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Analysis of the Multiple Award Contracting Strategy on U.S. Government Husbanding Service Provider (HSP) Prices

June 2020

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

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ABSTRACT

In 2016, the U.S. Navy transitioned from Single Award Contract (SAC) to Multiple-Award Contract (MAC) Indefinite-Delivery–Indefinite-Quantity (IDIQ) husbanding service contracts. Recent port services pricing data suggests that some services or ports may cost more under a MAC compared to a SAC. The objective of this study is to identify whether there is a statistically significant difference in price for U.S. Navy husbanding port services and to estimate the relationship of price between these two competitive husbanding service provider (HSP) contracting strategies. A price comparison between the contract types was performed using three fixed-effects regression models. The results of the models showed a statistically significant difference in price between SAC and MAC. The model estimated that for a given port and given ship type, the average price for HSP services was less for a MAC than for a SAC. Additionally, the effect of the MAC on price changes based on the port and service category. However, the effect of contract strategy on price could be marginally under- or overstated based on the immeasurable effects of nonmonetary qualitative factors. Further research will be required to understand the true cost–benefit of MACs and the overall best value to the government.

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LIST OF ACRONYMS AND ABBREVIATIONS

DoD	Department of Defense
FAR	Federal Acquisition Regulation
ELIN	Exhibit Line Item Number
GAO	Government Accountability Office
HSP	Husbanding Service Provider
IDIQ	Indefinite-Delivery–Indefinite-Quantity
MAC	Multiple Award Contract
NAVSUP	Naval Supply Systems Command
OSBP	Off-Ship Bill Pay
PWS	Performance Work Statement
QASP	Quality Assurance Surveillance Plan
RTOP	Request for Task Order Proposal
SAC	Single Award Contract

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EXECUTIVE SUMMARY

In a fiscally challenging environment filled with rising global competition, U.S. defense leaders require definitive, objective, and comprehensive information to guide strategic decision-making and maximize the available resources in support of the warfighter and promote mission success. The National Defense Strategy (NDS) discusses "Reform[ing] the [Defense] Department for Greater Performance and Affordability," which includes "budget discipline and affordability to achieve solvency" (DoD, 2018). In particular, the NDS advises defense leaders to "drive greater efficiency in procurement of materiel and services while pursuing opportunities to consolidate and streamline contracts in areas such as logistics, information technology, and support services" (DoD, 2018). As part of the reform effort, Naval Supply Systems Command (NAVSUP) established strategic priorities in the area of contract management, adopting a Multiple Award Contract (MAC) strategy to increase the amount of competition for Husbanding Service Provider (HSP) contracts. Theoretically, the effect of increased competition from the MAC would decrease costs to the government or provide greater value.

The HSP MAC phase-replaced the Single Award Contract (SAC) across all regions starting in 2016. Initially, the average cost of husbanding services per day decreased following the implementation of the HSP MAC, but the average cost unexpectedly increased in fiscal year 2019, raising the question of the effect of the MAC on price. The objective of this study is to determine if the prices for husbanding port services under a SAC and MAC are statistically different and to estimate the effect of the MAC on price. This study conducts a quantitative analysis of the measurable effects of the MAC strategy on price within the HSP program.

To investigate our research question, a port-service price comparison between contract types was performed using three fixed-effects regression models, which provide an estimate of the effect of the MAC on price while holding constant other factors that could confound this effect. This study used pricing data from HS Portal, an online database of husbanding service data which recorded HSP services data over a three-year period. The panel data provided contract Exhibit Line Item Number (ELIN) prices, including quantity,

ship type, unit of issue, and port location. A four-step process was used to remove erroneous data, which included removing observations with missing data elements, extreme values, and miscellaneous ELINs, and excluding ports not listed on the original base contract. We then developed three different fixed-effects linear regression models through an iterative trial-and-error process. As a result of our model development process, we chose not to include the effect of inflation due to quasi-omitted variable bias. Other variables were not included in the model because these variables were either not measurable or did not have sufficient data available (e.g., market anomalies such as special events, the differences in Statement of Work/Performance Work Statement between the contracts, and various other non-price factors). After completing the model development process, each regression model accounted for competition, contractor's pricing strategy, exchange rates, order quantity, ship category, service category, and port.

Results from the primary regression model (model 1) showed that, using a 95% confidence interval, the MAC reduced prices for port services by 14.8% to 20.6% using our preferred method. Using the port-specific analysis (model 2) and service-specific analysis (model 3), we found a preponderance of the statistically significant coefficient estimates were negative, representing a decrease in price for multiple award contracts. However, there was a large variation in price differences between single award and multiple award contracts based on the type of service category or the assigned port.

We used the results of the three models to conclude that the MAC effect decreased the average price for services in aggregate across all ports and service categories, but assessing the overall net benefit of the MAC requires additional data collection because there are other non-price factors that could add value for the government. Additional data sources could include measuring and incorporating non-price factors into the model, such as logistics lead time, dynamic force employment, operational security, and administrative workload. We provide a list of additional measurable data elements that would improve future research and may capture the true effect of competition internal to the MAC. Furthermore, we recommend that NAVSUP continue to use and execute the MAC on a global scale as the primary contracting mechanism for competing HSP services. We also suggest that other services and agencies use this study as a benchmark for adopting a MAC strategy into their organizations.

I. INTRODUCTION

Husbanding port services provide Navy ships with a wide range of commercial logistics and resupply services in various ports around the world. These services are currently contracted through the federal acquisitions process using Multiple Award Contracts (MAC) under an Indefinite Delivery Indefinite Quantity (IDIQ) base contract. Prior to the introduction of the MAC strategy, husbanding service provider (HSP) contracts were competed using a Single Award Contract (SAC), by which only a single offeror was awarded the base contract for a specified region. The MAC concept was introduced to maximize competition, leading to increased value or reduced prices for the Navy.

A. PURPOSE

The price per port visit is one metric the Navy uses to measure the effectiveness of MAC implementation. Following the phased implementation of MAC, the Navy recognized a reduction in costs per port visit from 2016 through 2018. However, recent pricing data indicates a recognizable increase in costs per port visit for 2019, which presents the possibility that some services or ports may cost more under a MAC compared to SAC. (See Figure 1.) This unexpected trend has prompted key stakeholders, such as Naval Supply Systems Command (NAVSUP) and type commanders, to inquire about the effect of the MAC strategy on the HSP contract prices and validate the concept that MACs reduce prices. Although the Navy has been exclusively executing MAC IDIQ contracts for husbanding services over the last three years, there has been no formal report or study conducted to document the effects of the change to MAC on port visit prices. To this end, the following study compares SAC and MAC strategies for Navy HSP services and explains the price effects of the MAC implementation using an individual fixed-effects regression model. Additionally, this study investigates the MAC effects of specific ports and specific types of services to explain the differences in prices. Ultimately, this study objectively examines the quantitative factor of price and presents qualitative factors such as administrative workload and combat effectiveness for senior leadership to consider when making net-benefit assessments of the contracting strategies and for informing future contracting policy.

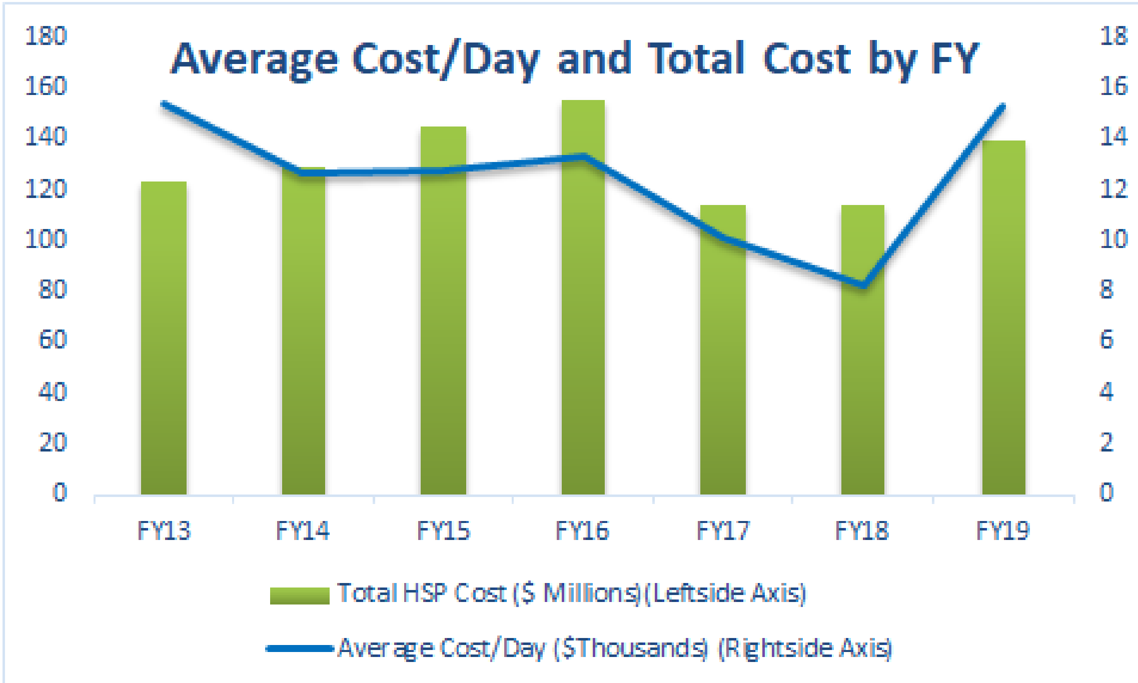

Figure 1. Average Cost/Day and Total Cost by FY

B. SIGNIFICANCE

According to Federal Acquisition Regulation (F.A.R.) 16.504, the government must, "to the maximum extent practicable, give preference to making multiple awards of indefinite-quantity contracts" (F.A.R 16.504, 2019). The Navy recognized a gap in the competitive strategy of the HSP contracts and an opportunity to shift from a SAC to a MAC strategy during the adoption of Off-Ship Bill Pay (OSBP). To increase competition among husbanding service contracts, the Navy began to implement use of MACs in 2016, which incorporated additional competition at the task order-level (T. Kunish, NAVSUP N72 Contracting Directorate, Fleet Support, email to authors, April 7, 2020). The reformed HSP policy was intended to maximize the competitive environment, in accordance with statutory and regulatory requirements, and reduce costs for the government. However, the mere fact that greater competition is introduced into the contracting strategy is not evidence or proof that the contracting strategy is superior for providing the government the lowest price or increased purchasing power. Although competition has proven to drive innovation and reduce costs to the buyer, there is no objective research to suggest that implementation of a MAC strategy will always reduce prices for the HSP program.

The F.A.R. 16.504 states that MAC should not be used if knowledge of the market shows that single award has more favorable conditions. Highly volatile markets increase prices for port services over time and can aggravate costs to the government. Under a SAC, the prices established during the contract award are fixed for the entirety of the performance period. In a SAC domain, the contractor is bound by the price ceiling, regardless of any fluctuations in the true market value of the services over time. In contrast, in a MAC situation, the prices may be a more accurate representation of the true market value of a particular service because the prices will likely change based on the current market conditions. A SAC does not respond to changes in the market because prices are fixed for the contract's period of performance. Therefore, the prices are less likely to change under a SAC but more likely to change under a MAC. These finely divided differences between both contract strategies illustrates the dynamic role of competition and reinforces the possibility that prices could increase or decrease under a MAC strategy. Our research explores the price differences between the SAC and MAC to determine if there is a significant difference in prices for HSP services and estimate the effects of contract strategy on price. Our primary research questions are:

- Are the average prices for services significantly different between SAC and MAC?
- What is the estimated effect of the MAC on price?
- Does the effect of the MAC on price change based on the type of service or port location?

C. BACKGROUND

The Navy routinely conducts port visits around the world and in fiscal year 2019 the Navy spent more than $139.6 million for husbanding services (see Figure 1). When a Navy ship enters a non-Navy port to conduct port visit operations, the ship requires commercial husbanding services. Depending on the contract region, there are roughly 480 line items of services available on the base contract; common services include harbor piloting, van rentals, phone rentals, waste removal, and force protection (NAVSUP, n.d.). These services are placed on contract and awarded to an HSP, a commercial vendor who has access to local resources and experience with providing port services to ships visiting in a specified region. Due to constantly changing schedules and requirements, the Navy utilizes an IDIQ firm-fixed price contract for all HSP contracts. Understanding the effects of contract strategy on pricing requires a clear understanding of IDIQ contracts, the dynamic role of competition in federal acquisitions, and the changes resulting from the 2014 Naval Audit Service's findings and recommendations.

1. Indefinite-Delivery–Indefinite-Quantity Contracts

The F.A.R. 16.504 defines "indefinite-delivery contracts" as providing "an indefinite quantity, within stated limits, of supplies or services during a fixed period." In a 2018 Government Accountability Office (GAO) report on federal acquisitions, William Woods explained that indefinite-delivery contracts are awarded "when the government does not know at the time of award the exact times and/or quantities of future deliveries" (Woods, 2018a, p. 1). These types of contracts are used when the government is unable to provide a determination, above a specified minimum, of quantities of services or specific time period needed.

There are three types of indefinite-delivery contracts accepted in federal acquisitions, but the most widely used type of contract is IDIQ. According to the GAO's 2017 report regarding use of indefinite contracts, the federal government obligates more than $130 billion on IDIQ contracts every year, with the Department of Defense (DoD) accounting for $88.4 billion of those obligations (Woods, 2017). The Fiscal Year 2020 President's Budget requested $761.8 billion in defense discretionary spending, meaning that based on the GAO estimate, roughly 11% of the overall discretionary budget would be obligated using indefinite-delivery contracts (White House, 2019). These figures convey the scale and magnitude of federal acquisition use of indefinite-delivery contracts and illustrate the importance of this contracting strategy for each agency and military service.

An IDIQ contract serves as the base-award contract, providing a preapproved set of terms and conditions that typically include pricing for products or services. An IDIQ contract is special because the base-award contract can be solicited as either a SAC or MAC. A SAC IDIQ contract signifies that a single contractor will be awarded all task orders during the period of performance. A MAC IDIQ contract signifies that multiple contractors will be selected from the competitive range, and task orders will be competed among the down-selected offerors. The most obvious difference between SAC and MAC IDIQ contracts is the role of competition.

2. Role of Competition

The role of competition within federal acquisition policy has been defined in various federal statutes and defense regulations. The Code of Federal Regulations states that "all procurement transactions shall be conducted in a manner to provide, to the maximum extent practical, open and free competition" (Competition, 2010). Similarly, the United States Code requires maximizing the competitive elements of a solicitation by ensuring "full and open competition through the use of competitive procedures" and by mandating the use of the "competitive procedure or combination of competitive procedures that [are] best suited under the circumstances of the procurement" (Competition requirements, 2010). The Competition in Contracting Act of 1984 mandates the use of competitive procedures for federal acquisition of supplies and services and requires agencies to "obtain full and open competition" (Competition requirements, 2010). According to Title 41 of USC, the phrase "full and open competition" implies that "all responsible sources are permitted to compete … [and that] responsible sources are permitted to submit sealed bids or competitive proposals on the procurement." Although the definition of terms and regulations for competition span across a wide range of references, all definitions support the argument for increasing competition in federal acquisitions.

In 2013, the GAO recognized an increase in sole-source contracts and a reduction in competitive contracts across all DoD acquisitions (Courts, 2013). As a result of the trends, the GAO recommended that federal agencies "develop guidance that could enable DoD components … to increase competition for the same goods and services" (Courts, 2013, p. 28). The DoD concurred with these findings and mandated that all the department services, notably the Department of the Navy, increase competition for goods and services in the future (Courts, 2013). Following these recommendations, the 2018 GAO report found that acquisition competition rates within the DoD had continued to decline from 2013 through 2017, with many prospective companies citing the complexity of the DoD acquisition process as a barrier (Woods, 2018b).

The theory behind increasing competition is to provide the government with greater purchasing power by encouraging sellers to maximize efficiency of resources. Purchasing power, also known as buying power, refers to the government's ability to buy more goods, services, or value with the same amount of money. Former Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L) Frank Kendall released the Better Buying Power acquisition reform policy to encourage smarter defense spending and increase the government's purchasing power (Kendall, 2015). One of the core tenets of the Better Buying Power policy is to "promote effective competition" (Kendall, 2015, p. 23), which is the best practice to improve decision-making and reduce costs without compromising defense capability. Creating a competitive environment is intended to incentivize contractors to reduce expenses, encourage innovation, promote efficiency, and increase performance to strengthen the quality of services. The objective of the initiative is intended to "create and maintain competitive environments, improve DoD outreach for technology and products from global markets, [and] increase small business participation, including more effective use of market research" (Kendall, 2015, attachment 1). The release of the Better Buying Power triggered the Defense Department to adopt more competitive contracting strategies and reform acquisition processes to improve purchasing power. An example of an agency taking actions consistent with the Better Buying Power initiative occurred when the NAVSUP contracting office, with concurrence from the fleet HSP program managers, transitioned away from the SAC strategy and instead adopted a MAC strategy for HSP contracts.

