as the defense drawdown henceforth), which helped prompt a greater emphasis on foreign military sales.

2.2.1 The Defense Industrial Base Review (IBR)

A combination of the 2008 financial crisis, 2011 debt-ceiling crisis, 2011 closing of the Iraq War, and BCA led the domestic demand for defense items to decline. Specifically, the budget caps mandated by the BCA from fiscal year (FY) 2012-2021 were significantly lower than requested funding levels, which triggered sequestration in 2013. A previous CSIS study found that the decline in budget carried over to the defense industrial base, which experienced decreased revenue across all platform portfolios:

> "CSIS analysis showed that buried within the substantial decline in defense contract obligations were significant variation from sector to sector, with declines varying from catastrophic (Land Vehicles), to steep (Facilities and Construction, Space Systems), to relatively modest (Ships & Submarines). Other sectors suffered a whipsaw effect in which solid business growth suddenly switched to sharp decline (Aircraft)" (McCormick, Hunter & Sanders, VI)

Moreover, medium and large federal vendors experienced the most variance in defense market share and the top companies working with DoD saw their portfolios shift from research and development (R&D) to products and services (McCormick, Hunter & Sanders 2018). The IBR (2018) also found that sequestration has led to lower defense spending compared to the levels projected before it was triggered.

The IBR has deemed sequestration as one of the five macro forces behind the risks that threaten the U.S. industrial base. The IBR discusses multiple ways in which sequestration causes risks to the industrial base, such as "inconsistent appropriations, uncertainty about future budgets, macro-level ambiguity in U.S. Government expenditures, and the effects of the Budget Control Act," (IBR 2018). The IBR argues that successful markets are dependent on predictability, where industries can invest and plan based on informed decisions. That said, Harrison notes that while the budget caps drove a gap between Obama administration budget proposals and actual results, the challenges in relying on the DoD's Five Year Defense Plan (FYDP) long predated the BCA:

> "While the FYDP is useful for planning purposes, in the past, it has been a poor indicator of where the budget is headed. As shown in Figure 2, the FYDPs submitted by the Reagan administration greatly exceeded the actual level of funding appropriated by Congress, and the Reagan FYDPs continued projecting growth even when the budget was declining. In the 1990s, the Clinton administration repeatedly projected a lower defense budget than Congress ultimately appropriated." (Harrison & Daniels, 2018, p.4)

The challenges of predicting did not go away even during the period of single party control of the Congress and the Executive Branch during the 114th Congress. As Seamus Daniels notes "While the NDS calls for a "more resource-sustainable approach" to fund this modernization effort, the unclassified summary of the strategy fails to delineate how it plans to fund its ambitions" (2018, p. 1).

However, all aspects of the present difficulty in predicting the demand for defense goods and services are familiar from prior eras. As noted by the Interagency Task Force's IBR, the spending uncertainty caused by sequestration often results in "peaks of surge and valleys of drought," that disrupt scale production because suppliers can be left with excess capacity during the valleys of drought (p.21). This can lead to long-term market distortion.

Lastly, the fluctuations in demand caused by the BCA has had rippling effects across defense industry supply chains where companies have struggled in their abilities to hire and retain the necessary skilled workforces for their products and services. While McCormick found that the U.S. subcontracting data was inadequate to fully examine supply chain questions, he did find "the market shock of sequestration and the defense drawdown had a disproportionate effect on Small and Medium-sized vendors" (McCormick, Hunter & Sanders, 2018, p.17). The IBR adds that, "Without correcting or mitigating this U.S. Government-inflicted damage, DoD will be increasingly challenged to ensure a secure and viable supply chain for the platforms critical to sustaining American military dominance" (p.21).

2.2.2 Transaction Cost

Transaction cost theory, as a general approach to understanding economic behavior, lays the foundation for analysis of contracts. As defined by Williamson (1981), transaction cost theory measures transaction costs along three dimensions: frequency, uncertainty, and asset specificity; with asset specificity especially relevant to defense contracting. Minimizing transaction costs is a main driver of municipal governments' decisions to contract services or products, and the type of transaction cost specific to a product or service plays a role in determining contract type. Thus, they are a strong driver of contract design and behavior (Brown and Potoski, 2003; Adler et al., 1998). In the context of military sales, FMS may raise costs for specific transactions due to the difficulties of international transfers, but it may also reduce transaction costs for overall projects by increasing economies of scale and reducing asset specificity. These effects are discussed in turn below.

International Supply Chains

Berghuis and Butter (2017) studied transaction costs in the context of international supply chains and found that international contracting has characteristics that result in high 'intangible' transaction costs that require contracts that are more detailed, complete, difficult, expensive, and that need higher-trust relationships. A previous CSIS study found that international acquisition programs "exhibit a greater level of inherent organizational complexity, which poses a range of obstacles…international programs encourage participants to behave opportunistically, face collective tradeoffs that result in sub-optimal end products for individual nations, and experience competing factors within their structure," (Sanders & Cohen, 2017). The study also found cases where the desired benefits were outweighed by adverse effects of international cooperation resulting in negative cost, schedule, and end-product outcomes. Berghuis and Butter note that these effects vary greatly based on the strength of the relationship between international partners, raising the possibility of measures of 'relational contracting' which may result in superior performance (2017).

Offsets

Offsets are a central and contentious aspect of international defense sales. Offsets are accompanying agreements to defense sales which require sellers to provide some economic value to the purchasing country as part of the terms of service. They may be direct, such as a requirement for the seller to purchase components from the buyer country, or indirect, such as a requirement for the seller to purchase or invest in goods or services unrelated to the military sale (Petty, 1999). For military sales conducted through FMS, federal policy is that "DoD does not encourage, enter into, or commit U.S. firms to FMS offset arrangements," (48 U.S.C §§225.7306). This policy does not, however, prevent U.S. firms from negotiating offsets as part of an FMS sale without direct DoD involvement.

Offsets in international defense sales raise potential issues for domestic economic benefits. Offset agreements may shift economic gains from production to host countries via local co-production or components restrictions, reduce competitiveness through technology and capacity transfers, and ultimately reduce or outweigh some of the economic benefits of FMS (Petty, 1999). Recently, DoD's stance on offsets in FMS has grown more supportive, including a reduction in oversight of offsets negotiated between contractors and foreign customers (Censer, 2018). Overall, both the transactional burden of negotiating offsets and the potential economic harms to U.S. production pose a theoretical challenge to the economic benefits of FMS.

Asset Specificity

While both international transaction costs and offsets pose challenges to the benefits of FMS, one strong argument for its benefits is the potential effect on asset specificity. For most procurement contracts, producing the final product requires significant investment in capital infrastructure, both physical and informational. Asset specificity refers to the level of specialization for that infrastructure (Williamson, 1981). When infrastructure can be used after contract completion to produce products for the open market or other contracts, the effective cost of investment for the supplier is decreased. When the infrastructure is specific to the current contract, as is frequently the case in the defense industry, the full cost of investment is borne by the supplier for that specific contract. Capital useful for post-contract production is effectively subsidized by that future revenue, while fully-specific infrastructure is not. The degree of asset specificity is therefore a crucial determinant of both contract price and degree of supplier investment. Where asset-specificity is high, infrastructure investment by the supplier is costlier and is thereby disincentivized. This can lead to under-investment and sub-optimal contracts or require costly monitoring and incentives to ensure adequate investment (Schmitz, 2001).

FMS offer a potential boon to the United States Government by reducing asset specificity. Asset specificity is high in defense contracting because it is typically a monopsony and requires highly specialized technical capacity, typically leaving suppliers with expensive infrastructure that cannot be reused after a defense contract expires. We should expect this to significantly increase prices: defense contracts experience high costs to infrastructure investment and require significant incentives (and accompanying monitoring) to overcome those costs and achieve and optimal product (Schmitz, 2001). FMS, however, alleviates the effects of monopsony, and allows for potential asset-reuse after a USG procurement contract expires. While the infrastructure remains specific to a technological product, it becomes viable for use in multiple contracts with multiple recipients. In short, the infrastructure may only be useful for producing F-15s, but producing F-15s for the United States, United Kingdom, etc., effectively reduces asset specificity by increasing the applications for the infrastructure.

Notably, this relies on the supplier *expecting* these future contracts. When firms know that FMS will occur, their estimates of asset-specificity should decrease, leading to increased investment and superior outcomes (Schmitz, 2001). This theory suggests that contracts including FMS from the outset with defense exportability features should have lower costs and superior outcomes to equivalent contracts that do not, and that the earlier in the process that FMS is included the stronger these effects should be.

Advantages of Scale

Alongside asset specificity, increases in scale can improve acquisition outcomes through other mechanisms. While asset specificity helps improve outcomes by increasing incentives to invest in up-front capital and training, high production output can help reduce per-unit costs of investment and training. Holding up-front costs constant, each additional unit of production reduces the average per-unit cost until it approaches the marginal cost of each new unit. This economy of scale is central to the effects of monopolies, in which potential harms of market consolidation must be weighed against the benefits of decreasing per-unit cost with increasing scale (Peltzman, 1997). Alongside the declining per-unit cost of infrastructure, increased scale carries benefits through learning curves. As production occurs, involved workers gain experience and tend to discover more efficient techniques, leading to a declining *marginal* cost to production, on top of the declining *average* cost to production experienced for physical infrastructure (Sanders & Huitink, 2019). Unlike in the case of domestic monopolies, FMS does not clearly reduce domestic competition in order to achieve gains in scale, but effectively creates new customers by expanding the potential pool of buyers to foreign governments. This may allow FMS to achieve economies of scale for defense industrial producers without making the traditional tradeoffs to competition experienced in domestic situations.

Economic benefits from decreasing unit cost last beyond the time of purchase. When FMS and domestic procurement run concurrently, economies of scale and learning curve benefits can extend to maintenance, upgrades, and other lifecycle costs, particularly as many FMS products require additional service and parts from the U.S. after the initial sale. In general, Kirkpatric finds that lower per-unit costs are associated with lower lifecycle costs, indicating not only a direct economy of scale to maintenance and parts, but a follow-on effect from reducing initial unit costs (2004). Taken together, these effects offer a theoretical case for FMS lowering per-unit and lifecycle costs, both of which could drive superior acquisition outcomes for programs and platforms which include FMS.

Finally, FMS transactions do not only affect the immediate production cycle, but may have lasting effects on communication, infrastructure, and future projects. The IBR highlights the importance of maintaining and growing defense cooperation agreements with partners and allies to achieve economies of scale and scope as well as interoperability. Specifically, the IBR mentions the FY2017 NDAA's addition of Australia and the United Kingdom to the National Technology Industrial Base (NTIB) as an opportunity to jointly work on industrial base challenges (Interagency Task Force, 2018). The FMS process may help establish and grow defense cooperation by providing U.S. produced materials, ultimately creating the conditions for joint development, DCS, or other forms of security sector cooperation which may carry economic benefits for the U.S. defense-industrial base.