3. HSP Program Changes

The HSP program underwent a Secretary of the Navy–mandated audit in 2014 by the Naval Audit Services following the discovery of procurement fraud between Navy officials and the Glenn Defense Marine Asia company. To address the internal control vulnerabilities and areas for improvement identified during the audit, the Navy implemented OSBP. This new process expanded the role and presence of Contracting Officer Representatives (CORs) within the fleet, providing greater surveillance of contractor services, improved quality control for payments, and better tracking of HSP costs.

Although the audit did not address the contracting strategy as a weakness or an area needing improvement, the shift from SAC to MAC complemented the implementation of OSBP by reducing the potential for fraudulent activity within the HSP program and improving pricing data for the contracting office. These changes enabled a rich database of pricing activity that is now being recorded in an online database called Husbanding Service (HS) Portal, formerly LogSSR, which represents the source of pricing data used for this study. Since the 2014 Naval Audit Service report did not address the HSP contracting strategy, the decision to change from a SAC- to MAC-type IDIQ contract was independent from the implementation of the OSBP process and instead was predominantly influenced by the Navy-wide acquisition reform rather than auditability.

D. CURRENT ISSUES IDENTIFIED

Although many DoD agencies have responded to the Better Buying Power initiative, there is a lack of evidence to show the specific effects of the MAC strategy on contractor's prices within the Navy's HSP program. Additionally, there has been no analysis to determine if the MAC effect on price is greater or less in certain ports or certain categories of services. Due to a vacuum of research in the field of HSP IDIQ SACs and MACs, the true cost of the MAC strategy, to include non-price factors, is still not fully understood. The goal of this study is to explore the effects of the MAC strategy on husbanding service prices. To accomplish this goal, we designed a regression model to estimate the effect a MAC has on price and determine if the effect on price changes based on the port or type of service.

E. SCOPE AND LIMITATIONS

This study aims to compare prices of servicers between SAC and MAC. All quantitative pricing data for the analysis was gathered from the HS Portal website. The data used in this analysis are based on prices for husbanding services paid by the government, dates indicating the date services were rendered, quantity of services provided, contract numbers corresponding to either SAC or MAC, and descriptions of the services provided. The data used in this study are unclassified but includes business sensitive information, such as pricing data of a specific contractor for a specific service.

The pricing data was used to obtain results but the specific prices for an individual contractor is not presented in this report in order to protect the pricing strategy of private businesses. Therefore, this study will not list any specific contractor's names or prices for task order award and the results do not provide any sensitive or restricted information about the contractors. The information provided in this analysis is public knowledge and does not restrict dissemination of our findings or results.

This study does not evaluate policies or procedures, and it is not the intention of this study to be the single source of information to determine the appropriate contract strategy for the HSP program. Non-price factors, such as quality or performance, cannot be fully isolated from cost, and therefore non-price factors must be considered to provide a complete net assessment. This study does not monetize or provide a cost–benefit analysis of the non-price factors.

This study's statistical model is designed to explain the relationship between price and contract method—specific to the Navy's HSP program—and provides consideration for non-price factors to arm decision-makers with additional information when developing future acquisition strategies.

F. CHAPTER OUTLINE

The remainder of this report is organized as follows: Chapter II presents an assessment of literature relevant to the purpose of the study. Chapter III reviews the contracting process for both SAC and MAC IDIQ contracts and describes the guiding regulations that govern the contracting process. Chapter IV describes the data and methodology used to conduct the analysis. Chapter V provides the analysis and interpretation of our results for various models. Lastly, Chapter VI ends with the conclusions and recommendations.

II. LITERATURE REVIEW

Assessing the literature related to comparing SAC and MAC requires drawing on a number of different materials: federally funded studies related to use of IDIQ contracts throughout the Department of Defense, other Naval Postgraduate School (NPS) MBA professional reports related to HSP, and numerous academic articles related to the measurement of qualitative factors that influence decision-making. Due to the recent shift from SAC to MAC for HSP contracts and the continuous maturation of the HSP landscape, there has been no research on whether the MAC, with a competitive market, lowers costs to the government. However, literature was reviewed to identify results from prior studies that compared trends between SAC and MAC in non-HSP environments and from other studies that involved assessing types of HSP contracts prior to the introduction of the MAC concept.

A. TRENDS IN THE USE OF MACS

The GAO has conducted research to track financial obligation between SAC and MAC to identify any trends across defense agencies over time. The GAO report *Defense Contracting: Use by the Department of Defense of Indefinite-Delivery Contracts from Fiscal Years 2015 through 2017* examined the amount of federal outlays across the DoD toward SAC and MAC IDIQ contracts from 2011 to 2015. The study showed that the percentage of federal outlays that were contractually obligated using IDIQ contracts increased over the five-year period, but that the majority of the IDIQ contracts were competed as a single-award rather than a multiple-award contract (Woods, 2018a). This report illustrates that the execution of IDIQ contracts has received congressional-level attention and validates the relevance for studying types of IDIQ-service contracts across the NAVSUP enterprise.

Unfortunately, this study was performed at the agency level and used a wide aperture of sampling, including IDIQ contracts from various military services and other federal organizations, without controlling for any differences between these organizations. Additionally, the various contracts sampled in the analysis executed funds from various types of appropriation categories, which would not provide an accurate comparison between contract types. For example, the study combined service contracts for base operations, like operations and maintenance for roofing repairs, with services for major weapon systems, like research and development for detecting malware and cybersecurity threats (Woods, 2018a). Finally, the analysis of the IDIQ contracts included sole-source, noncompetitive environments, which greatly overestimated the effects of pricing on contract strategy.

Although this report provides valuable insight on the difference in the overall amount of federal spending between single-award and multiple-award IDIQ contracts across the DoD, it was not intended to explain the relationship between price and contract strategy. The study did not use modeling or analysis to estimate any of the effects between single- and multiple-award IDIQ contracts and the prices for services. Therefore, this report adds value for the purpose of our research by identifying an increased use of IDIQ contracts across the defense organizations and a cultural shift toward the use of MACs, furthering a need to better understand the true effects of federal spending between SAC and MAC. However, the findings of this report do not support or challenge any of the results from our analysis because there was no direct comparison to government spending between SAC and MAC.

B. HSP RESEARCH

The most recent NPS study related to comparing benefits of different types of HSP contracts was conducted in 2007 by Gundemir et al. Their study conducted a comparative analysis of various contracting methods and strategies at the base-contract and task-order level. The study also provided models for forecasting port visit costs under a SAC strategy and conducted an analysis of costs between 2003 and 2004 using eight ports located in Fifth Fleet area of operation. The study revealed that the most preferred type of contract for HSP services depends largely on the trade-offs between the risk of uncertainty in the projected number of ports per year and the trade-off with the cost of flexibility.

Although the work of Gundemir et al. (2007) provides some useful information about the SAC IDIQ contract strategy, the scope of their analysis was based on outdated processes and a smaller sample size (sample size only included 12 services from 8 different ports) for forecasting future port service costs. An example of an outdated process was the billing procedures and administrative burden for processing payments during 2007, which has been streamlined and is now processed electronically through an online system called Wide Area Work Flow. Moreover, the report did not make any assessment of the MAC strategy because the strategy was still underutilized and not fully developed at the time of the study, making the analysis ineffective for comparison to the legacy SAC strategy. Because the environment has changed significantly over the last decade, this study does not provide significant value for future decision-making. However, the study is worthwhile because the report offers qualitative performance measures for consideration when developing the task-order and base-contract evaluation criteria. Additionally, much of the standardization effort that has been adopted by NAVSUP policy were consistent with the direction and recommendation of this report. Furthermore, consistent with the recommendation for standardization, NAVSUP is currently taking action to explore the potential for expanding contracting strategies at a global level across all fleets by forming a global MAC; implementation of this policy will have effects and outcomes that have not been objectively studied.

C. MAC FOR MAINTENANCE AVAILABILITIES

An NPS thesis published in 2015 by Matthew Duncan and Richard Hartl examined the impact of the Multiple-Award Contract–Multiple-Order (MAC-MO) contract strategy, relative to a SAC, on Navy surface maintenance periods. Their study compared this pilot-program strategy, which is now fully implemented and executed, with previous contracting strategies used in the procurement of maintenance contacts to determine efficiency and effectiveness of the contracting strategy. The study utilized the following existing maintenance contracts metrics:

1. Cost growth. Calculated by dividing the total dollar value of the contractual change by the total dollar value of the contract.
2. On-time award. Calculated by subtracting the actual award date from the estimated award date.
3. On-time completion. Calculated by dividing the number of availabilities completed on time by the total number of maintenance availabilities in that period.

The study determined that the MAC-MO was more effective at controlling growth and new work costs, but the effectiveness on other metrics were inconclusive in the comparison of strategies.

The primary limitation of this study was the limited data for MAC-MO contract availability. Due to the implementation of MAC-MO as a pilot program and the duration of maintenance availabilities, the data contained only five maintenance periods for comparing contracting strategies. A direct comparison between this MAC-MO study and our HSP study is not possible due to inherent differences and additional factors within the maintenance process. One inherent difference includes the types of services offered between maintenance contracts and HSP contracts; HSP services are services exclusively while the maintenance services include some direct material costs for repairs. The technical requirements for maintenance work vary greatly and have a much larger percentage of labor requirements. Additionally, the structure of the contracts is drastically different; maintenance contracts tend to be more complex, with incentive fees and extensive work packages, compared to HSP contracts, which are more simplex in nature and the period of performance for the task orders are relatively shorter in comparison. During the pilot program implementing MAC-MO, there were also several changes implemented beyond the increased competition factor. Included within the contract was a contracted third-party planner used for planning and analysis of the maintenance availabilities, as well as a change in the incentive structure from previous strategies. Due to these additional factors beyond a change in competition, a direct comparison between HSP and maintenance procurement of potential cost reduction using a MAC strategy is not possible. The study did not examine the total cost of procurement and instead used the metric for cost of growth and new work as measures of effectiveness rather than examining the reduction of prices.

D. QUALITATIVE

No data are currently recorded for Navy HSP qualitative information or standardized system for measuring the effectiveness of HSP contracts is in place. Within "Multiple Objective Decision-Making," Wall and Mackenzie (2015) outlined the basis of establishing such a system from the selection of relevant objectives and relative importance between price and effectiveness. With these models, decision-makers are forced to quantify the objectives which directly relate to the method of data collection and enable data-driven decisions (Wall & Mackenzie, 2015).

Within "Multi-criteria Decision-Making Based on Trust and Reputation in Supply Chain," Chang et al. specifically addressed supply-chain relationships between suppliers and customers of raw materials using a distribution system. The article is specific to a manufacturing supply chain rather than a service supply framework. The establishment of a type of reputation model in partnership with the relevant objective models provides a consistent standardized method for the evaluation of contractors regardless of location (Chang et al, 2014).

E. SUMMARY OF LITERATURE REVIEW

The current available literature is useful for understanding the broader scope of the Navy's husbanding service process and the competitive sourcing strategies used for single- and multiple-award IDIQ contracts. However, there is a complete gap across the contracting research for analyzing quantitative measures that explain the effects of IDIQ contract types on price. This research offers insight into the field of defense contract management and provides an initial data point for further studies to consider. Our research contributes a model that future analysts can use to better explain the relationship between contract strategy and price to scrutinize or substantiate future claims that greater competition is less costly.

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III. CONTRACTING PROCESS OVERVIEW AND HYPOTHESIS FORMULATION

The acquisition procedure for NAVSUP husbanding services has developed dramatically since the implementation of OSBP in 2015, but the process for awarding an HSP contract has remained fundamentally unchanged. To address the process for awarding a contract as it applies to HSP and for understanding the methodology of our analysis, this chapter explains the basic phases and milestones for NAVSUP HSP contracting, including the process for awarding the base contract and issuing a task order. Each process description identifies the differences between the SAC and MAC, which is essential for understanding the regression analysis. Additionally, the latter portion of this chapter describes potential effects of contract elements on contract prices and non-price contract variables, which serves as the basis for formulating our theory.

A. BASE CONTRACT AWARD PROCESS

A base contract performs like a catalog, allowing the contracting office to order services from a predetermined list. The base contract consists of general terms and conditions with ordering procedures and various contract clauses required by the F.A.R. The base contract consists of three phases: pre-award, award, and post-award. Each phase of the contract life cycle is further divided into the following major milestones: acquisition planning, solicitation, submission of proposals, evaluation of proposals, award of the base contract, contract execution, contract administration, and contract closeout (NMCA, 2019). Figure 2 provides a visual for understanding the relationship between these milestones relative to the overall contracting process.

Figure 2. Diagram of Contract Process Overview

Both SACs and MACs follow the same path through these phases and milestones of a contract but use different competitive strategies and processes for executing each milestone. The following sections describe each contracting milestone for the base contract, highlighting differences between the SAC and MAC.

1. Acquisition Planning

Early in the acquisition process, key stakeholders of the HSP program develop an acquisition plan. Contained in the acquisition plan is the Source Selection Plan (SSP), which acts as the guide for conducting an evaluation and analysis of the contractor's proposals. The SSP includes key decisions approved by the fleet customer that impact the acquisition, such as the contract evaluation criteria and contract type (i.e., the decision to use a SAC or MAC). HSP contracting follows F.A.R. Part 15:

> An agency can obtain best value in negotiated acquisitions by using any one or a combination of source selection approaches. In different types of acquisitions, the relative importance of cost or price may vary. For example, in acquisitions where the requirement is clearly definable and the risk of unsuccessful contract performance is minimal, cost or price may play a

> dominant role in source selection. The less definitive the requirement, the more development work required, or the greater the performance risk, the more technical or past performance considerations may play a dominant role in source selection.

Since port services are clearly definable, with minimal risk of unsuccessful performance, the source selection approach historically used prior to 2015 for awarding HSP base contracts was Lowest Price Technically Acceptable (LPTA). Under LPTA, contracts are awarded based on the lowest-priced offer that meets the minimum technical requirements of a port visit. However, following the implementation of OSBP in 2015, the Navy started to favor a trade-off source selection approach, which awards contracts to the offeror that represents the best overall value to the government based on a set of graded evaluation criteria. The decision authority and evaluation boards, comprised of the source selection team, are charged with determining the best source selection approach. F.A.R. 15.3, "Source Selection," outlines the procedures for establishing a source selection team, consisting of multiple acquisition disciplines (e.g., finance, engineering, legal) to ensure a comprehensive evaluation of offers.

2. Solicitation

After completing the acquisition plan, the contracting office generates a solicitation, or request for proposal (RFP), specifying the region's requirements for HSP services. This solicitation expresses the government's intentions to seek public offers for providing an indefinite delivery of HSP services. The solicitation contains the evaluation criteria identified in the source selection plan, which will be weighted higher than, lower than, or equal to price. The key difference between a SAC and MAC throughout the solicitation process is that a MAC RFP will state the government's intention to award the base contract to multiple contractors.

3. Contractor's Submission of Proposals

The prospective contractors are given time to review the solicitation material, the contract clauses, and the base contract terms and conditions. At this point, the prospective contractors will prepare and submit their proposals to the contracting office with all required documentation, including pricing data, consistent with the instructions provided in the solicitation. There are no differences between the SAC and MAC during this milestone from the government's perspective.

4. Evaluation of Proposals and Award of Base Contract

The evaluation of proposals begins when the solicitation period is complete and the prospective contractors have submitted their proposals. Consistent with the source selection plan, each evaluation criterion will be weighted differently depending on the government's intentions to award the base contract under a SAC or MAC. In accordance with the acquisition plan, the source selection team rates each proposal using the criteria published during the solicitation in order to determine the awardee(s) of the base contract. In a SAC, only one contractor will be awarded a base contract, while MACs award base contracts to multiple contractors. After awarding the base contract(s), contract execution begins, allowing ships to utilize the contract(s) to conduct port visits.

5. Execution, Administration, and Closeout

Contract execution takes place after the base contract is awarded. This milestone marks the beginning of the task order process where individual orders are issued against the base contract. Task orders are discussed in detail in the next section. During contract execution, the contracting office and contractor(s) maintain the contract through administration, which consists of periodic reviews of the performance of contractors and ensures completion of all applicable files and paperwork. Finally, at the end of the contract, the contracting office will administratively close out the contract in accordance with F.A.R. 4.804-5. Contract closeout consists of closing the contracting file after all balances are paid and all obligations are satisfied. Closeouts do not have any bearing on the results of this project and will not be discussed further.

Table 1 summarizes the major events in awarding a SAC or MAC HSP IDIQ base contract. The table illustrates the path the base contract award process uses for both the SAC and MAC. However, as previously stated, due to the competition differences between SACs and MACs, the process differences begin at the contract execution phase with issuing the task orders.

Table 1. Summary of HSP IDIQ Contract Phases

Phase	Milestone	Milestone description
Pre-award phase	Acquisition Plan	Acquisition strategy is developed to include contracting timeline, source selection, and evaluation criteria.
	Solicitation	Contracting office submits a Request for Proposal (RFP).
	Contractor submits proposals	Contractors prepare their proposals and submit all required documentation (to include pricing) to the contracting office.
	Evaluation of proposals	Contracting office conducts price analysis, if required, and make fair and reasonable determination using acquisition plan.
Award phase	Award of contract	The contracting officer awards base contract to the awardee(s).
Post-award phase	Contract Execution *** Task Orders	The period of performance begins. Naval ships request services resulting in individual task orders issued against the base contract. (For the process, see Figure 2.)
	Contract administration	The cognizant Contracting Officer Representative (COR) monitors the contractor's performance to ensure proper contract execution. A contractor evaluation is conducted periodically by the COR.
	Contract Closeout	After the period of performance ends, the contracting office administratively closes the file.

B. TASK ORDER AWARD PROCESS (CONTRACT EXECUTION)

The task order process is embedded within the post-award phase and occurs concurrently with the execution milestone of the base contract. Task orders contain the requirements for husbanding services, which are determined by naval vessels that will be conducting each port visit. Task orders are used to satisfy the requirements for an individual ship or, depending on the circumstances, multiple ships for multiple port visits. All task orders retain the same terms and conditions of the base contract, regardless of whether it is a SAC or MAC.

The key difference between a SAC and MAC is the effect of competition during the task order process, which is clearly identifiable and consequential to price. During this process, the contracting office will initiate individual orders, known as task orders, citing the base contract as the legal authority. Issuing a task order using a SAC is straightforward: all work is directed to the single awardee in accordance with the fixed-price rates stated in the base contract. The contracting office sends the list of requirements to the contractor, who in response submits a Port Cost Estimate (PCE). The PCE provides the estimated cost for each service requested by the contracting office; this cost should match the negotiated base contract price analysis. The contracting office verifies the accuracy of the PCE with the base contract and issues the task order through a bilateral agreement, in which both parties agree to fulfill their side of the agreement. The SAC task orders are issued with no additional competition; therefore, no further evaluation criteria are required. If there is a requirement that is not listed in the base contract, known as an unpriced line item, the contractor can propose a price they deem reasonable. The contracting office will negotiate unpriced line items to obtain a fair and reasonable price prior to issuing the task order.

The task order process for the MAC differs significantly and is more complex because an additional stage of competitive evaluation occurs among potential awardees. When the requirements are identified under a MAC, the contracting office identifies the appropriate evaluation criteria for the task order award. These evaluation criteria are based on the current circumstances and are independent of the criteria used for the base award.

The list of evaluation criteria provided by NAVSUP standard operating procedures include lowest price, LPTA, and past performance trade-off. Additionally, the HS Portal provides the port visit checklist, Quality Assurance (QA) reports, and other documentation to provide past performance information establishing confidence level and relevancy (NAVSUP, 2018).

The evaluation criteria and requirements are submitted to the multiple base contract awardees using a Request for Task Order Proposal (RTOP). The task order evaluation criteria can be different for each RTOP. For example, the RTOP for a particular port visit can be evaluated on lowest price, but on the next RTOP for the same port, the contracting office can use trade-off. Additionally, the contracting office also has the option to include multiple evaluation criteria, allowing the RTOP to be evaluated based on both past performance and price.

Another key difference with a MAC is the ability of a contracting office to bypass the RTOP process and unilaterally issue a task order to any awardee without competition. For example, NAVSUP contract solicitation number N68171-20-R-0001 states,

> Subject to F.A.R. 16.505 (b)(2), the Government has the right to issue a Task Order to a contractor within the ordering period and up to the contract maximum, and the contractor is obligated to perform the Task Order, regardless of whether the contractor submitted an offer in response to an RTOP for the Task Order (see the clause "Indefinite Quantity," F.A.R. 52.216-22 of this contract and F.A.R. 16.504 (a)(1)), or whether the Government issued an RTOP for the Task Order (see, e.g., F.A.R. 16.505(b)(1)(ii) and (b)(2)).

However, unlike the SAC sole awardee, the unilateral action would require the government to fair and reasonably compensate the selected awardee. Figure 3 is a side-by-side comparison of a SAC and MAC process flow for individual task orders.

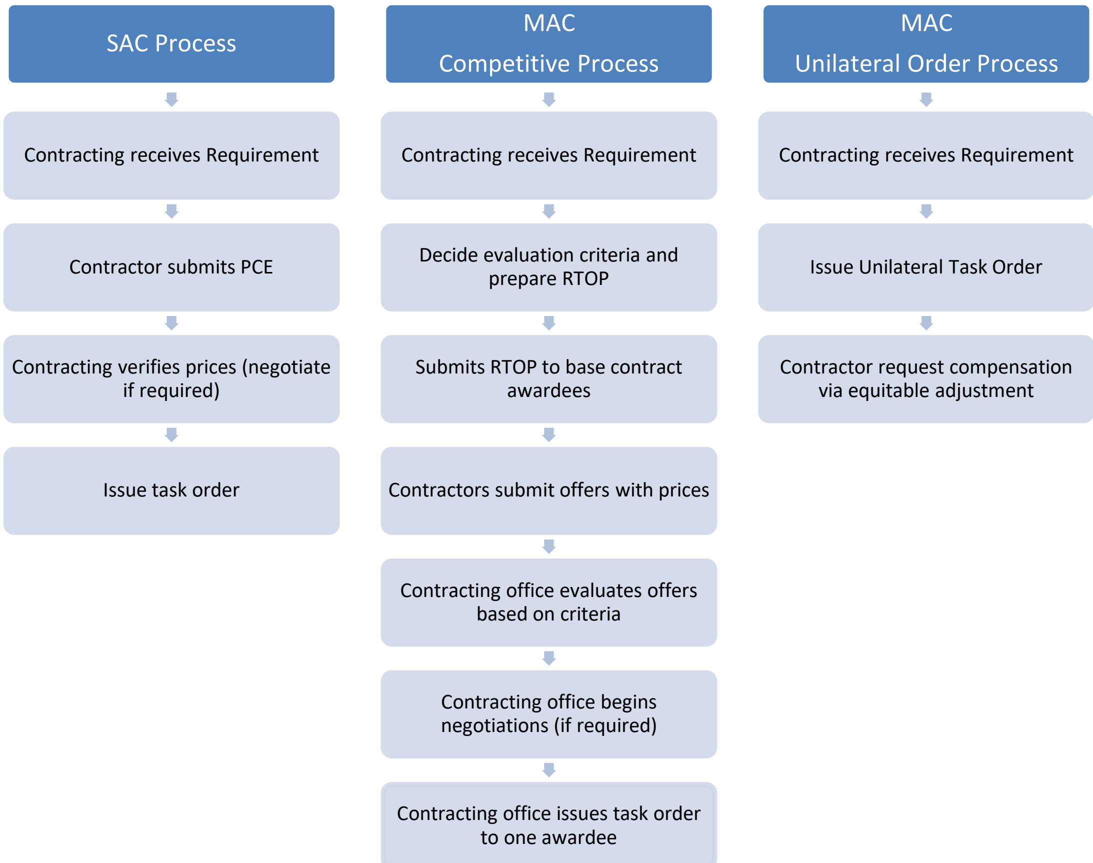

Figure 3. SAC and MAC Task Order Process Flow Charts

Historically, MAC task orders have been evaluated based on lowest price. However, guidance from the John S. McCain National Defense Authorization Act (NDAA) for Fiscal Year 2019 encourages contracting officers to utilize evaluation factors other than LPTA. As a result, NAVSUP has begun utilizing trade-off evaluation criteria for task orders. Depending on the acquisition plan, MACs likely offer greater benefit to the U.S. government on the base contract price because additional criteria, such as those previously listed, can be used to evaluate offerors at the task order level. However, SACs place greater emphasis on non-price related criteria during the evaluation of the base contract because the selected offeror will be the only awardee issued at the task order level for the full duration of the contract.

C. CONTRACT ELEMENTS AFFECTING CONTRACT PRICES

Based on recent HSP contracts awarded during the last four years, this section identifies differences in NAVSUP HSP contract elements between SACs and MACs that affect overall contract cost. The relationships between these contract elements and price serve as the basis for our hypothesis.

1. Number of Task Order Competitors

The primary contract element that affects price differently between a SAC and MAC is the number of base contract awardees that are competing for the task order. In a SAC, there is only one vendor, which simplifies communication and issuing task orders. Therefore, the task order prices are more predictable because the prices are no longer being negotiated through a competitive process, and most of the prices are established in the original base contract. By comparison, the MAC task orders are competed among multiple contractors. The contracting office must determine the number of vendors that will receive a base contract award during the base contract source selection processes. Typically, the number of vendors awarded the base contract is determined by the contracting office. The MAC prices are more volatile due to the second level of competition. The greater number of base contract awardees competing for task orders probably has a negative correlation to price, decreasing overall cost to the government (Oliver, n.d.)

2. Requirements Creep and Task Order Modifications

Changes to the port visit requirements are common and expected due to the dynamic nature of operational forces and unpredictable environments. For example, a ship may request an additional daily van service for the entire length of the port visit after the task order has been issued. If the requirement change occurs after the task order is issued, as is the case in this example, then the contracting office must issue a modification to the awarded task order. If the modification is issued after the contractor has made financial commitments, then the government could be liable for any changes in cost to the contractor. To mitigate the potential for additional costs, the contracting office attempts to finalize the requirements with the ship as early as possible, but there is always a risk of additional cost when issuing a modification.

However, changes to the price for the services will be different depending on whether the modification is issued under a SAC or MAC. Modifications that occur under a SAC contract are less likely to increase the price of the services. Since the SAC has fixed-price line items, the additional costs of the task order modification are equivalent to the prices listed in the original task order. For example, ordering a van rental for one day may cost $200 per day at a given port according to the base contract. Therefore, the cost of two days for one van rental is $400 ($200 × 2 days). If the ship changed the requirement to rent two vans for the same timeframe, then the cost will be $800 ($200 × 2 days × 2 vans). By contrast, the MAC is re-competed for every new task order. In the same scenario under a MAC, the contractor may propose an initial price of $200 per day for two days based on their RTOP proposal. However, if the ship requires an additional van, the contractor is entitled to charge up to the base contract maximum ceiling price. Unless otherwise specifically stated in the RTOP, the unit prices proposed in the RTOP offer are not binding and the contractor can change the price for the additional services. Additionally, the individual requirement change may be re-competed among all MAC awardees leading to multiple contractors providing services for one port visit. This leads to a situation where the contracting office must make a choice: negotiate the price and issue the modification to the existing task order or cancel the original task order and recompete the entire task order with the new requirements. Both options have the potential to increase costs to the government. Therefore, under a MAC, modifications as a result of increased requirements will likely have an additional (increasing) effect on prices because these additional requirements are not competed, whereas SAC is more likely to maintain the same unit price because priced line items are set in the base award.

3. Coverage Area

The MAC's use of a coverage area (rather than a specified list of ports used in a SAC) may have a downward effect on price, decreasing overall cost to the government. An HSP contract specifies either by port name or geographical area of potential locations requiring contracted husbanding services. Any port that requires husbanding services outside the geographical region specified in the contract is considered out of scope.

In a SAC, specific port names are identified in the contract, meaning that any port outside the contract's list of ports requires a modification agreed upon by all parties and must be negotiated into the contract, and these prices are not competed. As a result, the unpriced line items for the additional port location may have higher unit prices compared to the priced line items that were competed in the base award.

For a MAC, rather than naming specific ports, the contract lists countries, including all ports within the country's territorial waters. The inclusion of such a significant number of locations (which may include ports not yet built) means the contract awardees must consider providing services to all possible port locations within the coverage area, which will likely affect the proposal prices. Using a coverage area provides greater flexibility for the contracting office and, as a result, likely reduces the number of modifications for unpriced line items.

4. Commerciality

Unilateral changes are not a characteristic of a SAC or MAC, but NAVSUP HSP SACs have historically used commercial contract standards, while HSP MACs include noncommercial contract clauses. Noncommercial contract clauses provide the government with the authority to make changes to the contract without consent or agreement from the contractor. The use of noncommercial contract clauses offers the ability to issue unilateral changes, but has the potential for increasing cost to the contractor due to the increased risk.

According to the F.A.R. Part 12, "Acquisition of Commercial Items," contracting officers must determine whether an acquisition is a commercial or noncommercial service to identify the applicable clauses for the contract. The determination to use a commercial or noncommercial service is done during the acquisition plan development phase of the contracting process. The commercial and noncommercial contract clauses make a significant difference in how changes to both the base award and task orders are managed between the government and the contractor. For example, the commercial contract change clause requires both parties to bilaterally agree to any change to a contract before it becomes a legal obligation. However, the noncommercial contract change clause allows the government to make changes within the scope of the contract without consent from the contractor, known as a unilateral change. Unilateral contracts have a greater risk of increasing the cost to the government because the contractor will need to be fair and reasonably compensated with an equitable adjustment, which will involve negotiation between the contractor and the contracting office. As a result, since there is no competition when issuing an in-scope unilateral change, the prices are likely to be higher. For example, in a situation where the government issues a unilateral task order, the contractor will be incentivized to charge higher prices to compensate for the additional risk. Therefore, noncommercial clauses likely have an increasing effect on contract cost, increasing overall costs to the government.

5. Statement of Work/Performance Work Statement

A Statement of Work (SOW) or Performance Work Statement (PWS) is required in contracts to inform the contractor of the work expected to be accomplished. A SOW contains specific actions required of a contractor (e.g., "Provide a 12-passanger van every Monday at 7:00 a.m. regardless of weather conditions"), whereas a PWS describes required outcomes (e.g., "Provide ground transportation to/from the airport for transferring five (5) Sailors per week"). The SACs contain SOWs that vary between contracts and describe the specific needs tailored to the region within the scope. In contrast, MACs use a PWS that is derived from a standardized template, resulting in all PWSs having the same structure and elements with little variation because the intended outcome is essentially the same. By using a PWS, the contractor is empowered to use appropriate means and to leverage their strengths or competitive advantage to achieve the outcome. As a result, the use of a PWS lowers overall cost and is intended to improve quality.

6. Minimum Guarantee

In an IDIQ contract, SAC or MAC, contractors are afforded a minimum order quantity, which guarantees the awardee(s) will receive a minimum amount of business. As described in F.A.R. 16.5, the contracting office should consider minimum order requirements. The terms and conditions for a minimum guarantee is provided for both SAC and MAC. However, in a SAC, the single awardee obtains a minimum order guarantee, while the MAC provides all awardees a minimum order guarantee. For example, in a SAC the government may guarantee a minimum amount of $3,500 worth of services to just the one awardee who is expected to be the best and most qualified according to the base award evaluation criteria. Hypothetically, for a MAC with 10 contractors on the base award, all 10 contractors would receive that same $3,500 minimum order guarantee regardless of their past performance. As such, this situation may incentivize a unique form of competitive behavior for the MAC. Contractors are incentivized to submit a proposal to be awarded the task order but having the minimum guarantee may incentivize awardees to be more selective on submitting highly competitively priced proposals, or less selective when submitting less competitively priced proposals, knowing they are guaranteed work at some point during the length of the contract. For example, a contractor would likely only pursue a task order that was in their best interest because the minimum guarantee provides a contractor with the assurance of being awarded a minimum amount of work at some point during the length of the base contract. Although the minimum guarantee applies to each contractor similarly under both contract types, the MAC has greater risk of paying for services not rendered based on the greater number of contractors on the base award contract relative to the SAC. However, if the minimum order quantity or total number of contractors remains small, the dollar value of the minimum guarantee will likely be negligible compared to the overall contract. Therefore, the minimum guarantee should be considered the least-weighted contract element that could affect price.

D. EXTERNAL ELEMENTS AFFECTING CONTRACT PRICE

External elements affecting price refers to factors outside of the written contract that could change the price of services between SAC and MAC. Specific examples include the changes to the market value of services based on the supply and demand, the pricing strategy of the contractors based on their risk and profit, and change to the experience level of the contractors across the different region. Each of these external elements affecting contract price are described in this section and the estimated effect on price for both SAC and MAC.

1. Fluctuations in the Fair Market Value of Services Over Time

The true market value of each service depends on the supply and demand of the commodity at the time of the negotiations. Prices for services under a MAC are continuously changing based on the prices for the fair market value of services at the time of the RTOP. However, the prices for services under a SAC are less sensitive to the market and remain more consistent with the historical prices from previous port visits. Therefore, the market for services would affect the task order costs for a MAC more than a SAC. As a result, price changes within the market for port services could occur more frequently for a MAC, which may increase or decrease the prices for services over time.

2. Contractor Business Strategy and Risk Tolerance

Contractor price and performance may be influenced by their long-term strategy to maintain business with the government. Although contractor fees tend to be higher and more lucrative under private commercial acquisitions than in government acquisitions, government husbanding contracts tend to be more consistent. Therefore, contractors may sacrifice a higher fee to be more competitive in the market in the long run. In a SAC, pricing for the entire life of the contract (four years or longer) is determined up front, which involves significant risk on the contractor because they will need to predict future costs for services. Therefore, it is very likely the contractor will include a risk premium into their initial pricing. In comparison, pricing for a MAC is determined by the contractors for each individual task order (typically several weeks before work performance) and, therefore, the risk is much lower. The unquantifiable business strategy and risk tolerance cannot be measured, but we presume this could make prices for the MAC less expensive.

3. Changes in the Contractor's Ability and Experience When Conducting Market Research

As the MAC matures over the length of the contract, the offerors will become more familiar with the services required by the Navy. Increased familiarity with these services will provide the contractors a greater market sense, increased flexibility with changing requirements, and more opportunities to form networks with competitors and other organizations related to husbanding services. This allows husbanding agents to establish purchase agreements and improve efficiencies. For example, an experienced contractor may be aware of a reoccurring naval exercise at a specific port with limited resources and attempt to preemptively purchase those assets at a discounted rate, reducing the cost for the contractors and price for the government. As a result, the improved market experience and efficiencies gained over time under the MAC may allow the contractors to lower their proposals on task orders to remain more competitive. By contrast, a contractor under a SAC would likely be less motivated to reduce their prices because they are already the sole provider for task orders under the contract. Therefore, changes in the experience level of contractors could make the prices less expensive for MAC than SAC.