3 Conceptual Framework, Hypothesis, and Key Variables

This paper posits that a range of considerations from the security cooperation and assistance domain, as well as traditional economics and contracting literature, have a relationship with foreign military sales

contracting outcomes. On both the positive and negative sides of the ledger, strategic and political considerations by the United States and the purchaser nation may influence the level of support for the program and whether it completes delivery at all. Transaction costs literature, organizational complexity, and traditional considerations of scale provide a possible mechanism for these non-economic considerations to influence outcomes as the purchase quantities, supporting institutional infrastructure, and alignment of U.S. and recipients interests all depend on a variety of factors that can be better measured at the country-level rather than being specific to any given project.

Before discussing the hypothesis and key variables developed to examine these factors, the study team has a prerequisite falsifiable premise. This premises directly relate to the study's research questions and must be confirmed before the study team can have confidence in the dataset produced as part of this project.

> P_1: Foreign Military Sale data identifiable in the FPDS correlates with and captures a majority of the spending reporting from other sources.

As will be discussed in subsequent sections, the official labeling of FMS contracts is radically incomplete prior to 2016. The results section includes comparisons of FPDS data with that of the Defense Security Cooperation Agency (DSCA), the U.S. International Trade Commission (USITC), and the Stockholm International Peace Research Institute's (SIPRI) Arms Transfers database. While these are inexact comparisons, this cross validation is critical to establishing an appropriate level of confidence and caveats for use of the FPDS dataset in quantitative analysis. A prior version of this paper also sought to validate the dataset by examining contracting methods, and did not include USITC data. However, by adding USITC, the study team felt greater confidence in its ability to compare topline and platform specific spending totals, allowing us to focus our examination of contracting methods on the policy and performance aspects of their use, rather than trying to use them as a tool for validation of the FPDS dataset.

3.1.1 Transaction Costs

The paper's hypothesis comes directly from the economics literature and the asset specificity theory which holds that if there is a perceived greater and more widespread potential demand for a product, this incentivizes a variety of investments with positive implications for acquisition performance through decreased transactions cost:

> H_1 **Lower Specificity:** if a project has (does not have) an export agreement:
>
> - H_{1A}: the likelihood of ceiling breaches decreases (increases)
> - H_{1C}: the size of a ceiling breaches (should they occur) decreases (increases)

In modeling performance, this paper examines both overall DoD contracting and the FMS contract dataset specifically. This choice is inspired by the transaction cost literature emphasizes that acquirers respond to different transaction cost contexts with different forms of contracts. The organizational complexity inherent in cross-national customers, even if the contract itself is contained within the U.S. system, may change the relative utility of different contracting approaches.

3.1.2 Recipient Characteristics

The literature review identified important recipient characteristics with implications for security cooperation success: the nature of the security partnership and the strength of recipient institutions. This paper integrates multiple sources to create an measure key variables that make it straightforward to answer the index questions outlined below. These indices are intended to add transparency to the general public, policy makers, and practitioners in government and industry regarding how the recent push for greater FMS has played out in practice. They are also met, alongside the FPDS dataset, to be a tool for other researchers interested in studying the acquisition system itself or its affects on U.S. cooperation goals or the broader effects on those in recipient countries.

The first index focuses on a security assistance lens. This question posits that the nature and extent of cooperative arrangements between the U.S. and the recipient country have the potential to smooth the path for security cooperation success.

> **Security Partnership:** Measures the recipient's integration into the alliances with the seller increases based on the premise that closer relationships (less integrated) relationships lead to better (worse) security cooperation outcomes.

While formal alliances are clearly demarcated, there are some measurement challenges with this variable. For example, Egypt is a Major Non-NATO ally but is not part of a formal mutual defense pact with the United States while the Rio Treaty includes a score of Western Hemisphere countries including Cuba, which is not known for its security cooperation with the United States (U.S. Department of State, Treaty Affairs, n.d.). That said, the NATO alliance in particular incorporates both collective defense measures and acquisition related provisions and thus some level of differentiation should be possible, perhaps along separate treaty commitment and defense acquisition arrangement axes. The study team integrated the range of treaties and cooperative arrangements to classified recipient countries into different categories and then examined how the flow of FMS and other exports varies across them.

The second index has perhaps the strongest theoretical justification in the security assistance literature, but will also be a challenge for measure identification.

> **Institutional Health:** Measures the health of the recipient's institutions based on the premise that an increase (decrease) in health leads to better (worse) security cooperation outcomes.

This premise has multiple justifications. In political economy terms, more robust institutions reduce the risk of corruption and suggest greater capacity on the recipient's part and a lower risk of process breakdown. Second, institutional strength may prove directly relevant to the Leahy Laws, that restrict arms transfer to units in purchasing countries with a history of human rights abuses. The most direct justification comes from Andrew Boutton who argues "that in uncertain political environments — where regimes are riven by internal power struggles and institutions are underdeveloped — military aid can create a dangerous moral hazard" (2018, p. 7). Recipients who believe that their relationship with the provider ensures their security may engage in coup proofing behavior that undermines the effectiveness of military institutions and may exacerbate grievances within their country.

The study team had initially hoped to integrate these key variables within the contracting dataset and to test them as hypotheses. However, FPDS does not directly identify recipient countries and text parsing of contract description fields was only rarely able to isolate the country of interest. While it is possible to

identify the recipients for Major Defense Acquisition Programs, the study team considered and rejected this approach. In value terms, contracts with a labeled MDAP constitute less than a tenth of all DoD contracts and even in the more major weapon system-oriented FMS dataset only a bit over a quarter of contracts were labeled as attached to an MDAP. These are typically valuable contracts and in numerical terms these MDAP contracts make up only a tiny proportion of acquisition contracts. This is not to say that the majority of FMS does not constitute systems that were at one point MDAPs, but as development completes, especially if production for DoD purposes has ended, reporting requirements drop off dramatically. After exploring options, the study team chose to prioritize understanding the key variables and hypotheses in parallel rather than shift focus to MDAPs.

4 Data and Methods

4.1 Data Sources and Structure

4.1.1 Identifying the Datasets

This paper incorporates four primary datasets for studying FMS, each provided by a different organization. The first of these is the Defense Security Cooperation Agency's Historical Fact Book, which provides country-level overviews for arms transfers (2017). This data was available in PDF form, which our team scraped to assemble a dataset tracking country-year level data for FMS agreements and deliveries from 2010 to 2017. The DSCA data does publish announcements on individual transactions but does not provide more granular data in tabular form.[2]

The second dataset is the Stockholm International Peace Research Institute's Arms Transfer database (SIPRI, 2019). SIPRI provides as complete a record as possible of "all transfers of major conventional weapons", although their approach to reporting is intentionally conservative and requires multiple sources to verify that a delivery has happened. In theory these transfers can include DCS, though in practice these exports are harder to verify. The SIPRI Arms Transfer database does not include services, software, small arms, and in discussions SIPRI scholars said suspected that they underestimated the trade in electronics, comms, and sensors. Unlike DSCA, SIPRI provides information on individual transfers, including platform and delivery date. Importantly, due to the variability in pricing between identical platforms, SIPRI does not attempt to provide transaction size in U.S. Dollars, but uses a custom Trend Indicator Value (TIV) metric. TIV captures the military significance of the hardware transferred, and is intended for capturing general trends in transfers, not for measuring the discrete dollar size of the transfer. This limits the ability of SIPRI data to be directly integrated with other sources, but it provides extremely valuable directional data on transfers at both the country and platform level.

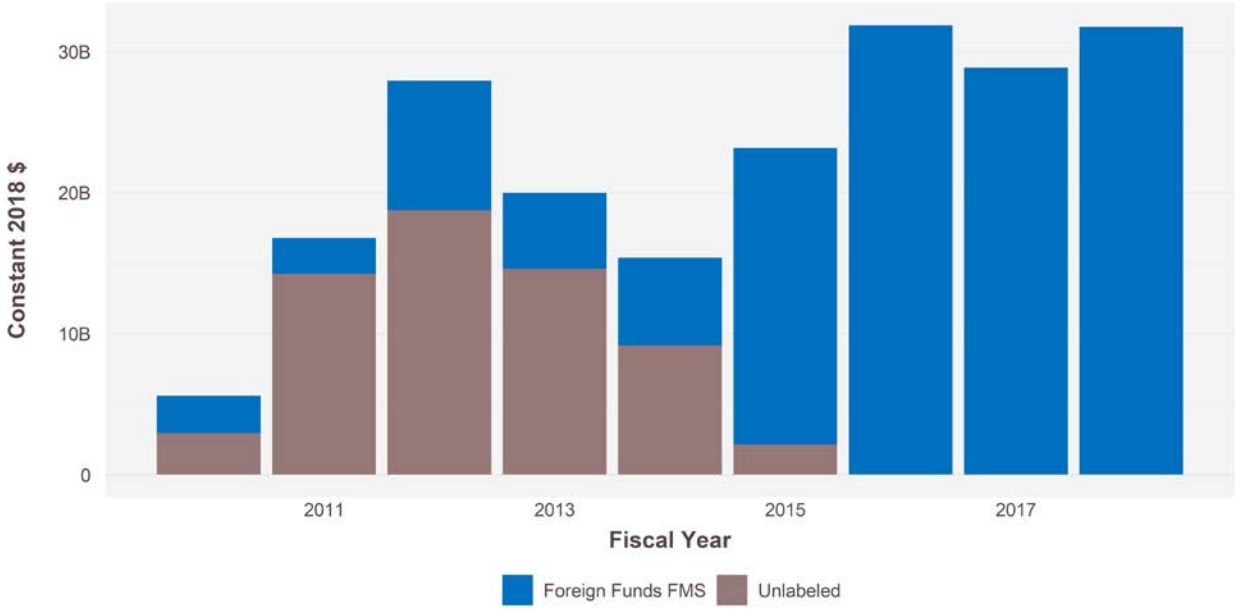
The third source comes from the U.S. International Trade Commission's DataWeb which tracks all merchandise trade to and from the United States starting in 1989 (United States Trade Commission, 2019). While the USITC no longer employs endues codes that directly track whether a good has a military purpose, the harmonized tariff system 10 digits codes include several dozen categories of military exclusive goods. Within the harmonized tariff system, the military categories are focused on platforms. Unfortunately, this means that USITC does not break out when dual-use items, e.g. electronics, communications equipment, or sensors, have a military end use. Likewise, services, likely

x

including R&D, do not fall within the definition of merchandise trade (United States Trade Commission, 2019). On the other hand, USITC data includes all U.S. arms exports including DCS. As a result, the differences between USITC and other sources do not necessarily constitute a disagreement but may simply capture different definitions of what qualifies as an export.

The final and most substantial dataset is the Federal Procurement Data System's database of nearly all acquisition transactions which uses the federal procurement system. FPDS offers transaction-level contract data on transactions, allowing for detailed breakdowns along types of contract structures, platforms, level of competition, and similar variables. Whether or not a transaction is FMS is recorded in the "foreign funding" field which "Indicates that a foreign government, international organization, or foreign military organization bears some of the cost of the acquisition," (USA Spending, 2019). While FPDS provides by far the most granular data on transactions, it suffers two major drawbacks. First, it does not have a column listing recipient countries and the country names are uncommon even in the plaintext descriptions of contract requirements. Second, "foreign funding" is only reliably reported in recent years, with a majority of data before 2015 being unlabeled. For this chart, the unlabeled data consists of those transaction with no information in the foreign funding field that met the criteria for hand-coded FMS identification based on their funding account.