4. Changes in Profit Margins of Contractors

Although fee is not part of the cost element, the contractor's profit margin could fundamentally change prices for services. Under a SAC, the contractor proposes prices based on an expected profit margin that is set at the start of the contract, whereas a MAC provides the opportunity for the contractors to change their profit margin with each RTOP. Therefore, the flexibility of changing profit margins over time on a MAC may allow more competitive pricing. For example, if a contractor proposes prices on a MAC for a given task order at 10% profit but does not get the award, that contractor may decrease their usual profit down to 9% to become more competitive for future task orders. Additionally, a contractor may choose to sacrifice some margin of profit to gain opportunities for establishing performance benchmarks or improve their overall performance rating. As a result, changes in profit could potentially cause prices for the MAC to be less expensive.

E. NON-PRICE FACTORS

Based on HSP contracts awarded during the last three years, this section identifies non-price factors that affect the overall value of the contract between NAVSUP HSP SACs and MACs, such as improved schedule or better performance. Identifying these non-price factors serves as a qualitative explanation for differences between contract types. During the course of this study, five non-price factors were identified that have the potential to influence the overall value of the contract type. However, due to lack of measurable data and lack of standardization for measuring each non-price factor, we were unable to provide a detailed analysis of each non-priced factor in our study. For example, we reviewed quality assurance review and performance ratings to identify qualitative changes to the MAC over time. However, we determined that the information provided within the performance ratings were not standard across numbered fleet commanders and the data did not provide measures of the actual contractor's performance that could be associated to an individual task order or specific service rendered.

1. Quality Assurance

All HSP contracts are required to have a quality assurance surveillance plan (QASP), which is designed to monitor the contract performance by providing a measurable means to evaluate the quality of a contract. Due to increased standardization since implementation of MACs, the evaluative quality of the QASP has increased. The QASPs found in SACs vary significantly based on region and timeframe because they are individually prepared by different offices at different times. The SAC QASP criteria specifically address pricing and administrative contract management elements with no contractor performance quality comments or customer input. In the MACs, the QASP is standardized and more consistent overall because NAVSUP standardized the format across all contracting offices. Additionally, the QASP includes direct user feedback in the form of contractor performance comments from the ships utilizing the contract. The CORs are delegated with the responsibility to ensure this requirement is completed. Figure 4 illustrates the differences between performance objectives found in a sample QASP for a SAC and MAC.

Regional Sample SAC QASP factors:	**Standardized MAC QASP factors:**
Timeliness of PCE submission: Binary rating of weather contractor generally submitted PCEs within the allotted window. Contractor submitting information into LogSSR (now HS Portal): Binary (and subjective) rating of weather contractor input data into LogSSR as required by the contract. Accuracy of invoices submitted: Binary (and subjective) rating of weather invoices were submitted without errors. Maintaining online pricing application: Binary rating of the online pricing application was utilized. Final pricing report submitted: Binary rating of weather the contractor submitted a pricing report. *Note: Binary ratings are either “Yes” or “No.”	Quality: Personnel, services, measurements, communications, support equipment, transportation. Schedule: Boarding, tugs/pilots, services rendered, cleanliness, force protection, daily reconciliation. Business Relations: Customer service orientation, accuracy and timeliness of invoices, customer satisfaction surveys. Regulatory Compliance: Compliance with local authorities, ECMRA reporting, human trafficking, transparency with costs. Small Business Competition (applicable within the United States) Cost Control Measures

Figure 4. Differences between SAC and MAC QASPs

2. Lead Time

Lead time is measured as the time between when the requirement is submitted by the requesting ship and when a task order is issued by the contracting office. For a SAC, the solicitation states the notional lead time for issuing the task order for each port. Upon awarding the contract, those lead times become part of the contractual agreement at the base contract level. This means that the base contract is responsible for holding the contractor to their proposed lead time for the entire period of performance. In a MAC, lead times are not discussed at the base contract level. The task order's period of performance is stated by the government, and the contractors submitting proposals are expected to meet the required timeline(s) for services.

3. Auditability and Contracting Administration

In the DoD contracting, auditability refers to the government's ability to accurately trace financial transactions, which conform with an organization's procurement processes and standards. Auditability includes having "competent people, capable processes, and effective internal controls to deter procurement fraud" (Rendon & Rendon 2015 , p. 726). The main difference between the SAC and MAC in terms of audibility occurs in the RTOP phase. During a MAC, each competed task order must conform to the same standards of policy, procedures, and determination of fair and reasonableness. In a SAC, there is only one contractor and the process for issuing a task order is not competed. As a result, the MAC requires an additional amount of documentation for each task order, which includes additional risk to auditability.

All contracts require administrative work to ensure proper processing of paperwork and documentation of all business transactions. This includes systems such as Wide Area Workflow for payment, System for Award Management for business registration, Contracting Officers Representative Tracking Tool, and the Contractor Performance Assessment Reporting System for quarterly performance reviews. Under the SAC, only one contractor needs to be managed whereas under a MAC, all base contract holders need to be administratively managed. This means a greater amount of contract administration would be performed under a MAC than SAC, which includes the additional amount of manpower and labor hours to manage.

4. OPSEC

Operational Security (OPSEC) refers to the management and protection of sensitive information from being transferred between government and contractors. Such information may include the dates and locations for husbanding services provided to the Navy. In the SAC, all business correspondence regarding a port visit stays between the government and the single awardee of the contract, which consists of only two parties. In a MAC, however, all potential awardees may be privy to information being shared by the government regarding a port visit. As a result, the increased number of parties will increase the risk to OPSEC because there will be more personnel that are provided information on the ship's logistical requirements for the port visit.

5. Dynamic Force Employment

In the context of HSP services, Dynamic Force Employment (DFE) refers to the combat effectiveness and competitive advantage the Navy achieves by remaining flexible and unpredictable when conducting port visits around the world. For example, DFE may include the ability for the contracting office to adjust to changes in a ship's schedule or support husbanding service requirements for urgent ship repairs in an overseas commercial port. In a SAC, there is less flexibility for the government to rapidly respond to new or changing requirements because there is only one contractor. In contrast, the MAC is competed for each port visit and the criteria for award can change along with the timeframe requirements needed by the government. As urgent requirements develop, the MAC has a greater capacity of supporting the requirements across a larger network of contractors and vendors. Therefore, the MAC has more flexibility to meet the government's requirements when resources are constrained, such as time or limited assets (e.g., brows, brow stands, fenders). However, the MAC could hypothetically take longer to award the task orders if the contracting office wants to wait for the most competitive proposal. Ultimately, the flexibility of the MAC results in greater combat effectiveness across a wide range of situations, which includes contingency operations or operating in contested areas.

6. Estimating the Value of Non-price Factors

Quantifying the non-price factors would allow future research to determine whether price or non-price factors provide the greatest advantage to the government and determine an estimate for the overall value of the MAC. An example of a non-price factor that may be valued more important than price could be the responsiveness to warfighter's needs under certain conditions of global conflicts. In a wartime scenario or periods of conflict, the service capacity and capability of the contractors servicing ports in contested environments could be limited based on the conditions of the infrastructure and economic stability of the local community. In a SAC, the Navy could be limited by the support capacity and resources provided by a single vendor during wartime conditions. By contrast, the MAC could allow the Navy the flexibility to use resources across multiple vendors to support the requirements at the time of need.

The Navy could experience problems similar to those experienced by the Department of Homeland Security when using a sole source IDIQ contract, similar to the SAC, to provide humanitarian assistance during a series of hurricanes that impacted the southeastern US in 2007. As a result of using the sole source IDIQ rather than a MAC, the single vendor providing debris removal reached maximum capacity while supporting requirements from non-DHS agencies and could not fulfill the minimum requirements for DHS (Mak 2019). As demonstrated by this example, SACs and sole source IDIQs could limit the opportunities for the government to remain flexible in a changing environment. The MAC likely provides greater flexibility and capability of supporting the requirements by using multiple contractors rather than relying on one single contractor to provide support. In the case of supporting the operational needs of the warfighter during a wartime scenario, the flexibility of using a MAC would likely be valued more than price.

Table 2 summarizes the five non-price factors, possible measurements of those non-price factors, and the potential effect on the MAC. This table could be used to improve our overall understanding of the non-price factors that exist today and assist government stakeholder when choosing a contracting strategy.

Table 2. Summary of Non-price Factors

Non-Price Factor	Measured by	Potential MAC Effect
Logistics Lead Time	Time between establishment of the initial requirement and awarding task order.	Increase time because each task order will need to be competed using “fair and reasonable” determination (unless it is not competed).
Dynamic Force Employment	Adjusting for short notice requirements outside the contract scope.	More flexibility to support requirements because there are multiple contractors, but could take longer to award a task order.
	Support standard services at non-standard ports. (Non-standard ports are considered any port not competed on the base contract.)	More flexible for multiple contractors to support non-standard ports.
	Ability to prepare, execute, and manage contracts during conflict and/or within contested environments.	Lower risk of not executing requirements because the contract includes resources across multiple contractors.
Administration and Auditability	The ability for the government to show evidence of a ‘fair and reasonable’ determination for non-price evaluation factors.	Less risk up front, more risk over the length of the contract because determination of fair and reasonableness reoccurs for each task order.
	Time required to complete administrative requirements.	Longer timeframe to issue task order.
	Number of administrative deliverables.	Increased administrative requirements with issuing task orders.
OPSEC	Number of contractors provided information on upcoming ship port visits	Higher risk of OPSEC because multiple contractors are made aware of upcoming port requirements.
Quality of Contractor Performance	Quality performance ratings for services provided by the contractor	Higher performance quality because contractors need to remain competitive to be awarded follow-on task orders.

F. SUMMARY

A SAC and MAC operate similarly during the earlier pre-award phase of the contract process, but they differ significantly during the award phase. The change from a SAC to a MAC strategy not only creates the most obvious difference of competition but also changes how potential contractors and the contracting office react to the acquisition environment. Additionally, the relevance of specific contract elements influences the actions of potential contractors and can affect the overall cost to the government. Table 3 summarizes the primary differences between SAC and MAC.

Table 3. Key Differences in Contracts between SAC and MAC

Element	Single Award HSP Contract	Multiple Award HSP Contract
Competition	All competition takes place at the base contract level	Each individual task order is competed among all base contract awardees
Number of awardees	One awardee	Multiple awardees
Coverage area	Specifically named ports	All ports within that country's territorial waters
Commercial vs. noncommercial contract clauses	All changes and task orders are bilateral	Government has the right to exercise unilateral changes and task orders
Statement of Work (SOW or PWS)	Varies from region to region	Based on a NAVSUP standardized template
Minimum guarantee	The single awardee is entitled to the minimum order guarantee	All awardees are entitled to a minimum order guarantee
Pricing	Contractor proposals list services and prices	Contractor proposals provide list of services with ceiling prices that can be provided at task order level
Quality Assurance Surveillance Plan (QASP)	Varies from contract to contract throughout each region	One standardized QASP is utilized in all MACs
Logistics lead time	Contractor determined at base contract level	Government dictated at the task order level
Contracting administration	One contractor managed	Multiple contractors managed
Evaluation criteria	Lowest Price Technically Acceptable (LPTA) / trade-off	Lowest Price at base and flexible criteria at task order level

IV. DATA AND METHODOLOGY

Based on the qualitative comparison made in Chapter III, it is likely that converting contracts to MACs would affect the price. Given the qualitative distinction between contract types, we speculated that the sum of these elements decrease price when transitioning from a SAC to a MAC, appropriately labeled as the "MAC." The MAC terminology can be used to describe both the explanatory variable, including all of the contract element differences between SAC to MAC, and the changes resulting from the transition from SAC to MAC. We expected that MAC would decrease price based on the contracting elements affecting price, primarily caused by the increase in the competition at the task order level. This section describes the analysis used to test the hypothesis that a SAC and MAC have statistically significant different effects on price and explains the design of the regression model used to estimate the MAC effect on price. Additionally, this section describes the fixed-effects regression model used to further investigate the MAC effect under certain criteria and determine if the costs associated with specific ports or service categories are affected more or less by the MAC effect.

A. SOURCE OF DATA

Over the last four years, the U.S. Navy has conducted an average of 4.15 port visits per day, or roughly 3.89 port visits per year on average for a given ship: albeit the number of ship visits per year depends largely on the deployment cycle of the ship and the number of active ships in inventory (NAVSUP, n.d.). Every port visit occurrence results in the collection and distribution of husbanding services and port service data and information. The source data used for this study were retrieved from the Navy's HS Portal. The HS Portal, formerly LogSSR, is an online repository of husbanding service information that stores data from Navy port visits worldwide, to include unit price for each service provided by the contractor. All data used for this study are unclassified and provided by NAVSUP (N7). The COR and other contracting personnel from the respective regions are responsible for ensuring invoices and other data sources are properly submitted and for verifying that the cost data are accurately recorded in HS Portal. These data constitute the foundation for the price comparison between the SAC and MAC. The sample used for this analysis includes individual-level panel data spanning a three-year period, from October 2016 to August 2019. We attempted to obtain data prior to October 2016, when the HS Portal website was initiated, to increase the sample size. However, previous records and pricing data stored in the legacy LogSSR system were no longer available. Given these conditions, we limited the research to include only the price data available on the HS Portal website. The HS Portal also contains other data sources used to develop the data sample, including contracts, statements of work, performance work statements, QASPs, and invoices.

B. DATA SAMPLE

The starting sample contained 83,714 observations of individual exhibit line item numbers (ELINs) exercised during port visits over the four-year period. An ELIN is an alphanumeric identification code assigned to a specific service or contract line item; it is used to identify the task order requirements. Both SACs and MACs use the same ELINs to identify the services. Each ELIN observation was identified as a SAC or MAC based on the contract number. Therefore, the contract number was used to create the MAC dummy variable, which separated SAC and MAC data. Additionally, both price and quantity were converted to the natural logarithmic form to explain the change in price from SAC to MAC as the percentage difference. We used the six data elements listed in Table 4 as the basis for the variables used in the model.

Table 4. Summary and Description of Required Data Elements in the Sample

Required Data Element	Description
Exhibit Line Item Number (ELIN)	Displays the nomenclature of the service provided
Contract number	Identifies the contract used for each observation
Price (P)	Provides the price per unit (USD)
Unit of Issue (UI)	Identifies the unit of issue for each service provided
Platform Type (T)	Identifies the platform type
Quantity (Q)	Identifies the quantity of units ordered for each observation

The distribution of ELINs exercised as either SAC or MAC within the data sample was germane to the study to illustrate that the observations were independent, and observations used for SAC were not used for MAC. The HSP MACs were first introduced in 2016 and all legacy SACs were eventually phase-replaced by MACs, leading to the full HSP MAC implementation in August 2018. The 35 months of data covering a three-year inclusive period for this study start with a 21-month period where both SAC and MAC were utilized during MAC implementation, followed by a 14-month period of only MACs.

C. CLEANING THE DATA

Cleaning the data is an important prerequisite to performing an analysis, as it improves the quality of the data sample by excluding incorrect or incomplete information, thereby improving the estimation power of the model. Removing the erroneous observations reduces the effects on price caused by factors other than the MAC effect and increases our confidence that the observed effect is caused by the difference in contract type. The following four steps were used to clean the data:

Step 1. Exclude observations with missing data elements. The first step in cleaning the data involved excluding observations with missing required data elements such as price, quantity, unit of issue, or ELIN code. These data fields were required for each observation in order for the model to achieve the objective of identifying the HSP MAC effect on price. Any observation missing one or multiple required data elements was omitted from the data sample. A total of 5,484 observations were removed due to missing data elements, which represents the majority of observations (52.3%) excluded from the model as a result of data cleaning.

Step 2. Exclude ports outside of base contract. The second step involved excluding port visits not included within the SAC base contract award because ports added to the SAC via modification were not competed and therefore likely result in a higher price. Unfortunately, no data element captured which prices were the result of a contract modification and, therefore, we could not control for this effect completely. We developed a search criterion used to identify the ports that were potentially added by a contract modification. To minimize the effect on prices caused by contract modifications for SAC observation, we manually searched for port visits with fewer than 50 observations in the previous three years and reviewed the base contracts to verify that these ports were added via modification. We used 50 observations as a threshold because we assumed 50 represented a high enough frequency of port services exercised for a given port that would be assigned to the original base contract and likely not a port added to the base contract via a modification. After identifying the ports with less than 50 observations over the three-year period, we reviewed the contract numbers assigned to those ports and validated those ports were added by a modification. One potential bias with our assumption is that there could potentially be other ports added by a contract modification that exceeded 50 observations. Although the data was not available to completely control for the effects of contract modifications, we determined this process was an acceptable alternative to minimize some of the effect without creating a significant bias based on the small percentage of observations excluded (less than 0.1%). Observations that were identified as not being part of the base contract were excluded from the analysis to avoid effects on price caused by contingency operations or rare occasions. For example, littoral combat ships require port visits in atypical locations to support post-delivery sail-around efforts, which require modifications to the original HSP base contract or a stand-alone contact. Contingency operations or rare occasions include services for ports that were not listed in the original base contract and require a modification to the contract. As a result, the modification may express prices that were not reflective of the contract type and instead capture the effect of the modification.