Figure 3: Limitations of Labeling of Foreign Funding



4.1.2 Contract Labeling via Machine Learning

Working with the FPDS data for analyzing FMS involved overcoming a significant missing data challenge. While 2016, 2017, and to a lesser extent 2015, were all reliably coded for foreign funding, in previous years coding was sparse or non-existent. In order to extend any analysis prior to 2015, it was necessary to create a classification process, in which unlabeled FPDS transactions can be labeled as either FMS or non-FMS.

To classify the unlabeled historical data, the study team experimented with several methods:

- Labeling contracts using hand-coded rules, which attempted to determine whether a transaction was FMS based on the treasury agency code and main account code recorded in FPDS.
- A machine learning classifier built using the Ranger package in R, an implementation of the random-forest family of algorithms.
- A neural network approach using the Tensorflow library in Python.
- A classifier built using the XGBoost library in Python, an implementation of the gradient-boosting trees family of algorithms.

All of the machine learning approaches were binary classifiers initially trained on known FPDS data, and were then used to classify unlabeled data from FY2012-2016 (a few transactions were unlabeled in 2016), filling in gaps in federal reporting. It should be noted that a minority of FY2012-2015 transactions were labeled in FPDS (and a majority of FY2016 transactions); these labels were retained across all labeling approaches (i.e. existing FPDS labels were preserved where they were present, and our custom classifier was used to label the remaining unlabeled data).

Ultimately, the XGBoost-based classifier, trained on a random sample drawn from all known data across FY2012-2017, performed the best on our largely categorical dataset out of the machine learning methods used. The predictions it provided for our unlabeled data was then joined to the known data (those transactions which were already labeled across FY2012-2017), to create a complete dataset across all our study years.

Given that most FMS transactions are paid for using a short list of funding accounts, the hand-rules approach was surprisingly robust in capturing FMS, but when compared with known 2016-2017 data, the hand-rules approach mis-identified 2.6% of the data in obligation terms (0.7% in terms of transaction count). When limited to known 2012-2015 data (which, though sparse, does exist) the hand-rules approach mis-identified only 1.5% of the data in obligation terms, suggesting a shift in how DoD manages or reports FMS in 2016-2017 versus earlier years.

Ultimately, the team selected to use the labels generated by the machine learning approach as the basis of our dataset used in the quantitative analysis laid out in this paper. The machine learning classifier has two main advantages over the hand-rules approach. First, the classifier performs better than the hand rules approach during diagnostic tests on random samples of the FY2012-2015 data, correctly identifying approximately an additional 0.1% of the known data of this period in obligation terms (relative to the hand rules approach), an improvement that, if extrapolated over the whole dataset, totals around three-quarters of a billion dollars in obligations. While this improvement is relatively small in the historical data, it does validate the approach, and as discussed above, is likely to be grow in size in future years if extended classification continues to be necessary, as the hand-rules approach seems to perform worse on the 2016-2017 data than on the 2012-2015 data, with the implication that future performance of the hand-rules approach will likely be worse than it is on the 2012-2015 data.

Second, the model correctly labels FY2016-2017 transactions (based on training on a random sample of known data, and then comparing to the remaining known 2016-2017 data) at a higher rate than the hand-rules approach (mislabeling rate of 0.67% as opposed to 0.7% for hand rules) – i.e. it displayed a lower propensity for mislabeling transactions during this time period than the hand-rules approach. Obviously, since the vast majority of 2016-2017 transactions have known labels, an improvement in

correctly labeling 2016-2017 transactions is less important, as the vast majority of these estimated labels will not actually be used in statistical testing. However, as mentioned previously, a small minority of 2016 contracts were left unlabeled in FPDS, and had to be labeled by estimation using one of our methods. Since the XGboost model performed better in classifying the known 2016-2017 data, it stands to reason that it has an advantage in correctly classifying those transactions in 2016 that are unlabeled, relative to the hand-rules approach.

It is worth mentioning here that to improve classifier performance, the study team added an additional binary variable to each transaction observation that measured whether or not a foreign country was mentioned in the text description of the transaction in FPDS. This variable was assembled through natural-language processing of the text description field using the spaCy library for Python.

The study team did attempt an alternative classifier training method in order to further improve performance, in which transactions in the training dataset were weighted in importance by the logged absolute value of their transaction amount, in theory, biasing the model towards identifying high-dollar transactions. The theory behind this was relatively straightforward: we were willing to sacrifice accuracy in labeling individual transactions in order to correctly capture more of the total FMS spending (i.e. it is more valuable to us to mislabel ten $1 transactions and correctly label one $10B transaction, rather than the opposite). That said, this specification of the classifier, trained on the weighted dataset, performed marginally worse than the classifier trained on an unweighted dataset in both number of transactions correctly labeled, and overall obligation amounts correctly labeled.[3]

4.2 Measurement of Independent and Dependent Variables

While all four datasets have limitations, between them they offer a number of valuable measures for analyzing FMS. DSCA, SIPRI, USITC, and classifier-extended FPDS allow for analysis of high-level trends in FMS expenditures over the last several years. These trends are measured via dollar value of total obligations for FPDS, dollar value of FMS deliveries for DSCA and USITC, and in TIVs (trend indicator values, a custom unit to measure value) for SIPRI.

Both SIPRI and FPDS record the type of arms being transferred, allowing for platform-level breakdowns of trends. However, the two datasets use a different taxonomy of platforms; for instance, SIPRI includes engines as a separate category while FPDS does not. Our team assembled a crosswalk from SIPRI to FPDS by coding the individual weapons platforms in the SIPRI categories which did not match FPDS portfolios. This makes it possible to break SIPRI data down into CSIS developed platform portfolios, allowing comparison between SIPRI and FPDS at the platform level. Additional work will be required to enable FPDS-to-SIPRI translation.

The vast majority of FMS transactions (in monetary terms) recorded in FPDS are made by the Department of Defense (for instance, in the 2012-2015 period, 99.5% of all FMS dollars passed through DoD). The study team thus decided to limit our FPDS-derived dataset purely to DoD contracting. The reader should thus be aware that models specified using FPDS-data compare DoD FMS contracting outcomes to the contracting outcomes of non-FMS DoD contracts. This step is taken both to simplify the

[3] The classifier trained on the weighted dataset provided predictions more in-line with those of the hand-rules method, which appears to track with the fact that the hand-rules used in said approach were developed by looking at trends in the highest-dollar FMS transactions.

analysis, but also to cut down on potential omitted variable bias, by avoiding comparing FMS DoD contract performance against non-FMS, non-DoD contracts, which may perform fundamentally differently simply because they are not DoD related, rather than because of any FMS-related characteristics.

USITC data lets us capture arms sales overseas based on the dollar value of deliveries, which we use to validate our approach with FPDS, in Section 5.1 Unfortunately, while USITC allows us to capture sales of platforms, it is much harder to capture other forms of FMS, like the sale of sensors, using the Harmonized Tariff System coding available in the USITC dataset. Moreover, USITC necessarily captures DCS, which, while interesting in itself, complicates cross-comparison with FMS-only sources. That said, the USITC data provides a very robust baseline to track US sales of arms abroad, and thus to track FMS, and is used in constructing our key variables for this paper, alongside SIPRI and DSCA.

4.3 Modelling

The paper's quantitative analysis section, which seeks to evaluate hypothesis one (H_1), utilizes our classifier extended FPDS dataset. The study team built six models for use in our quantitative analysis. Three of these models directly attempt to capture the relationships theorized about in H_1, and each model is run on a same random sample drawn from all defense completed contracts started during the FY2012-2017 period, except where otherwise specified. For each of these models, we estimate the effect of two binary variables on one of our three outcomes of interest: termination likelihood, ceiling breach likelihood, and ceiling breach size. These binary variables in turn capture whether a contract was FMS from its inception, or whether a contract became FMS after it started. Our ceiling breach size model is run only using observations in which a ceiling breach occurred, in order to avoid biasing our results towards zero, as contracts in which no ceiling breach occur far, far outnumber those in which they do.

Our three remaining models have the same dependent variables but are run only using FMS data. While these models obviously do not help us evaluate our hypothesis, they do let us evaluate whether FMS contracts, with their higher level of complexity, display fundamentally different relationships with our major contracting variables (a possibility laid out in section 3.1.1). This step was taken, instead of adding interaction terms between our FMS binary and those variables we theorized might display a different relationship in FMS and non-FMS cases, because the attempted inclusion of those interaction terms resulted in our model breaking through our acceptable variance inflation factor threshold.

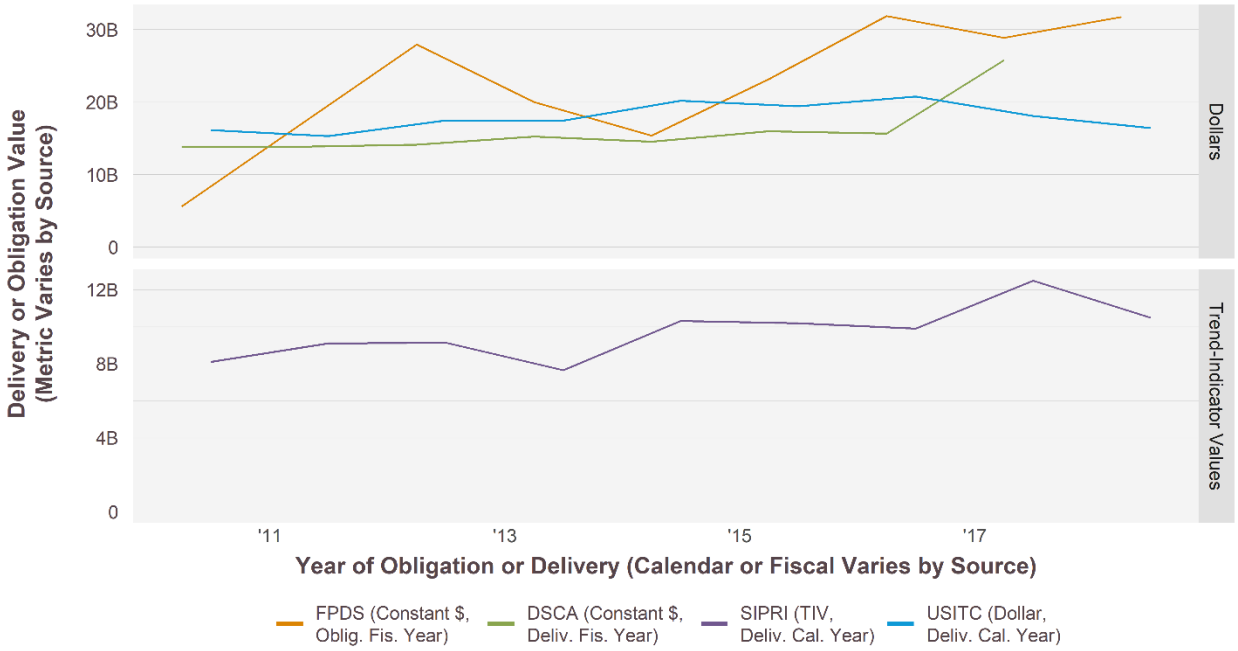
On a brief methodological note for the reader, we classify a contract as an FMS contract if any transaction associated with that contract is coded as FMS. Contracts are coded as FMS from the start if their initial transaction was coded as FMS. If a contract's initial transaction was not coded as FMS, but a subsequent transaction was, the contract is classified as FMS post-start. To be clear, we cannot truly hypothesis test using the FMS post-start variable, as a ceiling breach or partial termination, could, in theory, occur prior to the contract becoming FMS (though this seems implausible in the termination case). Our hypotheses are evaluated purely based on the estimated relationship between the outcome of interest and the FMS always binary.

5 Results

5.1 Validating FMS Contract Dataset

Before examining results or testing the hypotheses posited in this paper, it is essential to revisit the guiding research questions and falsifiable premise P_1 presented Chapter 3 of this paper, namely specifically about how the data in FPDS aligns with other sources. The first step towards answering that question is shown in Figure 4 below which displays the topline arms export value from all four datasets from 2010 to 2018. The period differs slightly from source to source, FPDS only begins reliably capturing FMS data in 2012 when funding accounts classification becomes consistently available. In the opposite direction, 2018 data is not yet available for DSCA.

Figure 4: Annual Arms Export Value by Source



Source: DSCA; USITC; SIPRI; FPDS; CSIS analysis. Unlabeled date had no net value and is excluded.

In interpreting Figure 4, it is important to remember the differing scope of each of the sources, noted also in the legends. Working through each of pairings with FPDS in turn, the values for FPDS and DSCA are both in constant dollars by fiscal year and report obligations and deliveries respectively. For FPDS, obligations refer to a payment promised from the government to a contractor. Deliveries are reliably accompanied by obligations, although if a contract is spread over multiple years, progress payments may result in FPDS obligations that precede DSCA deliveries. Nonetheless, it is noteworthy that once reliable FPDS data is available, the FPDS spend consistently exceeds that of DSCA. This is especially surprising because DSCA expenses should include costs to the government that do not result in obligations to contractors.

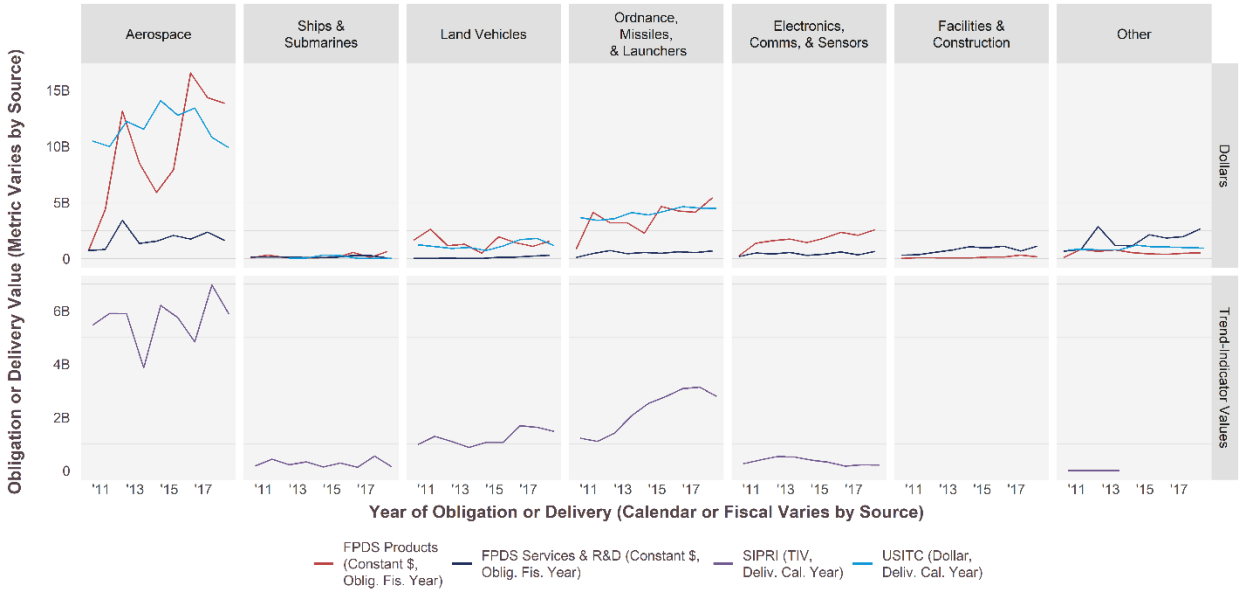
When comparing FPDS to USITC or SIPRI there are a greater number of critical differences than with DSCA. First, both SIPRI and USITC are primarily concerned with products and do not track services, which are an important part of the full package of FMS. Second, USITC and SIPRI are tracked by calendar year

rather than FPDS's fiscal year. Third, USITC includes DCS. SIPRI can include commercial to government exports in theory, but discussions with SIPRI scholars suggested that they believe that due to their strict three-source reporting requirements DCS exports would not be sufficiently documented to be covered in their database.

The fact that FPDS spending exceeds that of USITC does suggest that the FMS labeled transactions, even in the 2016 onward period when the data is most reliable, may include some transactions and obligations that are not exclusively FMS. Turning to SIPRI, that source measure exports in TIVs and not dollars, so the two scales are not directly comparable. Nonetheless, the similarity in trend is still noteworthy, as both SIPRI and FPDS show an increasing volume of deliveries despite regular setbacks.

To supplement the topline comparison, the study team broke down the FPDS, SIPRI, and USITC data into common platform categories to allow for more detailed cross comparison, shown in Figure 5. Because FPDS is the only source of the three to include service or R&D, FPDS products have been divided into a separate category to allow for easier comparison. The platform breakout inspires confidence because in most categories they show similar level and trends of exports. All three show that aircraft dominate U.S. arms exports while ships and submarines and land vehicles have low and relatively steady delivery rates. The sources also agree that Ordnance, Missiles, and Launchers is a distant second to Aerospace in terms of overall value, though SIPRI does show a steeper trend line of growth than the other two sources.

Figure 5: Annual Arms Export Value by Sources by Platform



Source: USITC; SIPRI; FPDS; CSIS analysis. Unlabeled date had no net value and is excluded.

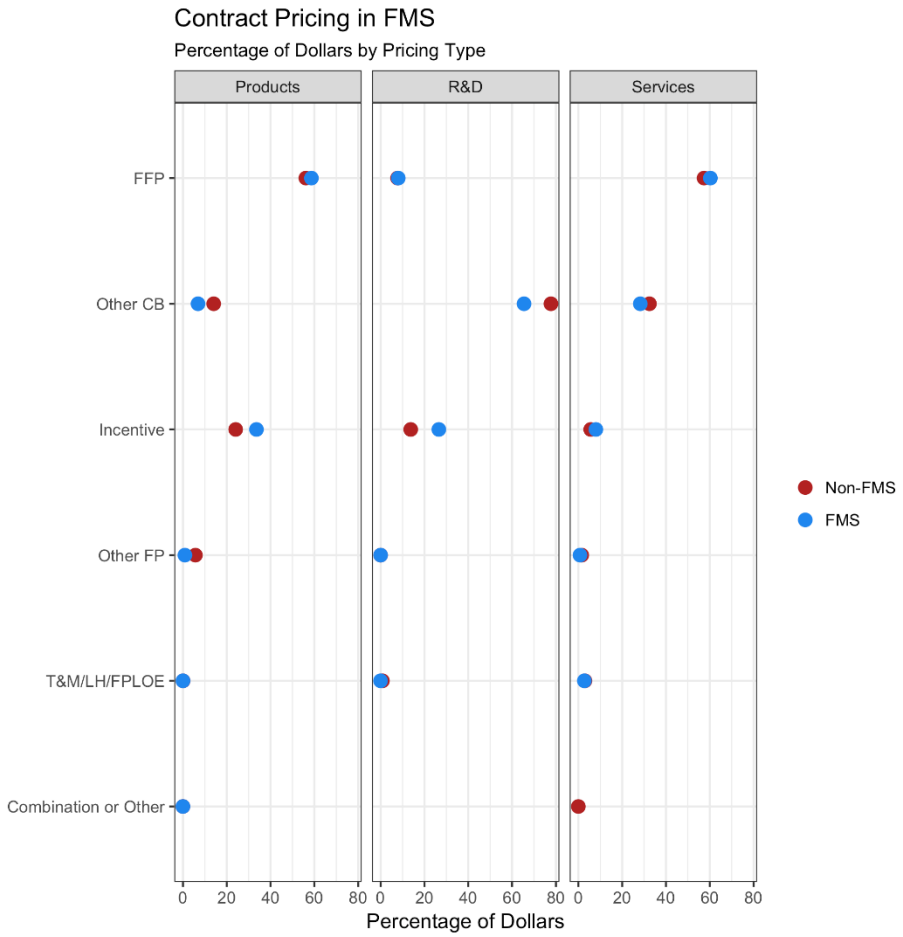
Across the first four categories that cover traditional weapon systems, the area where FPDS most diverged from the other two sources is in the volatility of FPDS's reported aerospace FmS exports. Closer examination by the study team found that FPDS contains several large aerospace FMS transactions in the spike year of 2012. In the past, CSIS analysis has found that large multiyear contracts sometimes show a similar pattern of large obligations in one year that that reflects the timing of payments more than any genuine fluctional in what is being produced.

There is greater divergence the three right columns in Figure 5, however, these differences can be primarily attributed to differences in reporting approaches than FPDS data quality issues. The delivery of electronics, communications, and sensors is harder for third parties to track and to estimate the value of, and consultations with SIPRI found that they believed there easily could be FMS exports in this category that their database was not tracking. The category is entirely absent for USITC due to aforementioned lack of detail on military end use of merchandise that is not a traditional platform or weapon. The difference in Facilities and Construction can also be attributed to the fact that neither SIPRI nor USITC cover services nor focus on the military products side of construction. By comparison, Foreign Military Construction Sales are a special category of FMS that is individually separately reported on by DSCA, though lumped with other forms of FMS for this report. Finally, the ther category includes products, services, as well as R&D and knowledge based that cannot be cleanly assigned to any prior platform category. The low reporting threshold for FPDS and its inclusion of almost all non-classified contracts mean that it as a source is best capable of capturing small bore transfers that are out of scope or not worth the effort for other sources to cleaning identify. That said, this is also an area where USITC captures a range of small arms exports while SIPRI covers those transfers in a different dataset.

5.2 Contracting Approaches for FMS

The transaction cost literature emphasizes that acquirers respond to different transaction cost context with different forms of contracts. Figure 6 shows the breakdown of contract pricing types for FMS and non-FMS DoD transactions.