Step 3. Exclude miscellaneous ELINs. The third step involved excluding ELINs intended to support miscellaneous services, commonly identified as "miscellaneous" service categories. These miscellaneous line items did not identify specific service tasks, which is necessary for a balanced price comparison between contracts. For example, the ELIN for "Other General Charter & Hire Items" appeared 3,042 times, with prices ranging from $1.00 to $232,242.70 per lot. One description listed under this ELIN states "[two (2)] lineboats for arrival and departure," and another description states "one (1) pallet jack for food stores onload," exemplifying the diversity of services within these miscellaneous ELINs. As a result, all observations listed as "miscellaneous" were manually reviewed and omitted from the model.

Step 4. Exclude extreme values in price and quantity. The final step was to review quantity and unit price to identify and remove potential extreme values. Extreme values represent outliers of the data, where the probability of occurrence in a random sample is unlikely. The effect of extreme values can skew the results of the model and risk understating or overstating the estimation. Extreme values might be caused by the contractor's pricing strategy. For example, some contractors purposely price a service for $1 but increase the price of another service to gain a competitive advantage during solicitation review. As a result, the true cost of the individual ELIN is masked by deliberate pricing actions of the contractor. Therefore, we excluded extreme values prior to performing the regression analysis using standardized values (z-score) as the criteria to improve the estimation accuracy of the model. Excluding extreme values from the model was an involved process with several steps, including a manual review to identify observations that should be excluded from the data sample.

To identify the extreme values, we calculated the standardized value of prices within each group composed of the same port, service, and platform type using a standard normal distribution. Prices with a standardized value greater than 3.09 and less than negative 3.09 were used to identify prices with a probability outside 99.8% of the normal distribution, or roughly three standard deviations away from the mean. This method was adopted from other research in the field of excluding extreme values and is considered a justifiable practice among statisticians (Arkes, 2019). These extreme values were flagged as potential observations for removal and required further investigation. However, not all flagged values were removed from the model simply because they were outside the standard normal confidence interval. Some of the extreme values could be explained by the competitive environment created by a MAC or the pricing strategy of the contractors. For example, the price per unit for a particular service may appear as extreme simply because the total price of the service increased or decreased significantly based on the market conditions. This example demonstrates how the extreme values could actually be capturing the causal effect of the MAC, which we did not want to exclude from the model. The process for reviewing extreme values was based on criteria established to assess the legitimacy of the price and our understanding of the comment descriptions provided in the HS Portal website for each observation. Flagged observations that were excluded for non-qualified prices were any observation that did not meet all three of the following criteria, which ascertain if the extreme value captures the actual competitive pricing of the MAC and/or some deliberate pricing strategy by the contractors:

- Observation must have comments with amplifying information
- Observations must have a comment description that indicates the service was provided in full (prorated or partial services were excluded).
- Observations must have a comment description that matches the description of other services within the same fixed effects group.

D. DESCRIPTIVE STATISTICS

A total of 9,769 observations were excluded from the data sample based on the four steps used for cleaning the data. Step 1 excluded 5,484 observations, while steps 2 through 4 were performed concurrently and excluded 4,285 observations. As a result, 73,945 observations remained after the data cleaning process. After data cleaning, approximately 36% of the data sample represented observations for SACs and 64% represented observations for MACs. Of the 9,769 observations omitted from the model based on the data cleaning, 92.7% of the observations for price were excluded from the SAC, while only 7.3% of observations were excluded for MAC. One possible explanation for SACs having the majority of the observations excluded from the model, relative to MAC, is related to the potential inaccuracy of pricing data per unit under the SAC. Greater emphasis for contract management and oversight, executed by the CORs, was implemented with the OSBP policy prior to the rollout of the MAC. As a result, the MACs received the full benefit of having a mature process for recording accurate pricing data, while the SAC did not. Additionally, the MAC requires a greater need to accurately compare cost per unit across all competitive task order proposals to ensure prices were established through a determination of fair and reasonableness, whereas a SAC is less competitive for each task order and based on historical pricing data for each contracting region. As a result of the data cleaning, our estimation may be over- or understating the true effect of the MAC on price based on the larger amount of SAC prices excluded from the model.

After the data cleaning we developed sample criteria to exclude observation that did not contribute to estimating any MAC effect on price. For example, if there were observations of prices for SACs under a specific group of ELIN–port–ship, but no observations of price for MAC given the identical group, then the SAC observations would be excluded from the fixed-effects model based on the sample criteria. As a result, a total of 24,708 observations were used for the data sample after completing the data cleaning and assigning the sample criteria for the fixed-effects groups. Figure 5 shows the change in distribution of SAC and MAC observations as a result of holding constant the fixed effects.

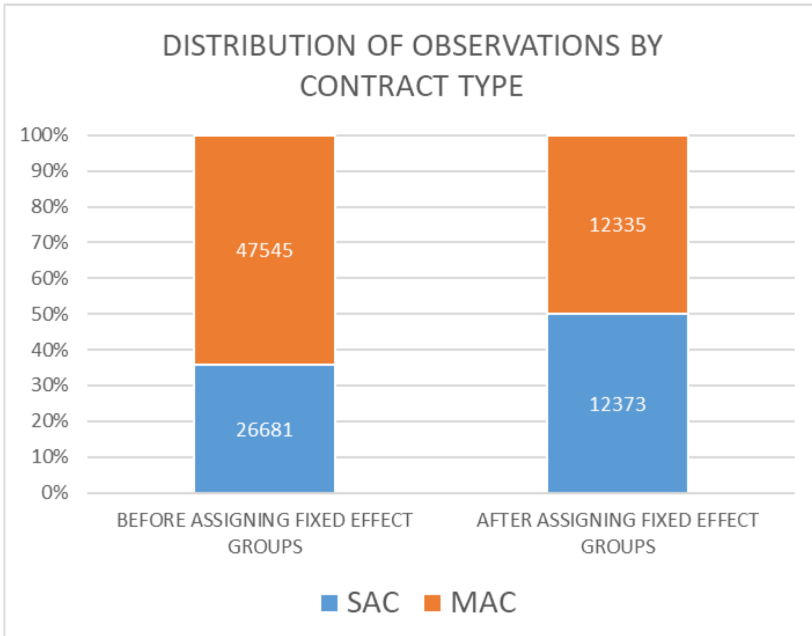

Figure 5. Distribution of SAC and MAC Observations in the Sample before and after Applying Fixed Effects Sample Criteria

E. DEVELOPING THE FIXED-EFFECTS LINEAR REGRESSION

To compare costs between SAC and MAC requires a regression model that compares costs across an even playing field. To do this, a fixed-effects regression model is used to estimate the relationship between an explanatory variable (MAC) and a dependent variable (price) by controlling for differences across contract type. The fixed effects model in this study compares prices between contract types where the only difference is the contract type, while the other factors such as the different ports, services, type of platform, and quantity are held constant. Therefore, the objective of the model is to estimate the MAC effect on prices of services within similar fixed-effects groups. The first step in developing the fixed-effects regression model was identifying the groups, which controls for group-invariant differences between SAC and MAC.

A direct comparison between SACs and MACs is complicated and difficult for various reasons. Simply taking the average cost of one ELIN from a SAC and comparing it to the average cost of the same ELIN from a MAC would be an inaccurate method for analyzing cost differences, because it does not account for the other observed variables that could be different across SAC and MAC contracts. For example, directly comparing the average unit cost of one hour of a crane rental under a SAC at Singapore to one hour of a crane rental under a MAC in Vietnam would not produce meaningful results because the difference between prices would be confounded by the inherent difference in prices for those regions; services in Singapore naturally cost more. The economies in these countries are vastly different; therefore, the costs for each service would be different for each port. Additionally, the average cost of services may be different based on the platform type. For example, the average cost for a bus rental used by a submarine might be different than the average cost for a bus rental used by an aircraft carrier. An aircraft carrier has a service consumption rate several times larger than other platform types due to its size. At times, there may be cases where the demand for resources exceeds the supply available, and the husbanding provider must import services to the region, which may significantly increase contract costs.

The solution for accurately comparing costs between SACs and MACs for similar services, ports, and platforms was using a fixed-effects model that compares contract type within groups of identical ELINs, identical ports, and similar platform types. Each group controls for the effects that are caused by differences between platform type, ELINs, and port. For example, the model compares one observation of a cruiser's van rental cost at a specific port under a SAC to a separate observation of a cruiser's cost for van rental at the same port under a MAC.

Creating groups of similar ELINs, port, and platform type required categorizing platforms by similar size. Categorizing platforms was necessary in the regression analysis to increase the number of groups for comparing prices between SAC and MAC, thereby ensuring adequate power in the model to obtain more precise estimates. Although the classes of ships are not identical, the analysis assumes that these platforms share enough similarities in service consumption to make an accurate comparison of costs. Comparing the cost of services for identical ships resulted in greater number of fixed-effect groups, but reduced the number of observations. Comparing the cost of services by ships of similar category resulted in smaller number of fixed-effect groups, but a greater number of total observations within the model. Therefore, categorizing the ships decreased the total number of groups, but allowed for a greater number of ELIN price comparisons, thereby improving our confidence that the regression estimate sample represents the true population. The rationale for separating ships into the six categories was balanced evenly between the estimated consumption of services (according to the standard logistics requisition quantities generated by the fleets) and approximate crew size. Table 5 provides a detailed list of ship classes, classified by category.

Table 5. Classes of Ship by Category

Category	Classes of Ships	Size/Function
1	All MSC vessels (T-AKE, T-AOE, etc.)	Military Sealift Command Resupply Ships
2	DDG, CG, LCS	Small Surface Combatants
3	LPD, LSD	Amphibious Combatants
4	SSN, SSBN, SSGN, MCM, PC	Submarine and Smaller Surface Combatants
5	LHD, LHA, LCC	Large Deck Non-CVNs
6	CVN	Aircraft Carrier

Note: Categories are based only on estimated consumption of services

F. FIXED-EFFECTS LINEAR REGRESSION APPLIED

By using a fixed-effects model, specific variables can be held constant, and a model can be developed to explain the true difference in price between a SAC and MAC. In particular, the fixed-effects linear regression model allows for comparison of the contract types within the groups that controlled for differences of ELIN, platform type, and port. A fixed-effects regression method was used to calculate the coefficient estimates and confidence intervals for variables within groups, ensuring that the model is only comparing prices within the same group. Fixed-effects linear regression uses the following different types of variables.

1. Outcome Variable

Price is defined as the outcome variable, which is measured in U.S. dollars (USD) on a per-unit basis. Each unit change within the outcome variable is explained by the change in contract type. The regression model uses invoiced prices as the outcome variable which includes the contractor's profit. The logarithmic form of price was calculated to transform the outcome variable to a logarithmic scale in order to measure the percentage change in price going from SAC to MAC.

2. Key Explanatory Variable

The key explanatory factor for the change in price is the MAC, which is characterized by observations that exercise services with the presence of a MAC indicator. The MAC indicators were identified by cross-referencing contract numbers on a list identifying the contract as SAC or MAC. The observed contract type was used as the key explanatory variable in the fixed-effects model. Given that SACs represent the baseline and historical contract type used for HSP services, the MAC effect measures the difference between price for SAC and MAC.

3. Control Variables

Three control variables were considered for the model to capture any observed effects on price: quantity, inflation, and rate. These control variables were held constant to provide a proper comparison of price between SAC and MAC and ensure there were no confounding factors.

a. Quantity

Quantity was considered a control variable because the quantity of services ordered could change between SAC and MAC. The greater quantity demanded for services could affect the price per unit between contract type. Similar to the effect of economies of scale, theoretically, the average unit price decreases as the volume purchased increases in the long run. This means that ships ordering a greater quantity should have a lower unit price for services compared to ships that order a smaller quantity. For example, assume we are comparing the MAC prices of oily waste offload between two identical ships, Ship A and

Ship B (see Table 6). Ship A used the port visit as a liberty port and only removed 200 cubic meters of oily waste. On the other hand, Ship B used the port visit as a maintenance port and removed 200,000 cubic meters of oily waste. The magnitude of quantities ordered between the two ships could potentially affect unit price based on the composition of overhead costs and fixed costs per unit. Continuing with the previous example, if the oily waste removal has a fixed cost of $1,000 per service plus $1 for every cubic meter removed, then the unit cost for the Ship A would be $6 and the unit cost for the Ship B would be $1.005. Therefore, a control variable for quantity was included into the model to ensure that the price comparison between SAC and MAC was not due to differences in the quantity of husbanding services ordered.

Table 6. Example Unit Quantity Cost

	Ship A–Liberty Port	**Ship B–Maintenance Port**
Fixed cost	$1,000	$1,000
Order quantity	200	200,000
Variable cost	$1 / meter cubed	$1 / meter cubed
Total cost	$1,200	$201,000
Per unit cost	$6	$1.005

b. Inflation

To control for the inflation rate and changes in port, a consumer price index dummy inflation variable, also called a trend effect, was created for each port over the four-year period. Cost for each ELIN varies significantly depending on location. Each country has a different inflation rate, and many countries have micro-economies, which can influence service costs. For example, the cost of a gallon of potable water in Yokosuka, Japan, is different from the cost of a gallon of water in Tokyo, Japan—based on the different costs associated with those markets. The inflation rates may be considered negligible for one region over a four-year period. However, the difference in inflation rates across all the sampled ports in aggregate could significantly misrepresent the effect of contract type on cost.

c. *Exchange Rates*

All cost data is provided in USD; however, the true value of the USD depends on the exchange rate at the time of transaction. Therefore, an exchange rate variable was created to control for the effects of changing exchange rates. Exchange rate data for the United States for the inclusive time period of the data sample was obtained from Federal Reserve Economic Data, which is maintained by the Federal Reserve Bank of St. Louis.

4. Omitted Variables

Some of the other determinants of price may be impossible to control for in the model; these are considered omitted variables. A fixed-effects model is used to better control for the unobserved heterogeneous effect of the change between contract type. However, there are still other unavoidable factors influencing price that could be different across SAC and MAC, which could create confounding effects in the price differences and cause biased results from our model. The actual number of unobservable individual effects that exist can never be known for certain, but an estimate can be made. Examples of potential omitted variables are described below. For each omitted factor described below, we discuss potential causes for the difference between SAC and MAC and indicate the direction of the bias on the estimate of price.

a. *Unethical Behavior*

The model developed does not account for unobserved or potential unethical behaviors within HSP contracting, such as price gouging, collusion, and bid rigging. Although the Navy has converted to an OSBP system that segregates responsibilities and adds redundancy to safeguard against criminal interests, it would be unwise to assume that the pricing data is completely immune to such activity or other exploitation. Although the risk of unethical behavior is minimal across both SAC and MAC with the current OSBP system, each contract type responds differently to the various forms of unethical behavior, which changes the effect of competition. According to *The Responsible Contract Manger*, "corruption can make fair competition impossible," which applies to both contract types differently because the competition at the task order level is different (Cohen & Eimicke, 2008, p. 26). Under a SAC, a single contractor provides husbanding services, which does not allow for collusion during the task order proposal. In a MAC, price gouging is more unlikely because the contractors need to remain competitive for each task order proposal, but the opportunities for collusion are greater. Because both contract types respond differently to types of unethical behavior, it is unclear which direction this bias would affect price.

b. Changes from Market Anomalies and Special Events

A number of diverse events can take place that affect market conditions, such as natural disasters, multinational exercises, multiple Navy ships' visits, or fluctuating strength of foreign economies. This study does not consider the market fluctuations in prices that may result from such activities. For example, naval exercises like the Rim of the Pacific exercise occur every two years, which causes scarcity of shared resources among naval and commercial ships in that region. The surge in prices is known to exist, but there is no mechanism to control for this rapid fluctuation during the time period that the MAC was being implemented. As a result, these rare occurrences may have occurred under one contract type but not the other. Because the pricing changes caused by anomalies and special events likely follow the same behavior as the prices during market fluctuations, we assume that this phenomenon would have greater effect on price in the MAC than SAC. Based on the theory of supply and demand, we suspect that the effect of these rare occurrences would likely increase prices for the MAC.

c. Changes to PWS/SOW and Tiered-Pricing System

This study does not account for SAC and MAC differences in PWS or SOW, such as the volumetric pricing system and vehicle mileage limitations. A SOW is used to describe the requirements of a SAC, while a PWS is used to describe the requirements of a MAC. In the SAC, all unit prices are static in the base award, and the same unit price does not change regardless of the quantity ordered. In the MAC, a volumetric pricing system was developed where the contractor can propose tiered pricing during the RTOP phase. In a tiered-pricing system, the price per unit changes based on a range of quantities. For example, the tiered-pricing scheme may establish one price per unit of waste removal less than 50 cubic meters and a different price per unit for waste removal greater than 50 cubic meters. In addition to the volumetric pricing system, some ELINs' pricing standards were changed based on the rental agreements. For example, vans were authorized limited mileage under a SAC, but unlimited mileage under a MAC. The direction of the bias could change depending on the quantity ordered for MAC but remain unchanged for the SAC. Therefore, the effect of MAC on price may be influenced by changes caused by the tiered-pricing system.