Figure 6 Contract Pricing for FMS versus non-FMS contracts



FMS and non-FMS pricing structures are similar in many ways, especially for service provision. For both products and R&D however, there is meaningful divergence in contract structure in keeping with expectations from the theoretical literature. FMS transactions tend to use incentive-based contracts, specifically fixed-price incentive fee, more frequently than non-FMS transactions. That approach was favored, where appropriate, by the Better Buying Power initiatives and would be in keeping with the use of higher-incentive contracts in the presence of reduced monitoring capacity and higher transaction costs as may be the case in international transfers. Interestingly, the higher use of incentives by FMS contracts does not result in a drop of firm-fixed-price contracts. Instead, FMS transactions tend to use other cost-based mechanisms less often than non-FMS transactions, which may suggest differences in monitoring capacity or degree of trust for domestic sales as opposed to FMS.

5.3 Ceiling Breach Models

Table 1: Ceiling Breaches

	DoD Likelihood (Logit)	**FMS Likelihood (Logit)**	**DoD Size Given Breach (Regression)**	**FMS Size Given Breach (Regression)**
(Intercept)	**-6.15** (0.38)***	**-5.90** (0.58)***	**6.78** (0.15)***	**7.85** (0.43)***
Study Variables				

FMS=Always	0.23 (0.34)		0.03 (0.09)	
FMS=Post-Start	-0.32 (1.07)	**0.99** (0.13)***	0.14 (0.17)	0.28 (0.22)
Contract Characteristics				
Log(Init. Base)	**1.39** (0.11)***	**1.16** (0.13)***	**3.01** (0.03)***	**2.96** (0.20)***
Log(Init. Ceiling:Base)	**0.07** (0.02)***	0.02 (0.02)	**0.07** (0.01)***	-0.01 (0.05)
Log(Planned Dur.)	**0.45** (0.10)***	**0.81** (0.20)***	**0.28** (0.03)***	-0.11 (0.32)
Comp=1 offer	-0.00 (0.12)	-0.38 (0.20).	**-0.07** (0.04)*	-0.37 (0.37)
Comp=2-4 offers	0.04 (0.10)	-0.14 (0.15)	**-0.06** (0.03)*	-0.19 (0.25)
Comp=5+ offers	-0.02 (0.10)	-0.16 (0.20)	-0.05 (0.03).	-0.12 (0.35)
Vehicle=S-IDC	-0.14 (0.11)	**-0.67** (0.14)***	0.06 (0.03).	-0.07 (0.24)
Vehicle=M-IDC	0.23 (0.13).	-0.27 (0.21)	0.07 (0.04).	-0.48 (0.34)
Vehicle=FSS/GWAC	-0.23 (0.17)	-0.09 (0.37)	-0.03 (0.05)	-0.64 (0.67)
Vehicle=BPA/BOA	**-0.34** (0.16)*	**-1.14** (0.20)***	-0.06 (0.05)	-0.43 (0.37)
Pricing=Other Fixed-Price	**-1.96** (0.54)***	0.01 (0.67)	-0.11 (0.12)	**2.08** (1.06)*
Pricing=Incentive Fee	**2.48** (0.45)***	-0.04 (1.07)	**1.19** (0.17)***	0.47 (2.01)
Pricing=Comb. or Other	-13.39 (27.29)	0.12 (0.79)	0.50 (0.40)	0.21 (1.46)
Pricing=Other Cost-Based	0.19 (0.21)	**0.48** (0.20)*	**0.94** (0.06)***	0.57 (0.30).
Pricing=T&M/LH/FP:LoE	**0.74** (0.37)*	**1.34** (0.40)***	**0.67** (0.12)***	1.04 (0.70)
Pricing=UCA	**1.22** (0.21)***	**0.74** (0.14)***	0.06 (0.07)	**0.50** (0.23)*
NAICS/Office Characteristics				
Log(Subsector HHI)	**-0.36** (0.17)*	-0.45 (0.25).	0.09 (0.06)	0.22 (0.33)
Log(Subsector DoD:US)	0.24 (0.24)	-0.40 (0.22).	0.02 (0.12)	-0.17 (0.31)
Log(Det. Ind. HHI)	-0.00 (0.13)	0.33 (0.19).	0.04 (0.04)	0.30 (0.25)
Log(Det. Ind. DoD:US)	0.03 (0.06)	**-0.24** (0.12)*	0.04 (0.03)	**-0.30** (0.13)*
Log(Det. Ind. DoD Obl.)	0.23 (0.13).	**0.97** (0.21)***	**0.16** (0.05)***	**0.88** (0.26)***
Log(Det. Ind. Salary)	**-0.37** (0.15)*	**-0.81** (0.24)***	0.00 (0.06)	0.02 (0.28)
Log(Office Focus)	-0.01 (0.15)	0.20 (0.27)	-0.07 (0.05)	-0.24 (0.22)
Paired Years	0.09 (0.10)	0.31 (0.17).	0.01 (0.03)	0.11 (0.28)
Log(Paired Obl.)	-0.18 (0.12)	-0.06 (0.18)	0.06 (0.03).	0.15 (0.30)
Interactions				
Log(Det. Ind. Salary):Pricing=Other Fixed-Price			**1.15** (0.29)***	
Log(Det. Ind. Salary):Pricing=Incentive Fee			**-2.06** (0.45)***	
Log(Det. Ind. Salary):Pricing=Comb./Other			0.45 (1.26)	
Pricing=Log(Det. Ind. Salary):Other Cost-Based			**-0.57** (0.15)***	
Log(Det. Ind. Salary):Pricing=T&M/LH/FP:LoE			-0.34 (0.21)	
Log(Det. Ind. Salary):Pricing=UCA			-0.06 (0.14)	
AIC	8806.83	5018.65	194175.37	2866.20
BIC	9150.99	5305.37	194526.42	3005.65
Log Likelihood	-4370.41	-2478.32	-97047.69	-1402.10
Num. obs.	250000	76818	47869	664
Num. groups: Office:Agency	1091	479	732	
Num. groups: NAICS6:NAICS3	765	495	682	
Num. groups: Place	127		128	28
Num. groups: NAICS3	79	66	79	30
Num. groups: Agency	23	14	23	10
Var: Office:Agency (Intercept)	1.20	1.34	0.27	
Var: NAICS6:NAICS3 (Intercept)	0.38	0.55	0.13	
Var: Place (Intercept)	0.27		0.14	0.12
Var: NAICS3 (Intercept)	0.25	0.03	0.18	0.20
Var: Agency (Intercept)	0.75	1.83	0.10	0.04
Var: Residual			3.28	3.94

***p < 0.001, **p < 0.01, *p < 0.05, .p < 0.1. Numerical inputs are rescaled.

Table 1 above shows the model results for the two logistic regression ceiling breach likelihood models and then two size of breach, should a breach occur models. The models based on the DoD-wide datasets are listed first in each pairing and that first model is used to evaluate H_1. The second model in each pairing is run exclusively on the FMS dataset and is included for comparison sake to examine whether the drivers for FMS are different than those for the acquisition system writ large. Due to challenges with identifying models and avoiding negative eigen values, the multilevel groups included varied between different models. If a grouping was not used for a model, the entry in that column for number of groups and variance is left blank.

5.3.1 Ceiling Breach Likelihood

Ceiling Breach likelihood has a binary outcome, a breach occurred or it did not, and as a result uses a logit model. The regression coefficients in Table 1 are useful for comparing the relative magnitude of estimated affect across various models, but to better understand the influence of a single variable, refer to Appendix B: Table B-1 to see the odds ratios for each variable.

The model does not support H_1 as there is no statistically significant relationship between contracts that are FMS from the start. Even were the coefficient significant, the sign is positive, which is contrary to the hypothesis's prediction that FMS contracting would be associated with a lower risk of ceiling breaches.

Comparing the DoD-wide model and the FMS only model, when a variable is significant in both models, they consistently have the same sign. The unmodified base size of the contract and the unmodified duration are significantly estimate a greater likelihood of breaches in both models at the 0.1 percent level. Use of a Blanket Purchase Award/Basic Ordering Agreement (BPA/BOA) vehicle as estimated lower risk of breach in both models, although the significance was greater for the FMS model (5 percent level for DoD-wide and 0.1 percent level for FMS and use of a Undefinitized Contract Award (UCA) contracts estimated greater risks of ceiling breaches for both models (significant at the 0.1 percent level). Finally high wage sectors are associated with lower risks of breaches in the DoD-wide and FMS models (significant at the 5 percent and 0.1 percent level, respectively.

This is not to say that the two models match, more than half the time when a coefficient is significant in one model, it is not significant in the other. Focusing on the FMS model, the differences fell in three categories. First, Single-Award Indefinite Delivery Contracts estimate lower risk of breaches (significant at the 0.1 percent level) and while BPA/BOA estimates lower risk for both models, the coefficient is three times as large for the FMS model. Second, other cost-based and time and materials/labor hours/Fixed Price:Level of Effort (T&M/LH/FP:LoE) contracts are each associated with higher risk for FMS contracts (significant at the 5 percent at 0.1 percent level respectively). However, this does not translate into general challenges with contract pricing mechanisms that include cost, as incentive fee contracts estimate higher risk for the DoD-wide model (significant at the 0.1 level) but not for the FMS model. Finally, the size of the DoD presence in an industry estimates greater risk and as does a larger DoD industry relative to the U.S. economy as a whole (significant at the 0.1 level and the 5 percent level, respectively).

5.3.2 Ceiling Breach Size

In the model of ceiling breach size, both FMS variable categories, FMS always, and FMS post-start, have no statistically significant effect on the size of a contract ceiling breach, should said breach occur, meaning we find no support for $\mathbf{H_{1C}}$ (based on the FMS always result).

For the DoD-wise model, while incentive pricing schemes and those pricing schemes falling into the other cost-based category (the range of cost-plus contracting approaches with the exception of cost plus incentive fee) both have a positive, statistically significant effect in this model on ceiling breach size (as expected), when interacted with average NAICS6 industry salary, which we use as a proxy for how complex the contracting task is, the interaction term in both cases displays a highly statistically significant, strong negative relationship with ceiling breach size. In other words, as industry average salary rises, the magnitude of the statistically significant positive effect other cost-based pricing schemes and incentive pricing schemes has on the estimated ceiling breach size decreases, and in the case of incentive pricing schemes, actually flips to negative for the very highest levels of average industry salary.

The FMS only model is broadly consistent with the results of model run on both FMS and non-FMS data, despite some variations in the magnitude (but not direction) of some mutually statistically significant variables. No mutually statistically significant variables demonstrate contrasting relationships between the two models.

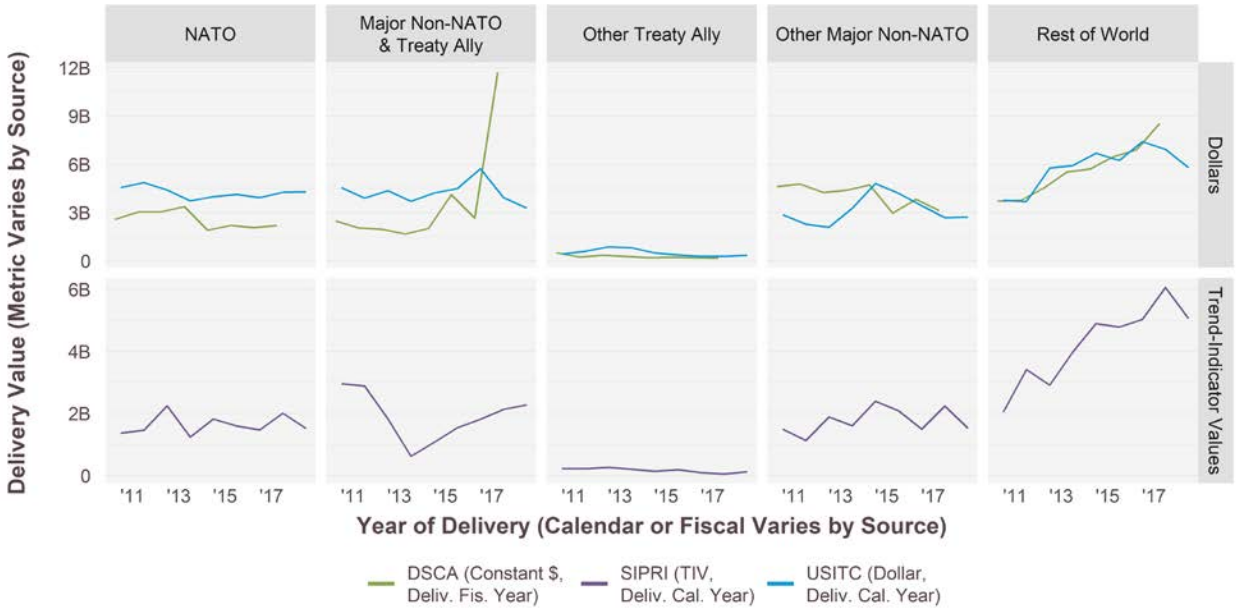
Focusing on the FMS model, UCA contracts and other fixed price contract estimate a greater size of breach, should one occur (both significant at the 5 percent level). Interestingly, the FMS model results for breach size and likelihood mirror each other for the level of defense spending in a detailed industry and the ratio of that industry to the U.S. economy as a whole, with greater defense obligations in a detailed industry and a proportionally larger industry being associated with greater risks (significant at the 0.1 percent and 0.05 percent level respectively).

5.4 Trends in U.S. Arms Trade

This section analyzes the current state of use FMS exports with special attention to key variables identified during the literature review: the extent of security partnership between the seller and the buyer and the institutional health of the purchasing country.

For analyzing the alliance status in FMS contracting outcomes, the research team consolidated the range of US allies and partners into several broad categories. The first security partnership grouping is the NATO alliance and its member states which includes the 28 NATO countries, not including the United States. The second grouping covers a category called “Major Non-NATO & Treaty Allies,” which includes countries that are both designated as official Major Non-NATO allies and are also actively in a formal U.S collective defense agreement (US House of Representatives, 2019). For example, the Republic of Korea is both designated as a Major Non-NATO ally and is also simultaneously part of the bilateral Republic of Korea Treaty signed in 1953 with the United States, which qualifies Korea for the “Major Non-NATO and Treaty Allies” category in our study. Third, we use the “Other Major Non-NATO” grouping to capture those countries that are designated Major Non-NATO allies, but not also in separate US collective defense arrangements such as Israel, Taiwan, and Egypt. Fourth, we use the “Other Treaty Ally” designation, which includes countries that are in US collective defense arrangements, but are not designated Major Non-NATO allies. Finally, “Rest of World” captures all remaining countries.

Figure 7 U.S. Arms Exports by Relationship with Buyer



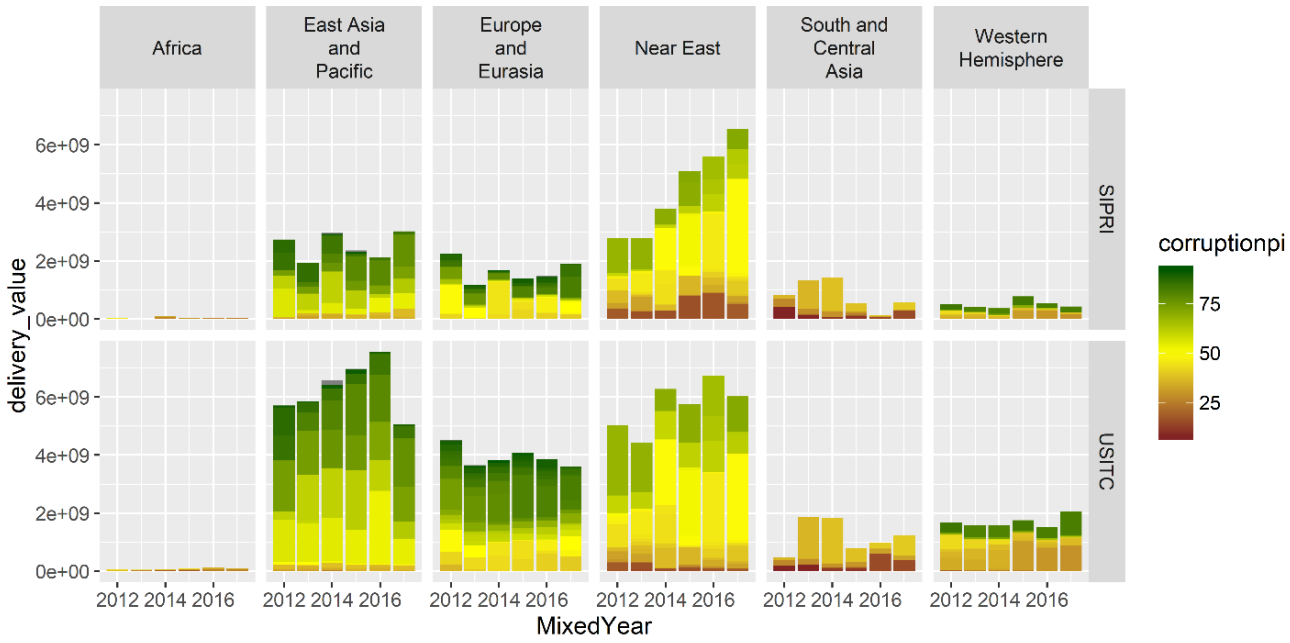
When looking specifically at the "NATO" allies grouping, Figure 7 shows that the USITC and DSCA data are fairly agreeable; however, the USITC data shows a higher delivery value than that of the DSCA data. This could likely be explained due to the fact that the USITC data captures DCS. For many of the United States' closest allies, like those in NATO, DSC generally plays a more prominent role in their imports from the United States than any other component, which is likely why their DCS exceeds their FMS. Similarly, this is perhaps why the USITC data has consistently higher totals than the DSCA data for the "NATO" category.

As relationships between the US and countries get closer, it is often also the case that the industrial relationships grow closer. This is why DCS, shown through USITC data, is so high in both the "NATO" and "Major Non-NATO and Treaty Ally" categories. Major Non-NATO status also grants designated countries various military and acquisition benefits, which also bring those countries closer the US. This is likely why the "Major Non-NATO and Treaty Ally" section includes generally high DCS totals, although they have been declining in the observed years. It seems like the "Other Major Non-NATO" category, which captures any countries that were not already captured, still has higher DCS totals than those in the "Other Treaty Ally" category. The "Other Treaty Ally" category may be steadily the lowest in its delivery value totals which may reflect a tendency to elevate those countries that are significant FMS partners to Major Non-NATO ally status. Absent such a move, these countries are solely in mutual defense treaties, which does not grant them the same kinds of acquisition advantages as those designated as Major Non-NATO or NATO.

For the "Rest of the World" category, FMS seems to play the most prominent role and a steadily increasing role than it does in any other category of alliance-level. This is seen through the DSCA data trend lines in Figure 7. FMS totals are consistently higher on average for "Rest of World" than in most other alliance category (aside from the sharp increase in FMS exports observed in the "Major Non-NATO and Treaty Ally" category which is due to the aforementioned Republic of Korea DSCA reporting case).

Countries captured in “Rest of World” may be less capable, capacity wise, to handle the services support themselves and might need services support through FMS, which is also subsequently why those FMS totals might also be higher.

Figure 8: Corruption Perceptions by Region



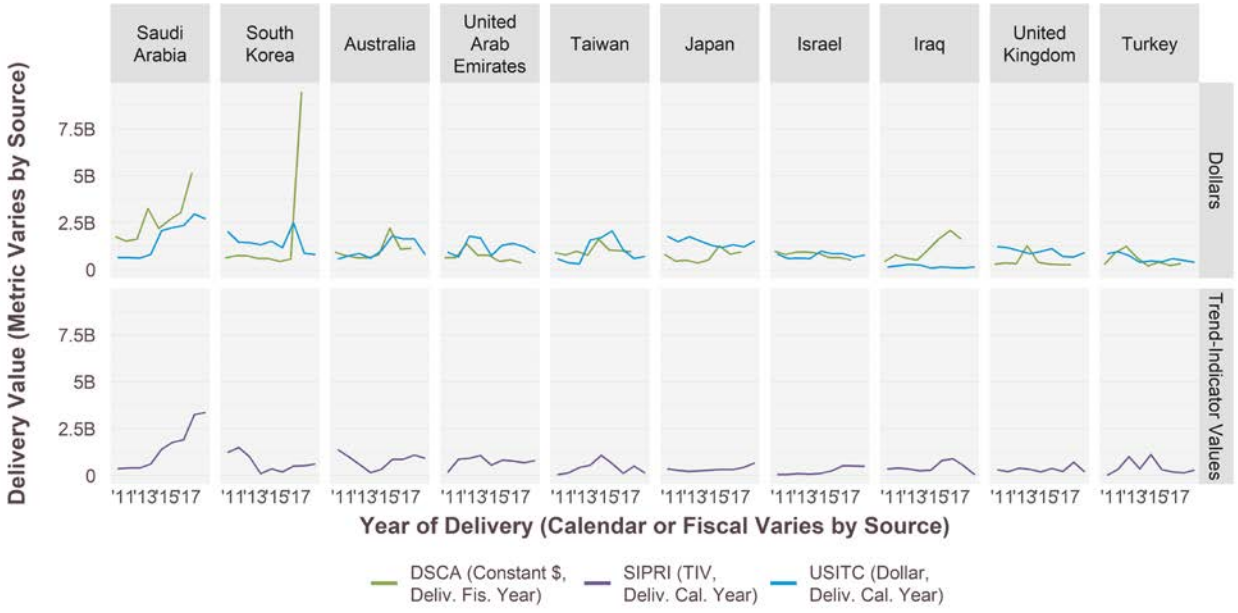
Note: Non-Regional Deliveries are Excluded from this Figure

As discussed in Chapter 2, security sector assistance scholars emphasize the importance of partnering with recipient countries who not only share aligned defense objectives with the United States, but who have the institutional infrastructure to reduce the risk that major government expenditures, such as FMS purchases, will be used to further rulers’ personal interests, for example by strengthening support within their armed forces, rather than serving the nation’s interests. Shared value commitments and a willingness to build up institutions, in order to ensure long-term success of programs. Furthermore, under the Leahy Laws, recipient countries of US security sector assistance are not to commit gross violations of human rights. Due to the general importance given to good governance in partner nations in the field, the study team wanted a way to examine exports based on transparency levels.