G. MODEL DEVELOPMENT

We developed the fixed-effects model over several iterations and tested the model through a trial-and-error process to determine the best estimate for the MAC effect on cost. The baseline model included a sample of all ports with the trend variables excluded. The second iteration of the model included the same sample of all ports but included the trend variables to capture port-specific inflation effects. Comparing the first two models demonstrated the importance of controlling for inflation by including the trend variables for all ports. Finally, a third iteration of the model was developed that included only ports with a coefficient estimated on its trend variables by using the results from the previous model. The trend variables were included for only those ports with a coefficient estimate, because the MAC effect could be influenced by the inflation in ports without data to estimate their trend effect.

Unfortunately, the effects from the trend variables used for the model resulted in negative coefficients, meaning that the inflation term decreased the MAC effect on price. Although there may be some ports that exhibit an effect of deflation due to the cheaper costs of services over time, it is more likely that the trend variables were capturing an unobserved effect. We believe that the unobserved effect being captured by the trend variable were caused by fluctuations in the market value of services over time and by the increased competitive pricing among contractors, which would explain the negative coefficients. These unobserved effects can best be explained as quasi-omitted variables, which are variables that are intended to control for omitted variables but instead introduce other omitted variable effects. Therefore, we decided to remove the inflation control variable and use the baseline model as the most accurate method for hypothesis testing and estimation of the MAC effect.

Although we chose to remove the inflation based on quasi-omitted variable bias, we know that inflation exists, and we would expect inflation to increase prices of services over time. We concluded that the trend variable we used to measure the effect of inflation was also likely capturing changes to the market conditions over time. The changes to the market condition would likely only affect prices in a MAC based on competing task orders on a reoccurring basis. Meanwhile, prices for services under SAC would remain less dependent of market conditions because prices are fixed. Therefore, knowing fluctuations of prices exist within each market for port-services, the confounding effect of market conditions were interfering with the true effect of inflation. As a result, our regression did not capture the effects of inflation.

The baseline fixed-effects linear regression model, labeled Model 1, was used to create two additional fixed-effects models to explain the MAC effect for specific ports and specific service categories. Model 2 was used to evaluate and quantify any port-specific MAC effects. A total of 338 ports were analyzed for port-specific effects using the same sample criteria from the main model, with one additional sample criterion to account for the large number of ports omitted from the sample: only ports with a coefficient estimate for port-specific MAC were included within the data sample to avoid any effect caused by ports without data to estimate their port-specific effect. This was an iterative process that first required running the regression model, then assigning a dummy variable to identify ports with enough observations to estimate the port-specific MAC effect and ports without a coefficient estimate. A total of 237 ports were omitted from Model 2 based on port-specific sample criteria.

Model 3 was used to calculate service-specific MAC effects to understand how the MAC effect changed for each service category and identify which service categories had the largest MAC effect on price. We divided services into 18 categories according to the ELIN category names provided in the HS Portal website and used this category identifier to analyze the MAC effect under the same sample criteria as the primary model. Table 7 provides a list of the 16 service categories and the common services provided for each category.

Table 7. Common Services Provided for Each Service Category

Service Category	Unit of Issue	Common Services
Brow, Crane, Forklift, & Manlift	EA, GP, HR	Platform to transit in/off ship and vehicles that move material
Collection, Holding, and Transfer	MT, CM	Services to remove wastewater (pier side or anchored)
Fleet Landing	EA	Rental of location/platform to disembark ship
Force Protection Barriers	EA, DZ	Management of Physical barriers to control foot traffic
Force Protection Personnel & Equip	EA, DZ, GP	Pier security personnel and equipment such as x-ray machines and metal detectors
Force Protection Supplies	Various	Other items required for force protections such as forms, reflector vests, and signage
Fresh Potable Water	MT, CM	Drinkable water that meets US Navy standards
General Charter & Hire Items	EA, GP	Miscellaneous category to capture all other General Charter & Hire items.
General Utility	Various	Power connection between ship and pier
Husbanding Fees	DY	Fee charged by the husbanding agent for coordination of all services provided.
Land Transportation (Personnel)	HR/DY	Hiring drivers of rented vehicles such as buses and utility trucks/vans
Provisions	Various	Food required for subsistence
Ship Movement Services	DY/HR	Cost to have Tugs and other equipment on standby for short-notice departures.
Telephone Services	Various	Rental of cell phones and portable WIFI
Trash Removal	CM	Removal of solid waste
Water Ferry/Taxi Services	HR/DY	Hiring water taxis to transport personnel from ship to fleet landing area

The three models are labeled and summarized in Table 8. Each model was based on a 95% confidence interval, or an alpha of 0.05. Alpha represents the probability of committing a Type I error, meaning the probability that the null hypothesis is true.

Table 8. Summary of Fixed-Effects Regression Models

Model Number	Description
Model 1	Sample criteria includes same port, service, and ship type with observations for both SAC and MAC over time
Model 2	Same sample criteria as Model 1, but the key explanatory variables are port dummy variables, showing port-specific MAC effects
Model 3	Same sample criteria as Model 1, but the key explanatory variables are service categories, showing service-specific MAC effects

H. MODEL FRAMEWORK

Chapter III discussed the various elements that could affect differences in price between SAC and MAC. From this qualitative comparison, we formulated the framework of our regression model, which captures the effects of these elements into two mechanism of the MAC. The first mechanism is that the MAC increases the amount of competition, which decreases the price. The second mechanism is that the MAC improves the pricing strategy of the contractors, which also decreases the price. In our model, the estimate for β_1 captures the effects of both mechanism and is designed to measure the change in price from SACs to MACs, while holding other factors constant. Therefore, the effect of the MAC on price captures the increased competition and pricing strategy, and controls for exchange rate and quantity ordered, using within-group fixed effects. The effect can be explained graphically in Figure 6, which represents the basis of our theory that the MAC decreases price for the government. Although we know that the effect of inflation exists, we chose not to include inflation as a mediating factor in the graphic interpretation due to quasi-omitted variable bias.

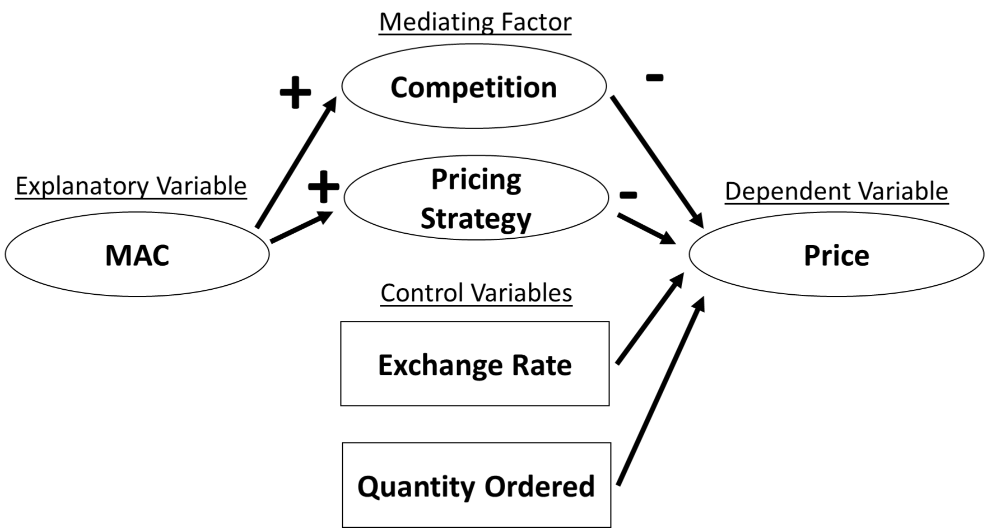

Figure 6. Graphical Interpretation of Model Framework

I. QUANTIFYING RESEARCH QUESTIONS

The hypothesis that the average price for SACs is different from the average price for MACs is defined as

$$H_o\text{: } P_{SAC} = P_{MAC}$$

$$H_a\text{: } P_{SAC} \neq P_{MAC},$$

where

P = the natural log of price for SAC and MAC.

The null hypothesis assumes that there is no difference between average price of SAC and MAC type contracts. The hypothesis test is using a two-tailed test based on a 95% confidence level, which means the alpha for this model is 0.025. A least squares linear fixed-effects regression was developed to conduct the hypothesis testing and estimate the MAC effect. The following formula postulates the relationship between contract type and price

$$P_{irfs} = \beta_1 MAC + \beta_2 Q_{rfs} + \beta_3 X_t + \alpha_{rfs} + \varepsilon,$$

where

P_{irfs} = the natural log of price for contract (i) in port (r), for function (f), and for class of ship (s)

MAC = dummy variable for type of contract

Q = variable that indicates the natural log of quantity ordered

X = exchange rate for a given time (t)

α = fixed effects of port, function, ship groups

ε = error term

The observed *p* value was used to test the hypothesis that the price difference between SACs and MACs were statistically different. However, there is an ongoing debate across the statistics community over the true interpretation of *p* values and confidence intervals when determining the significance of relationships using empirical data. The American Statistical Association released a statement that provides principles for interpreting the *p* value (Wasserstein, 2016). Researchers suggest that the probability of the estimate being accurate is dramatically less than what the confidence interval adequately assumes. For example, Sellke, et al. (2001) evaluated the fallacy of using *p* values by calculating the odds of conducting a Type II error (i.e., failing to reject a null hypothesis when it should be rejected), using a Bayesian reasoning. Selke's research determines that the true likelihood that the relationship is accurate based on a *p* value of 0.05 is actually much less than 95%. Although we recognize the purpose of avoiding false conclusions based on the *p* values, we are confident making determinations of statistical significance based on the large sample size and relatively small *p* values (<0.001).

The results section describes the difference between costs for SAC and MAC as "statistically significant." Readers should be cautious when interpreting statistical significance because it can lead to false dichotomous conclusions. Wasserstein et al. (2019) suggest that researchers should refrain from using the words "statistically significant" and consider alternative descriptions of the relationships and effects. By contrast, other statisticians are comfortable using the *p* value as evidence of the results' statistical significance if the *p* value threshold is less than 0.005 (Benjamin et al., 2018; Johnson et al., 2013). For this study, we remained conservative and reserved the term "statistically significant" for *p* values less than or equal to 0.001, or a 99.9% probability that the results are true, with a 95% confidence interval.

J. SUMMARY

In preparation for performing the empirical portion of this study and testing the hypothesis, the observed data sample was filtered for either inaccurate or incomplete data. Additionally, three fixed-effects linear regression models were developed to estimate the effect of the MAC on price, which control for type of service, ship type, port, quantity, and exchange rate. Overall, given the contracting data collected, we are highly confident that the regression model developed for conducting the analysis best describes the relationship between contract type and price.

V. RESULTS

Chapter IV explained the data variables and the three regression models designed to analyze the price data between SACs and MACs. Model 1 was used to determine if the mean of prices for SAC and MAC are different and analyze the overall relationship between price and the MAC. Models 2 and 3 were used to determine changes to prices caused from the MAC based on port-specific and service-specific criteria. Put differently, we identified if the MAC changes prices based on the port or category of services. The next step was running the regression models and examining the results. We used Stata16 (statistical software version 16 created by StataCorp).

A. INTRODUCTION

This chapter interprets and explains the results of the quantitative analysis, all of which support our conclusion: we concluded that there is a significant difference between average price of SACs and MACs. The MAC did, on average, decrease the price for services, and the magnitude of the effect on price varied based on the specific port or service category.

B. EXTREME RESIDUALS

To illustrate the sensitivity of the results to extreme residuals, Figure 7 shows the coefficient of the MAC on the primary model after each iteration of assessing the standardized residuals. With each iteration of removing extreme residuals, a greater number of MAC observations were being omitted relative to the number of SAC observations. The MAC observations below the mean price were being omitted, meaning the MAC was less inexpensive after each iteration. Therefore, the coefficient estimate of the MAC on price became more positive, and the difference in prices between SAC and MAC decreased as the number of iterations increased. Although we are not certain why the MAC had a greater number of extreme residuals, one possible explanation could be that the extreme values were the result of the abnormal market prices during the MAC transition, while the competitive prices were still being established. Another possible explanation could be the result of the omitted variable discussed in Chapter IV, or possibly some other unknown effect that was not included in the model. A total of 1,188 observations were removed from the model, which 82.5% of the total extreme residuals removed were MAC observations.

The Root Mean Square Error (RMSE) was also measured after each iteration of removing extreme price values to assess the error between the model's explanation of the MAC on price and the data sample's actual relationship. The RMSE measures the error between the sample data points and the fixed-effects regression line. The RMSE decreased after each iteration of removing extreme values, which was expected as we reduced the amount of error. Both the estimate of the MAC on price and the RMSE approach a limit as the iterative process approaches an infinite number of iterations. Given the primary model used to analyze the overall MAC effect, we assess the coefficient estimate and RMSE are less sensitive and responsive to extreme variables after four iterations of removing extreme residuals. Therefore, we chose the fourth iteration as a preferred model as the basis for reporting our results. However, to remain more objective in the results, the tables for each model also includes the results prior to removing extreme residuals as a reference and comparison between our preferred method and the unmodified results.

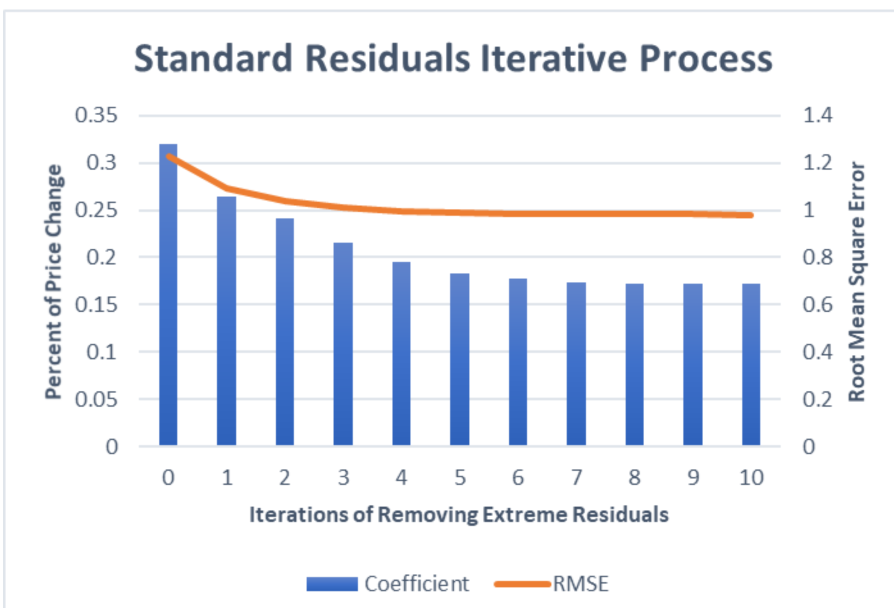

Figure 7. Graph of Change in Percent of Price and RMSE with Iterations of Removing Extreme Residuals

C. MODEL 1: PRIMARY REGRESSION ANALYSIS

Model 1, the primary model, was used to test the null hypothesis and determine if there is a statistically significant difference between prices for SACs and MACs. Table 9 shows the results from the regression analysis, which describes in statistical terms—holding other factors constant—how the MAC significantly reduces the prices for husbanding services overall. The regression results indicate a coefficient estimate of -0.320 before removing extreme residuals and -0.195 for the preferred method, meaning there is a strong negative relationship. The percent increase or decrease was obtained by using the exponential function of the logarithmic coefficient, subtracting by one, and then multiplying by 100 (Ford, 2018). The estimate from the model thus indicates that given an average price of an ELIN under a SAC, the average price of a MAC for the same ELIN and under the same conditions of ship type and port, will, on average, cost 17.7% less. The 95% confidence interval for the preferred model indicates a range of difference in price decrease between 20.6% and 14.8% for the MAC using the preferred method. Although the 99% confidence internal is not shown in the table, the results indicate a difference in price ranging between -0.148 (13.8% decrease) and -0.242 (21.4% decrease) for the MAC using the preferred method. The results of the two-tailed test from Model 1 show that the explanatory variable, labeled "MAC," which measures the difference in means of prices between SAC and MAC, had a *p* value of 0.000. Since the p value was less than alpha, our results indicate that our null hypothesis should be rejected and supports our theory that the prices between a SAC and MAC are statistically different.

Table 9. Fixed-Effects Regression Results for Model 1

	Before Removing Extreme Residuals					After Removing Extreme Residuals (Preferred Method)				
	Coefficient (%)		Std. Error	Confidence Interval (%)		Coefficient (%)		Std. Error	Confidence Interval (%)	
MAC	-0.320 **(-27.4)**	**	0.022	-0.362 **(-30.4)**	-0.278 **(-24.3)**	-0.195 **(-17.7)**	**	0.018	-0.231 **(-20.6)**	-0.160 **(-14.8)**
Log(Quantity)	-0.375	**	0.009	-0.392	-0.358	-0.366	**	0.008	-0.381	-0.351
Exchange	0.021	**	0.003	0.016	0.026	0.013	**	0.002	0.008	0.017
Constant	2.801	**	0.309	2.194	3.407	3.951	**	0.262	3.437	4.465

Results are based on 95% confidence intervals
Statistical significance based on ** p<0.001, * p<0.01

D. MODEL 2: PORT-SPECIFIC ANALYSIS

Model 2 was used to identify the effect of the MAC on price for individual ports and determine if the difference in price between SAC and MAC changes based on different ports. Using the results from Model 2, we selected the top 25 ports based on the total number of observations to analyze the MAC effects for these 25 different ports. Although there a total of 338 ports were analyzed for the port-specific MAC effects, we arbitrarily used 25 as a cutoff to display concisely in the table; but, we intentionally selected ports with the greatest number of observations to increase the statistical power of those estimates. The results for the remaining 313 ports are shown in the Appendix.

Of the top 25 ports we identified from Model 2 after removing extreme residual, 14 of these indicated a *p* value of less than 0.001, which we considered statistically significant (see Table 10). Of the top 25 ports, 10 show a negative relationship between price and the MAC, meaning the prices were less expensive for MAC relative to SAC. The port with the most negative coefficient estimate for the MAC was Augusta Bay, which had a 95% confidence interval between -1.407 (75.51% decrease) and -0.979 (62.43% decrease). The remaining four statistically significant ports show a positive effect of the MAC on price, with Fujairah having the largest coefficient estimate and a 95% confidence interval between 0.992 (169.66% increase) and 1.228 (241.44% increase).

There is a possibility that the positive coefficients could be the result of some other effect, either one of the omitted variables we identified early on, or potentially another unobserved variable not identified in the model. Another possibility is that the positive effects from the mechanism of pricing strategy could have a greater effect on price than the negative effects from increased competition, which could theoretically increase prices for services as the market matures. Although we are not certain of the explanation for the positive coefficient of the MAC in these four ports, Type 1 errors were a possibility that we considered before making any conclusions for individual ports. There is a generally acceptable standard among statisticians, when performing a regression analysis, that Type 1 errors occur in about 5% of the statistically significant relationships due to natural variation (Arkes, 2019). As a result, *if* there was no effect of the MAC on price, *then* we would expect roughly 17 ports (5%) of the total 338 ports would have a statistically significant coefficient estimate, either positive or negative, but in actuality, do not share a relationship. Thus, some of the 14 statistically significant ports could actually be Type 1 errors. Therefore, it would be false to use the results of Model 2 to make claims that specific ports are more or less favorable at reducing prices from the MAC. However, based on the preponderance of negative coefficients relative to positive coefficients, we can safely conclude that the effect of the MAC on price changes based on the individual port and the preponderance of the statistically significant coefficient estimates were negative, meaning the MAC was less expensive than SAC.

Table 10. Fixed Effects Regression Results for Model 2

	Before Removing Extreme Residuals					After Removing Extreme Residuals (Preferred Method)				
Ports	Obs.	Confidence Interval (%)			S. Err.	Obs.	Confidence Interval (%)			S. Err.
Jebel Ali	3835	0.039 (3.98)	0.227 (25.48)	*	0.048	3515	0.39 (47.7)	0.551 (73.50)	**	0.041
Khalifa Bin Salman	3479	-0.24 (-21.34)	-0.042 (-4.11)	*	0.051	3304	-0.158 (-14.62)	0.008 (0.80)		0.042
Djibouti	2472	-0.442 (-35.73)	-0.208 (-18.78)	**	0.060	2346	-0.326 (-27.82)	-0.134 (-12.54)	**	0.049
Fujairah	1616	0.608 (83.68)	0.884 (142.06)	**	0.070	1449	0.992 (169.66)	1.228 (241.44)	**	0.060
Mina Salman	1444	-0.486 (-38.49)	-0.117 (-11.04)	**	0.094	1399	-0.232 (-20.71)	0.07 (7.25)		0.077
Augusta Bay	959	-1.871 (-84.6)	-1.37 (-74.59)	**	0.128	813	-1.407 (-75.51)	-0.979 (-62.43)	**	0.109
Al Duqm	843	-0.766 (-53.51)	-0.383 (-31.82)	**	0.098	805	-0.911 (-59.79)	-0.584 (-44.23)	**	0.083
Salalah	680	-0.194 (-17.63)	0.256 (29.18)		0.115	624	0.149 (16.07)	0.526 (69.22)	**	0.096
Sasebo	664	-0.986 (-62.69)	-0.6 (-45.12)	**	0.099	655	-0.858 (-57.6)	-0.543 (-41.9)	**	0.080
Chinhae	614	-0.758 (-53.14)	-0.343 (-29.04)	**	0.106	599	-0.668 (-48.73)	-0.324 (-27.67)	**	0.088
Piraeus	553	-1.043 (-64.76)	-0.47 (-37.50)	**	0.146	458	-0.692 (-49.94)	-0.205 (-18.54)	**	0.124
Muscat	483	0.133 (14.22)	0.594 (81.12)	*	0.118	430	0.399 (49.03)	0.81 (124.79)	**	0.105
Manila	380	-0.803 (-55.2)	-0.217 (-19.51)	**	0.149	340	-0.514 (-40.19)	-0.023 (-2.27)		0.125
Morehead City	368	-1.384 (-74.94)	-0.797 (-54.93)	**	0.150	296	-1.464 (-76.87)	-0.882 (-58.6)	**	0.148
Faslane	364	-1.71 (-81.91)	-0.899 (-59.30)	**	0.207	318	-1.222 (-70.54)	-0.556 (-42.65)	**	0.170
Yokosuka	331	-0.947 (-61.21)	-0.347 (-29.32)	**	0.153	312	-1.027 (-64.19)	-0.534 (-41.37)	**	0.126
Pusan (Busan)	319	-0.862 (-57.77)	-0.277 (-24.19)	**	0.149	312	-0.746 (-52.57)	-0.271 (-23.74)	**	0.121
Doha	278	-0.471 (-37.56)	0.154 (16.65)		0.159	269	-0.2 (-18.13)	0.314 (36.89)		0.131
Brisbane	236	-0.15 (-13.93)	0.506 (65.86)		0.167	229	-0.236 (-21.02)	0.299 (34.85)		0.137
Abu Dhabi	208	-0.904 (-59.51)	0.264 (30.21)		0.298	203	-0.48 (-38.12)	0.561 (75.24)		0.266
Hong Kong	179	-0.304 (-26.21)	0.459 (58.25)		0.195	177	-0.188 (-17.14)	0.429 (53.57)		0.158
Rodman	168	-1.465 (-76.89)	-0.631 (-46.79)	**	0.213	164	-1.275 (-72.06)	-0.596 (-44.90)	**	0.173
Aqaba	167	-0.769 (-53.65)	0.153 (16.53)		0.235	164	-0.783 (-54.3)	-0.02 (-1.98)		0.194
Haakensvern	165	-1.23 (-70.77)	-0.12 (-11.31)		0.282	154	-1.434 (-76.16)	-0.492 (-38.86)	**	0.240
Townsville	158	-0.545 (-42.02)	0.3 (34.99)		0.216	155	-0.228 (-20.39)	0.475 (60.80)		0.179

Results are based on 95% confidence intervals (CI)

Statistical significance based on ** p<0.001, * p<0.01

E. MODEL 3: SERVICE-SPECIFIC ANALYSIS

Model 3 was used to identify service-specific MAC effects on price and determine if the difference in price between SAC and MAC changes based on different service categories. Table 11 provides the results for the Model 3 regression. The results for the preferred method indicate that 13 of the 16 service categories were statically significant, with *p* values less than 0.001. Of the 16 service categories, 11 represented a statistically significant negative relationship between the MAC and price, meaning that MACs were less expensive than SACs for the statistically significant service categories. General Utility Services showed the most negative coefficient estimates (between -1.566 and -2.34 at a 95% confidence interval) and Provisions showed the most positive coefficient estimates (between 1.190 and 4.356 at a 95% confidence interval). However, both of these service categories had the fewest number of observations in their respective fixed effect group: 11 observations for Provisions and 147 observations for General Utility Services. Therefore, these large coefficient estimates could be more representative of the smaller sample size within those groups than the actual effect of the MAC on price. Collection, Holding and Transfer and Fresh Potable Water services were also statistically significant and have relatively large negative coefficient estimates with a relatively larger sample size, 699 and 1,008 observations, respectively. Collection, Holding and Transfer showed coefficient estimates at the 95% confidence level between -0.504 (39.59% decrease on price) and -0.848 (57.17% decrease on price), while Fresh Potable Water showed coefficient estimates between -0.616 (45.99% decrease in price) and -0.914 (59.91% decrease in price). One pattern that we recognized with these two services in particular is they both use volumetric units of measurement for calculating price per unit. The results could show that the mechanism for pricing strategy, which was affected by the tired pricing system, could have a greater negative effect on price than the negative effect of competition on price.

Table 11. Fixed-Effects Regression Results for Model 3

Service Category	Before Removing Extreme Residuals: Confidence Interval (as percent)			Std. Error	Obs.	After Removing Extreme Residuals (Preferred Method): Confidence Interval (as percent)			Std. Error
Land Transportation Services	-0.591 (-44.62)	-0.414 (-33.90)	**	-0.045	3917	-0.306 (-26.36)	-0.157 (-14.53)	**	-0.038
Husbanding Fees	-0.501 (-39.41)	-0.321 (-27.46)	**	-0.046	3776	-0.222 (-19.91)	-0.07 (-6.76)	**	-0.039
Ship Movement Services	-0.297 (-25.70)	-0.085 (-8.15)	**	-0.054	3216	-0.262 (-23.05)	-0.083 (-7.96)	**	-0.046
General Charter & Hire Items	-0.076 (-7.32)	0.155 (16.77)		-0.059	2579	-0.005 (-0.5)	0.189 (20.80)		-0.049
Telephone Services & Communications	-0.633 (-46.9)	-0.396 (-32.7)	**	-0.060	2123	-0.567 (-43.28)	-0.363 (-30.44)	**	-0.052
Brow, Crane, Forklift, & Manlift	0.193 (21.29)	0.463 (58.88)	**	-0.069	2050	0.274 (31.52)	0.501 (65.04)	**	-0.058
Trash Removal	-0.551 (-42.36)	-0.282 (-24.57)	**	-0.069	1696	-0.509 (-39.89)	-0.287 (-24.95)	**	-0.057
Fresh Potable Water	-1.012 (-63.65)	-0.654 (-48)	**	-0.091	1008	-0.914 (-59.91)	-0.616 (-45.99)	**	-0.076
Force Protection Supplies	-0.311 (-26.73)	0.09 (9.42)		-0.102	747	-0.53 (-41.14)	-0.178 (-16.31)	**	-0.090
Collection, Holding, and Transfer	-0.901 (-59.38)	-0.506 (-39.71)	**	-0.101	699	-0.848 (-57.17)	-0.504 (-39.59)	**	-0.088
Fleet Landing	-1.014 (-63.72)	-0.494 (-38.98)	**	-0.132	453	-0.787 (-54.48)	-0.353 (-29.74)	**	-0.111
Force Protection Personnel & Equipment	-0.718 (-51.23)	-0.194 (-17.63)	**	-0.134	428	-0.653 (-47.95)	-0.22 (-19.75)	**	-0.111
Force Protection Barriers	0.196 (21.65)	0.727 (106.89)	**	-0.135	425	-0.023 (-2.27)	0.443 (55.74)		-0.119
Water Ferry/Taxi Services	-0.63 (-46.74)	0.019 (1.92)		0.166	251	-0.476 (-37.87)	0.072 (7.47)		0.140
General Utility Services	-2.141 (-88.25)	-1.315 (-73.15)	**	-0.211	147	-2.340 (-90.37)	-1.566 (-79.11)	**	-0.197
Provisions	0.855 (135.14)	4.708 (10983.0)		-0.983	11	1.19 (228.71)	4.356 (7694.4)	**	-0.808

Results are based on 95% confidence intervals

Statistical significance based on ** $p<0.001$, * $p<0.01$

F. DISCUSSION AND CAVEATS

The results of the primary model, which includes all ports and service categories, shows that the MAC reduces the average price of an ELIN by 17.7% based on the preferred model but the estimate of the effects ranged from a 27.4% decrease in price to a 13.8% decrease in price depending on the number of iterations of removing extreme residuals or the confidence level of the estimates. Both exchange rate and quantity had low values of standard error for their respective coefficient estimates, meaning that the predicted values of the betas were highly accurate. The estimated effect of the MAC on price changes dramatically based on either the type of service being provided or the port used for executing the services.

Although the methods for developing our models are grounded in solid academic practices, we caution readers to remain critical of the results when formulating an opinion of the effect of the MAC on price. For example, one way to misinterpret the results of Model 2 would be to assume that the 14 statistically significant ports accurately represent the entire population of observed prices. A reader might incorrectly conclude that the Navy should avoid ship visits to ports that had a positive relationship between price and the MAC, misinterpreting that these ports are more expensive. Our model was not used to compare costs between ports, but rather comparing prices between SACs and MACs at different ports. A better way to interpret the results is that on average, MACs are typically less expensive than SACs for a given port. It is also important to remember that the results represent one interpretation of the relationship between the contract type and price based on the model we used to interpret the sample data, and furthermore, this model is not the actual relationship of the true population of HSP prices. Put simply, there is enough randomness and variation in the data that it would be inappropriate to base a conclusion on which ports provide the best value to the government based on these port-specific results. These results were intended to highlight the changes to the estimated effect of MAC on price as opposed to which ports provide the least cost to the government; the latter is already tracked by regional HSP contracting personnel and measured based on port-cost estimates and historical cost and pricing data.

Another important caveat is that the results of our model do not universally apply to all types of IDIQ contracts. Although we found statistically significant results in our comparison between SAC and MAC, these results can only be applied to the husbanding service contracts and not translate directly to all types of IDIQ contracts from other organizations. Our results do not imply that all types of IDIQ contracts across the Navy or the DoD display statistically significant relationships between price and contract type because there may exist other factors outside of HSP program that are not considered in our model and could have a greater effect on price. For example, negotiating with offerors over program data rights of proprietary information might apply to a non-HSP related program but does not apply to our model. Overall, the results of this study should be used as an indicator and to establish an initial data point at estimating the effects of competition and other pricing strategy factors on price for MACs.

G. SUMMARY

The results of the three models provides evidence that supports our theory that the MAC has a statistically significant effect on price. To this end, we are confident making the claim that the price for the average service for a MAC-type contract is less expensive than a SAC. However, based on the sensitivity to extreme values, the degree of certainty to which this estimate predicts the effect of MAC-type contracts on price is still not fully known.

VI. RECOMMENDATIONS AND CONCLUSION

Using a fixed-effects linear regression model, we determined that the implementation of a MAC strategy for HSP services had a statistically significant effect on price, and although the effects varied greatly based on location and service category, we found that the full causal effect of the MAC, on average, reduces the price for a given service by 17.7%. Therefore, we can conclude that the overall increase in daily costs per port visit for FY19, introduced in Figure 1 in Chapter I, is likely not caused by the MAC and results from some other effects.

Our results are important for Navy stakeholders and senior leadership because these findings validate the theory that the MAC contracting strategy is a more affordable acquisition approach overall than SAC for HSP services. The MAC strategy is consistent with the Better Buying Power initiative and exemplifies contracting best-practices within the Navy. Given the high visibility and audits of the HSP program over the last decade, this report provides objective evidence showing that the MAC strategy is effectively reducing costs for husbanding services for the Navy, which enables leadership to make informed decisions regarding future changes to the HSP acquisition strategy.

A. RECOMMENDATIONS FOR FUTURE STUDY AND PROCESS CHANGES

Based on the findings of our research, we identified several recommendations and opportunities for future studies for HSP stakeholders to consider.

1. Recommendation #1. Improve Accuracy of Pricing Data

One of the problems that we recognized during the data cleaning portion of our research was the inaccuracy and inconsistency of pricing data for each ELIN. Some of the pricing data from the invoices did not represent the true price of the services because contractors would erroneously price some ELINS by an inconsistent unit of issue. We also recognized various instances where the data was entered erroneously: either the quantity-price combination was reversed, or the unit of issue was mislabeled. We recognized that the database contains manual inputs from multiple contracting offices and CORs.

Therefore, some of the data entry issues from the sample may have affected the results of the model. We recommend that contracting personnel providing oversight on the HSP contracts ensure that the pricing data certified in Wide Area Workflow for each ELIN is consistently capturing the same unit quantity.

2. Recommendation #2. Measure Effects of Competition on Price with On-ramp and Off-ramps in Global MAC

Throughout the course of our research we determined that increased competition from SAC to MAC decreased price. However, we did not measure the effects of competition internal to the MAC to analyze the effect of competition on price between MACs. A series of follow-on questions to our research would be: what are the effects of price based on the number of task order proposals received for each port visit, what are the effects on price based on number of contractors eligible on the base award contract competing for each task order, and lastly, how would the effects change if the number of contractors on the base award contract periodically changed throughout the length of the contract? NAVSUP is currently working on an initiative to implement a global MAC, which would offer opportunities for on-ramping/off-ramping contractors throughout the performance period.