Using the Corruption Perceptions Index (CPI) produced by Transparency International, the study team created a chart, matching CPI data with the relevant data from SIPRI and USITC, which ultimately combines to show US exports regionally with their respective transparency values. CPI codes countries on a scale of 0 to 100, with 0 being the most corrupt and 100 being the least corrupt “based on perceived levels of public sector corruption” (Corruption Perceptions Index, 2019). In this index, Sweden ranks among the highest in transparency at an 85, while a country like Syria ranks at a 13, which is one of the least transparent and most corrupt.

Figure 8 provides the region-by-region breakdown of US exports and total delivery values. The gradient key incorporates the CPI values with darker green being closer to 100 (least perceived corruption) and red being closer to 0 (most perceived corruption). While the Near East region ultimately receives the highest value of US exports over the years studied, it is not the least corrupt region as a whole (least corrupt is Europe and Eurasia). That being said, it is also not the most corrupt region the US exports to either, which appears to be South and Central Asia. The East Asia and Pacific region appears to have healthier institutions and still receives a substantial amount of US exports.

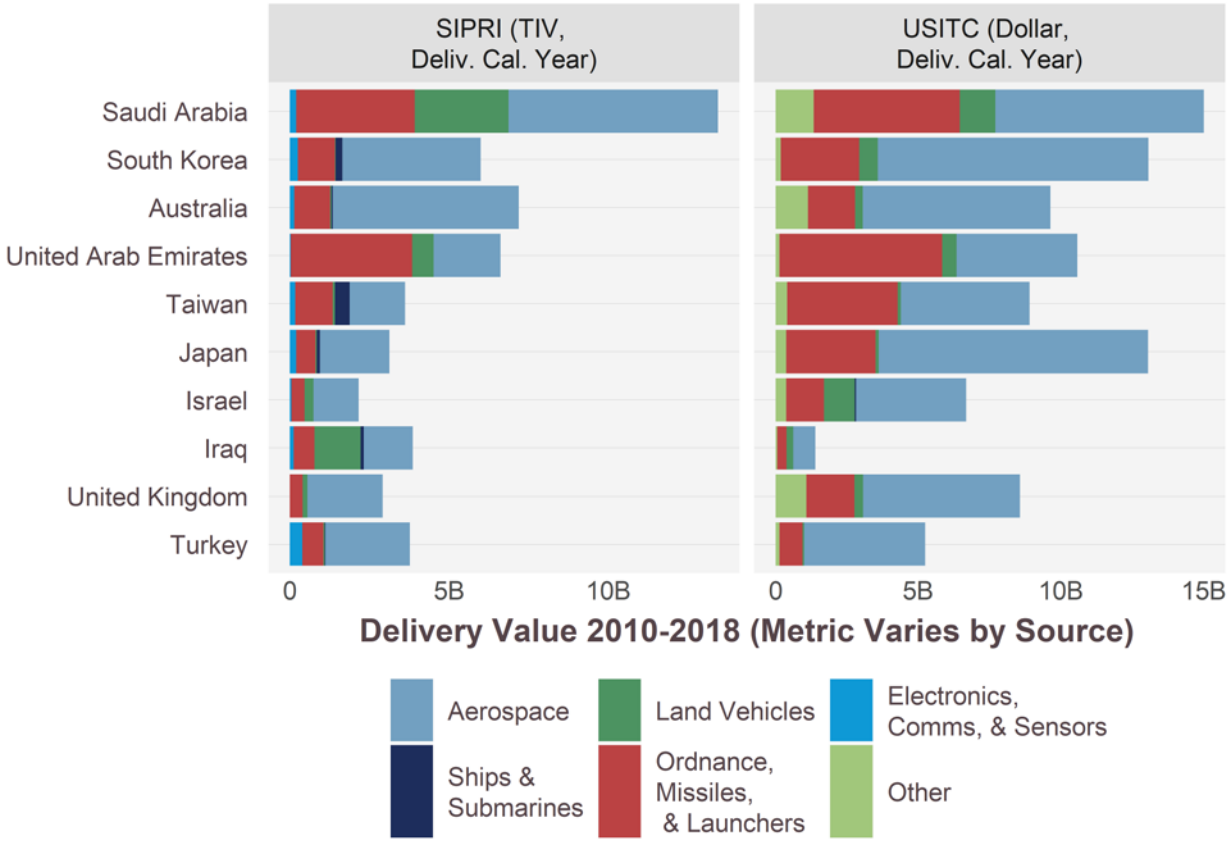
Figure 10: Top 10 Recipients 2010-2018



The country-by-country breakdown of US exports shows that 1) the Near East and 2) the East Asia and Pacific regions tend to receive the highest amount of US transfer. Specifically, Figure 9 shows the Top 10 recipients of US exports by country for approximately the 2010 to 2018 timeframe. The chart presents the data in a scale fashion from left to right, with the left-hand side being the recipient country with the highest amount of US articles and services transferred over the years studied. As shown in the figure, Saudi Arabia received the highest number of arms exports from the United States across the years of study, with South Korea coming in second, Australia third, and the United Arab Emirates in fourth. Previously in the paper, it was observed that FMS totals typically exceed DCS transfers in the Near East region. While the country breakdowns for Saudi Arabia and Iraq follow that general trend of FMS playing a bigger role than DCS, observed through the higher DSCA totals versus USITC totals, it appears that in the United Arab Emirates case, DCS may play a bigger role than FMS.

When breaking these countries down by platform, Figure 9 shows that the United States mainly exports items in the following categories to Saudi Arabia in highest to lowest order: 1) aerospace, 2) ordnance, missiles, and launchers, 3) land vehicles. Although ships and submarines make up a small amount of US exports when looking at the broader picture, they do appear in a notable amount in the East Asia and Pacific region countries including Taiwan, South Korea, Japan, and less so, but still notable in Australia.

Figure 9: Platform Breakdown for Top 10 Recipients, 2010-2018



6 Discussion and Conclusion

First, this section reviews the research question that drove this project. Then, it addresses limitations of the research, reviews finding on what the results tell us about the state of FMS, and concludes with the larger implications of this study.

6.1 Answers to Research Questions

1. **How can contracts that utilize FMS be better identified in FPDS using information from other fields?**

The machine learning approach employed by this paper was able to fill in the gaps on FMS contracting in the 2012-2015 period. This approach was still dependent on the availability of highly relevant columns, notably the funding account, but nonetheless was still able to achieve greater accuracy than hand coding methods. This approach is no substitute for proper labeling at the start, but has the potential to address a common, real-world challenge. While in many cases, the amount of unlabeled, or worse mislabeled data, in FPDS has declined over recent years, there is rarely time or budget to go back and make largescale improvements to prior years. When there are enough clues and approaches to cross-validation available, machine learning of past data can redouble the benefits of improving present data.

Despite this good news, the study team was not able to find a way to bulk identify the recipient countries for FMS transactions. While some existing fields would assist in identifying the recipient an FMS transaction, for example equipment related services may be identifiable by examining the place of performance, public FPDS data does not have a column to track what country a given transaction is supporting. There are multiple ways to resolve this problem gap, but even simply making sure that the text description notes the recipient country would be a vast improvement over what we found to be standard practice. Any progress in better tying FPDS transaction to the notification announcement they are supporting would also aid in addressing this egregious absence.

2. **How does FPDS foreign funding data align with the Defense Security Cooperation Agency's FMS data?**

While FPDS and DSCA totals follow similar patterns, the FPDS figures for FMS contracts generally substantially exceed the deliveries reported by DSCA. This is not just a property of the machine learning labeled data, but holds true in both 2016 and 2017, where the FMS label is reliably filled in. Some of this gap may reflect obligations on deliveries in years to come, however, its persistence over the 2012-2017 period suggests that this is not simply a matter of timing. Second, this may be partially due to the possibility that, even when an FPDS transaction is correctly identified as containing FMS funding, that does not necessarily mean that the entirety of the transaction, let alone the contract, is for an international audience. FMS is tightly integrated into the U.S. acquisition system and practitioners have noted that international customers may only be one funder among many in a large bundled buy. Nonetheless, this possibility does merit further study, especially considering that there are already provisions within FPDS that break out the FMS portions of larger transaction.[4],This explanation also remains speculative and hand-verification of a selection of the largest FMS transactions in FPDS did not find any mixed transactions.

3. **Do FMS contracts perform better than non-FMS contracts?**

The paper did not find support for H_1 and indeed in comparing models for the whole of DoD and for the FMS dataset specifically did not present stark contradictions. In some cases, a variable was significant for one but not the other, but no clear-cut findings on special approaches to FMS contract actions emerged from the literature or the modeling effort.

4. **What variables contribute to the performance of FMS contracts and in what direction and magnitude?**

Comparing the results for the overall DoD dataset and the FMS dataset for the model of ceiling breach likelihood and size, when said breach occurs found broad similarities, as is discussed in section 5.3. However, while there were not any notable contradictory results between what estimates better performance for all DoD contracting and for FMS contracting specifically, the FMS model did find some significant variables that were less important or not significant at all in the larger model. For both ceiling breach likelihood and size, given a breach occurring, risks rose when the product or service being acquired was in a detailed industry with large DoD expenditures (0.1 percent significance level) and

[4] The GSA FPDS-Next Generation Data Element Dictionary (2017) advises users to "Assign a unique Transaction Number for each report when multiple reports are required for a single contracting action such as 1) actions that include both Foreign Military Sales and non-FMS requirements," (p. 17)

when DoD spending in the detailed industry was proportionally larger compared to the U.S. economy as a whole (5 percent significance level). This result is not of much use to someone seeking the best way to procure weapon systems, but it does suggest that the FMS system is capable of handling a broad range of products and services through the U.S. acquisition system. The other significant results seemed consistent with existing practice. Contract vehicles, specifically single-award IDCs and and BPA/BOAs were associated with a lower risk of ceiling breach (0.1 significance level). The results on pricing were mixed between the likelihood and size model, but notable risk increases associated with incentive fee contracting in the DoD-wide dataset did not extend to the models built on the FMS dataset.

6.2 Limitations of these Results

The dataset used for the FPDS analysis covers completed contracts that began between fiscal year 2012 to fiscal year 2017. While this step allows capturing a wider range of the available FMS data, it also means that in more recent years, the sample includes necessarily shorter duration contracts. Perhaps because of this shift to more recent data, the study team encountered challenges with models not just feeling to converge but also warnings of models being nearly unidentifiable: large eigenvalue ratio. In some cases, this forced the study team to remove multilevel variables that would have been otherwise been left in and result reduce the level of consistency between different models.

The absence of country labeling limits the ability of the and future researchers to directly observe whether recipient characteristics variables, such as the security partnership and institutional health discussed in section 5.4, influenced outcomes within the acquisition system. By making the connection between the FMS data and partnership status and the Transparency International corruption perception data, the study team seeks to enable future practitioners and researchers to build on the work done by this paper in integrating multiple sources .

Given the absence information needed for country labeling within FPDS, the study team was not able to directly test the impact of these security assistance factors on the acquisition system. The limitations on tracking FMS spending in FMS significantly impede not just the research questions raised in this paper, but a range of other pertinent questions regarding this important and controversial subset of defense contracting. For security sector assistance in particular, assessment, monitoring, and evaluation are watchwords. More rigorous data enables anyone seeking to understand the benefits and risks of present FMS. By presenting the key variables and the underlying data, the study team hopes to assist future practitioners and researchers.

6.3 State of FMS

What has changed and what remains steady?

Over the 2012-2018 period there has been significant growth in the Near East and in Ordnance, Missiles, and Launcher deliveries. Saudi Arabia has shown the most growth in receipts across all three sources, although for other countries their prominence depends on the measure and metric used. It is too soon to see the implications of the April 2018 revisions to the Conventional Arms Transfer policy in this data, especially because this report is focused on deliveries, which often have a longer lead time, rather than agreements which can be more reactive to changes in leadership approach.

However, in the bigger picture, despite the political and economic drives discussed in the introduction, for much of the world the state of foreign military sales has shown a great deal of continuity during this

period. Breaking down the world by security agreement, NATO and Major Non-NATO allies (divided in this paper based on whether they are in a mutual defense agreement) are each recipients of a steady share of U.S. exports, but much of the growth comes from countries that do not fit in these categories. From an institutional perspective it is countries that have been in the middle-tier of corruption perceptions that have experienced the most growth. Based on the security assistance literature, these trends signal a growth of potential risk for the acquisition branch of security cooperation.

Have we seen a shift in U.S. exports to greater FMS at the expense of DCS?

This topic has been a concern of industry, and one which is illuminated by comparing USITC, which includes both categories of experts, to those of the DSCA which is focused on FMS. Even setting aside the possibly anomalous spike in deliveries to the Republic of Korea in 2017, this has been a period of growth for FMS, so displacement of other forms of exports is not out of the question. However, the relative increase in FMS appears to be driven more by the composition of recipient countries than by any given group of country choosing to rely more on FMS and less on DCS. This does not rule out a counterfactual that some of these sales may have been made by DCS were in not for the push in FMS. However, for countries that do not have as close of a security relationship to the United State, reinforcing ties through FMS purchase and full package support can be part of the appeal.

6.4 Closing Thoughts

For both those interested in the political and the economic side of FMS, greater transparency can enable understanding of its change state and the related risks and benefits. While the breadth and quality of reporting has faced setbacks on some fronts, the improved labeling of FPDS opens up a new avenue for evaluating the economic case and monitoring whether a major announced agreements are translating into reality. The study team hopes this report helps build on the reports of those inside government and the hard work of NGOs to illuminate the system and its interconnected and at times competing goals.

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Appendix A: About the Authors

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Samantha Cohen – worked as a research associate with the Defense-Industrial Initiatives Group at CSIS. Her work focuses on managing and analyzing data to identify relationships among policies, defense spending, and the related impacts on the United Sates and national security. Her recent research focused on designing and managing international joint development programs, new entrants' survival rates and business graduation in the market for government contracts, and defense acquisition trends. Ms. Cohen holds a B.S. in economics from American University in Washington, D.C., and an M.S. in economics from Katholieke Universiteit (KU) Leuven Belgium.

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Appendix B: Model Odds Ratios

Table B-1 DoD-Wide Dataset Ceiling Breach Odds Ratios

variable	OR	2.50%	97.50%
(Intercept)	0.00	0.00	0.00
FMS=Always	1.25	0.64	2.46
FMS=Post-Start	0.73	0.09	5.93
Log(Init. Base)	4.03	3.28	4.95
Log(Init. Ceiling:Base)	1.08	1.03	1.12
Log(Planned Dur.)	1.56	1.29	1.89
Comp=1 offer	1.00	0.78	1.27
Comp=2-4 offers	1.05	0.87	1.26
Comp=5+ offers	0.98	0.80	1.21
Vehicle=S-IDC	0.87	0.70	1.07
Vehicle=M-IDC	1.26	0.97	1.64
Vehicle=FSS/GWAC	0.80	0.57	1.12
Vehicle=BPA/BOA	0.71	0.52	0.97
Pricing=Other Fixed-Price	0.14	0.05	0.40
Pricing=Incentive Fee	11.90	4.92	28.77
Pricing=Comb. or Other	0.00	0.00	2.6E+17
Pricing=Other Cost-Based	1.21	0.79	1.84
Pricing=T&M/LH/FP:LoE	2.09	1.02	4.29
Pricing=UCA	3.37	2.23	5.11
Log(Det. Ind. HHI)	1.00	0.77	1.30
Log(Det. Ind. DoD:US)	1.03	0.92	1.15
Log(Det. Ind. DoD Obl.)	1.26	0.97	1.62
Log(Det. Ind. Salary)	0.69	0.52	0.93
Log(Subsector HHI)	0.70	0.51	0.97
Log(Subsector DoD:US)	1.28	0.80	2.05
Paired Years	1.09	0.89	1.33
Log(Paired Obl.)	0.83	0.66	1.04
Log(Office Focus)	0.99	0.74	1.33

Table B-2 FMS Dataset Ceiling Breach Odds Ratios

variable	OR	2.50%	97.50%
(Intercept)	0.00	0.00	0.01
FMS=Post-Start	2.70	2.09	3.50
Log(Init. Base)	3.18	2.47	4.10
Log(Init. Ceiling:Base)	1.02	0.97	1.06
Log(Planned Dur.)	2.24	1.53	3.29
Comp=1 offer	0.69	0.46	1.02
Comp=2-4 offers	0.87	0.65	1.15
Comp=5+ offers	0.85	0.57	1.27
Vehicle=S-IDC	0.51	0.39	0.67
Vehicle=M-IDC	0.77	0.50	1.17
Vehicle=FSS/GWAC	0.91	0.44	1.88
Vehicle=BPA/BOA	0.32	0.22	0.47
Pricing=Other Fixed-Price	1.01	0.27	3.77
Pricing=Incentive Fee	0.96	0.12	7.78
Pricing=Comb. or Other	1.13	0.24	5.32
Pricing=Other Cost-Based	1.62	1.10	2.39
Pricing=T&M/LH/FP:LoE	3.81	1.72	8.41
Pricing=UCA	2.10	1.61	2.74
Log(Det. Ind. HHI)	1.39	0.96	2.00
Log(Det. Ind. DoD:US)	0.79	0.63	0.99
Log(Det. Ind. DoD Obl.)	2.63	1.73	3.98
Log(Det. Ind. Salary)	0.45	0.28	0.71
Log(Subsector HHI)	0.64	0.39	1.04
Log(Subsector DoD:US)	0.67	0.44	1.02
Paired Years	1.37	0.99	1.90
Log(Paired Obl.)	0.94	0.66	1.35
Log(Office Focus)	1.22	0.72	2.06

Appendix C: Model Diagnostics

Figure 10 Fitted and Residual Plots for DoD-Wide Dataset Ceiling Breaches

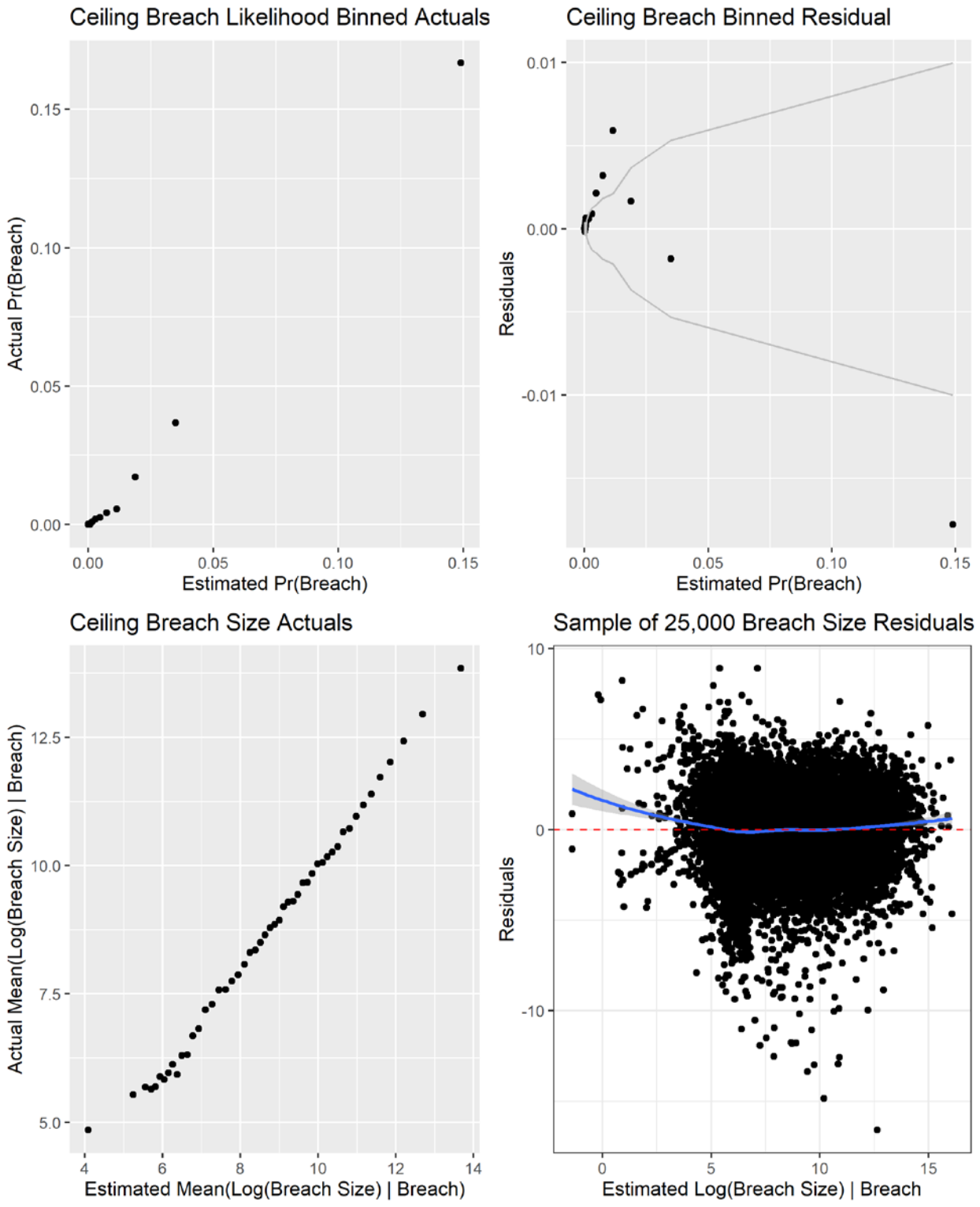

Figure 11 Fitted and Residual Plots for FMS Dataset Ceiling Breaches