On-ramps and off-ramps are decision points throughout the length of the contract which allow the government to increase or decrease the number of contractors included on the base contract. On-ramps provide the government with the opportunity to include new entrants into the market, thereby increasing the competition at the task order level. Increasing the number of contractors on an IDIQ contract, and consequently increasing the MAC effect, would theoretically reduce the prices. However, the effects of competition on price may have diminishing returns and approach a limit as the number of contractors are added to the base contract. To explore this notion further, a follow-on study could research the optimal number of contractors to award on an HSP MAC. With off-ramps, the government has the opportunity to remove poor performing contractors or contractors that fail to submit a minimum number of proposals. The process of including an off-ramp may appear illogical because removing contractors directly decreases competition. However, without an off-ramp to remove underperforming contractors, the government wrongfully assumes every contractor on the MAC remains equally competitive for each task order. Additionally, from the contractor's perspective, the risk of an off-ramp creates greater willingness to bid on port visits despite potentially greater opportunity costs with commercial non-Navy businesses. This behavior among the contractors needs to be reinforced by the government for maintaining a competitive pool of contractors, specifically for ports that are higher risk or less profitable for the contractors. For example, assuming no proposals were received on an RTOP for a specific port because commercial industry offered a greater profit to all potential contractors on the MAC, the Navy would be forced to unilaterally issue a task order to one of those contractors. As a result, the selected contractor would be obligated to satisfy the requirements under less preferable conditions, otherwise the contractor would have submitted a proposal. This phenomenon may create a situation where the contractor is forced to balance quality with the ability to fully satisfy the needs of the task order. This theory suggests that the quality of the services provided by the contractors could be lower for ports that have less competition because they present greater risk or less profitability to the contractor. Therefore, the introduction of an on-ramping and off-ramping tool further warrants a need for measuring the effects on price by periodically altering the number of contractors.

3. Recommendation #3. Measure Non-price Factors

We recommend that contracting personnel managing the HSP program develop a system to measure qualitative data to capture changes to non-price factors in the MAC over the length of the contract. The findings of this study have shown that MACs have a measurable advantage over SACs when evaluating these contract types based entirely on price. However, this study is not a comprehensive comparison, and there are non-price factors that are relevant for determining the overall value of the MAC effect. Therefore, a new benchmark to measure the performance of the MAC over time for both price and non-price factors is required. We recommend that NAVSUP and interested parties develop a policy to measure and translate non-price factors into a standardized quantitative measure, enabling analysis of the changes in value of the MAC over time. Therefore, we need quality data to be measurable and standardized if we want to assess the overall net benefit of the MAC over time.

B. CONCLUSION

Our contributions in the fields of contracting and federal acquisitions for the HSP program approached a limit based on the accuracy and availability of data. The comparison of SAC and MAC will continue to be an issue that the Navy will face outside of the HSP domain, and this study provides a strong foundation for other organizations to reference that are currently using SAC IDIQs and want to consider implementing MACs. Our findings could be a valuable data point for making a case to implement a greater number of MACs across all branches of service and expanding the scale of the current MACs, similar to the HSP global MAC. The global MAC will reduce the number of HSP contracts awarded across the regions, centralize the contract administration through one procurement contracting office, and offer on-ramping and off-ramping opportunities to expand or shrink the pool of contractors as necessary.

Based on our findings, we recommend the Navy implement the MAC strategy on a global scale in order to decrease overall HSP contract prices. However, although a global MAC is recommended to reduce overall HSP prices, this approach might not be the best value or least cost to the government for all ports or situations, as evidenced by the results from Model 2. Further research could be done to investigating the possibility of utilizing MAC-SAC hybrid HSP contracts for ports that showed positive coefficients for the MAC. A SAC-MAC hybrid would likely increase administrative workload but also allow contracting offices to issue task orders from whichever contract vehicle, either SAC or MAC, offered the lowest prices based on the market conditions.

With the emerging global MAC, we see a need for greater accuracy of data collection, measuring the effects of competition on price with on-ramping and off-ramping, and formalizing measurement of non-price factors. Further research could use our model to study the effects of the global MAC on price and incorporate additional non-price factors to determine the overall benefit for the Navy.

APPENDIX. MODEL 2 RESULTS USING PREFERRED METHOD

Regression results

	Coefficient.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Abidjan	0.000	.	.	.	.	.	
Abu Dhabi	0.040	0.266	0.15	0.880	-0.480	0.561	
Acajutla	0.000	.	.	.	.	.	
Agair	0.000	.	.	.	.	.	
Agigea	0.000	.	.	.	.	.	
Aksaz	-2.591	0.392	-6.60	0.000	-3.361	-1.822	***
Al Duqm	-0.747	0.083	-8.96	0.000	-0.911	-0.584	***
Alexandria	-1.581	0.294	-5.38	0.000	-2.158	-1.004	***
Algiers	0.000	.	.	.	.	.	
Amsterdam	0.000	.	.	.	.	.	
Anchorage AK	0.000	.	.	.	.	.	
Annapolis MD	-0.291	0.404	-0.72	0.471	-1.083	0.500	
Aqaba (Port of Aqaba)	-0.402	0.194	-2.06	0.039	-0.783	-0.020	**
Ashdod	0.000	.	.	.	.	.	
Astakos	0.000	.	.	.	.	.	
Astoria OR	0.135	0.306	0.44	0.659	-0.464	0.734	
Auckland	0.000	.	.	.	.	.	
Augusta Bay	-1.193	0.109	-10.91	0.000	-1.407	-0.979	***
Balboa	0.000	.	.	.	.	.	
Bali	0.000	.	.	.	.	.	
Baltimore MD	0.463	0.286	1.62	0.105	-0.097	1.024	
Bar	0.000	.	.	.	.	.	
Barbers Point HI	0.000	.	.	.	.	.	
Barcelona	0.000	.	.	.	.	.	
Batumi	0.000	.	.	.	.	.	
Belfast	0.000	.	.	.	.	.	
Bengkulu	0.000	.	.	.	.	.	
Betio	0.000	.	.	.	.	.	
Bitung	0.000	.	.	.	.	.	
Bodoe	0.000	.	.	.	.	.	
Boston MA	0.000	.	.	.	.	.	
Bourgas	0.000	.	.	.	.	.	
Brest	-0.327	0.437	-0.75	0.454	-1.184	0.530	
Bridgetown	0.000	.	.	.	.	.	
Brindisi	0.000	.	.	.	.	.	
Brisbane	0.032	0.137	0.23	0.816	-0.236	0.299	
Bristol	0.000	.	.	.	.	.	
Bristol RI	0.000	.	.	.	.	.	
Bronx, NYC (Kings Point), NY	0.000	.	.	.	.	.	
Bronx, NYC (SUNY), NY	0.388	0.680	0.57	0.568	-0.944	1.720	
Brooklyn, NYC, NY	0.000	.	.	.	.	.	
Buffalo NY	0.000	.	.	.	.	.	
Cabo San Lucas	0.000	.	.	.	.	.	
Cagliari	0.000	.	.	.	.	.	
Cairns	-0.237	0.342	-0.69	0.488	-0.908	0.433	
Callao	-1.260	0.299	-4.21	0.000	-1.846	-0.674	***
Cam Ranh Bay	0.000	.	.	.	.	.	

Cape Canaveral FL	0.000	.	.	.	.	.	
Cartagena	-0.790	0.288	-2.75	0.006	-1.354	-0.226	***
Catania	0.000	.	.	.	.	.	
Cebu	0.000	.	.	.	.	.	
Changi Naval Base	0.000	.	.	.	.	.	
Charleston SC	-0.755	0.335	-2.25	0.024	-1.411	-0.099	**
Chennai	0.000	.	.	.	.	.	
Cherbourg	0.000	.	.	.	.	.	
Chinhae	-0.496	0.088	-5.66	0.000	-0.668	-0.324	***
Chuuk	0.000	.	.	.	.	.	
Civitavecchia	0.000	.	.	.	.	.	
Cleveland OH	0.000	.	.	.	.	.	
Colombo	0.059	0.256	0.23	0.819	-0.443	0.560	
Colon	-0.472	0.454	-1.04	0.298	-1.362	0.418	
Constanza	-0.591	0.254	-2.33	0.020	-1.088	-0.095	**
Copenhagen	0.000	.	.	.	.	.	
Corfu	0.000	.	.	.	.	.	
Cork	-0.959	0.423	-2.27	0.023	-1.788	-0.130	**
Cristobal	0.200	0.293	0.68	0.495	-0.375	0.775	
Crombie	0.000	.	.	.	.	.	
Da Nang	0.000	.	.	.	.	.	
Dakar	0.000	.	.	.	.	.	
Danish Straits	0.000	.	.	.	.	.	
Dardanelles - Bosporus	-5.783	0.704	-8.22	0.000	-7.162	-4.403	***
Darwin	-0.026	0.197	-0.13	0.893	-0.413	0.360	
Davao	0.000	.	.	.	.	.	
Detroit MI	0.000	.	.	.	.	.	
Dili	-0.937	0.448	-2.09	0.037	-1.815	-0.058	**
Djibouti	-0.230	0.049	-4.69	0.000	-0.326	-0.134	***
Doha	0.057	0.131	0.43	0.666	-0.200	0.314	
Donghae	0.000	.	.	.	.	.	
Dover	0.000	.	.	.	.	.	
Dubai	-0.509	0.492	-1.04	0.300	-1.473	0.454	
Dubrovnik	0.000	.	.	.	.	.	
Durres	0.000	.	.	.	.	.	
Eastport ME	0.000	.	.	.	.	.	
Eckenforde	0.000	.	.	.	.	.	
Eilat	-0.341	0.308	-1.11	0.268	-0.944	0.262	
Ensenada	0.000	.	.	.	.	.	
Esmeraldas	0.000	.	.	.	.	.	
Esquimalt	0.000	.	.	.	.	.	
Faslane	-0.889	0.170	-5.23	0.000	-1.222	-0.556	***
Ferrol	0.000	.	.	.	.	.	
Fort-de-France	0.000	.	.	.	.	.	
Freeport	0.000	.	.	.	.	.	
Fujairah	1.110	0.060	18.43	0.000	0.992	1.228	***
Funafuti	0.000	.	.	.	.	.	
Funchal	0.257	0.331	0.78	0.438	-0.392	0.906	
Gaeta	0.351	0.305	1.15	0.250	-0.247	0.949	
Gdynia	0.000	.	.	.	.	.	
Georgetown	-0.048	0.454	-0.10	0.916	-0.937	0.842	
Gibraltar	0.000	.	.	.	.	.	
Gladstone	0.000	.	.	.	.	.	
Glasgow	0.000	.	.	.	.	.	
Goa	0.000	.	.	.	.	.	
Greenock	-4.651	0.680	-6.84	0.000	-5.983	-3.319	***

Gulfport MS	-0.978	0.316	-3.10	0.002	-1.597	-0.359	***
Gwangyang	0.000	.	.	.	.	.	
Haakensvern	-0.963	0.240	-4.01	0.000	-1.434	-0.492	***
Haifa	0.000	.	.	.	.	.	
Hakodate	0.000	.	.	.	.	.	
Halifax	0.000	.	.	.	.	.	
Hamad Port	0.000	.	.	.	.	.	
Hambantota	0.000	.	.	.	.	.	
Harstad	0.000	.	.	.	.	.	
Helsinki	0.000	.	.	.	.	.	
Heraklion	0.000	.	.	.	.	.	
Homer AK	0.000	.	.	.	.	.	
Hong Kong	0.120	0.158	0.76	0.445	-0.188	0.429	
Honiara	0.014	0.362	0.04	0.969	-0.694	0.723	
Honolulu HI	0.000	.	.	.	.	.	
Inverness	0.000	.	.	.	.	.	
Ishikariwan Bay New Port	0.000	.	.	.	.	.	
Istanbul	0.000	.	.	.	.	.	
Iwakuni	0.000	.	.	.	.	.	
Izmir	0.000	.	.	.	.	.	
Jacksonville FL	-0.812	0.300	-2.71	0.007	-1.401	-0.224	***
Jakarta	0.000	.	.	.	.	.	
Jebel Ali	0.470	0.041	11.45	0.000	0.390	0.551	***
Jeddah	-0.889	0.430	-2.07	0.039	-1.733	-0.046	**
Jeju (Cheju)	-0.120	0.228	-0.53	0.598	-0.566	0.326	
Jubail (Commercial Port)	0.000	.	.	.	.	.	
Juneau AK	0.000	.	.	.	.	.	
Karachi	0.000	.	.	.	.	.	
Ketchikan AK	0.000	.	.	.	.	.	
Key West FL	-1.558	0.240	-6.48	0.000	-2.029	-1.087	***
Khalifa Bin Salman Port	-0.075	0.042	-1.77	0.077	-0.158	0.008	*
Kiel	0.000	.	.	.	.	.	
Klaipeda	0.000	.	.	.	.	.	
Koper	0.000	.	.	.	.	.	
Koror	0.000	.	.	.	.	.	
Kota Kinabalu	0.000	.	.	.	.	.	
Kuantan	0.000	.	.	.	.	.	
Kuching	0.000	.	.	.	.	.	
La Spezia	0.000	.	.	.	.	.	
Laboe	0.000	.	.	.	.	.	
Laem Chabang	0.000	.	.	.	.	.	
Lagos	0.000	.	.	.	.	.	
Lahaina HI	0.000	.	.	.	.	.	
Langkawi	0.000	.	.	.	.	.	
Larnaca	-1.380	0.258	-5.36	0.000	-1.885	-0.875	***
Libreville	0.000	.	.	.	.	.	
Limassol	0.000	.	.	.	.	.	
Lisbon	-0.755	0.261	-2.89	0.004	-1.267	-0.243	***
Livorno	0.000	.	.	.	.	.	
Lochstriven	0.000	.	.	.	.	.	
Long Beach CA	-0.453	1.359	-0.33	0.739	-3.117	2.212	
Los Angeles CA	-0.026	0.304	-0.09	0.932	-0.622	0.570	
Lumut Naval Base	0.000	.	.	.	.	.	
Maizuru	0.000	.	.	.	.	.	

Majuro	0.000	.	.	.	.	.	
Makassar	0.000	.	.	.	.	.	
Malaga	-0.834	0.291	-2.86	0.004	-1.405	-0.263	***
Malakal	0.000	.	.	.	.	.	
Malibu	0.000	.	.	.	.	.	
Man Of War	0.000	.	.	.	.	.	
Manhattan, NYC, NY	0.000	.	.	.	.	.	
Manila	-0.269	0.125	-2.15	0.032	-0.514	-0.023	**
Manta	0.000	.	.	.	.	.	
Manzanillo	-1.180	0.174	-6.80	0.000	-1.520	-0.840	***
Marmaris	0.000	.	.	.	.	.	
Marseille	0.000	.	.	.	.	.	
Masan	0.000	.	.	.	.	.	
Maura	-0.203	0.257	-0.79	0.430	-0.706	0.301	
Mazatlan	0.000	.	.	.	.	.	
Mesaieed	-0.496	0.338	-1.47	0.143	-1.159	0.167	
Miami FL	0.000	.	.	.	.	.	
Mina Salman	-0.081	0.077	-1.05	0.293	-0.232	0.070	
Mindelo	0.000	.	.	.	.	.	
Mobile AL	-0.831	0.299	-2.78	0.006	-1.417	-0.244	***
Mohammed Al Ahmad Naval Base (Ras Al ..	2.907	0.551	5.28	0.000	1.828	3.987	***
Mokpo	0.000	.	.	.	.	.	
Montego Bay	0.000	.	.	.	.	.	
Montevideo	0.000	.	.	.	.	.	
Montreal	-1.405	0.312	-4.51	0.000	-2.016	-0.794	***
Morehead City NC	-1.173	0.148	-7.91	0.000	-1.464	-0.882	***
Muara	0.000	.	.	.	.	.	
Muscat (Port Sultan Qaboos)	0.605	0.105	5.76	0.000	0.399	0.810	***
Muscat (Port of Muscat)	0.000	.	.	.	.	.	
NAVSTA Okinawa (White Beach)	0.000	.	.	.	.	.	
Napoli (Naples)	-6.045	1.177	-5.13	0.000	-8.352	-3.737	***
Narvik	0.000	.	.	.	.	.	
Nassau	-0.956	0.364	-2.63	0.009	-1.669	-0.243	***
New London CT	0.000	.	.	.	.	.	
New Orleans LA	0.000	.	.	.	.	.	
Newport RI	-1.721	0.415	-4.15	0.000	-2.533	-0.908	***
Nha Trang	0.000	.	.	.	.	.	
Niigata	0.000	.	.	.	.	.	
Norfolk VA	-0.567	0.451	-1.25	0.209	-1.452	0.318	
Noumea	0.000	.	.	.	.	.	
Nuku Alofa	0.000	.	.	.	.	.	
Oakland CA	0.000	.	.	.	.	.	
Ocho Rios	0.000	.	.	.	.	.	
Odessa	0.000	.	.	.	.	.	
Ominato	0.430	0.357	1.21	0.228	-0.270	1.129	
Orkanger	0.000	.	.	.	.	.	
Oslo	0.000	.	.	.	.	.	
Otaru	0.256	0.347	0.74	0.462	-0.425	0.936	
Pago-Pago	0.000	.	.	.	.	.	
Palma de Mallorca	0.000	.	.	.	.	.	

Panama Canal Transit	-0.495	0.229	-2.16	0.031	-0.944	-0.045	**
Pascagoula MS	0.000	.	.	.	.	.	
Penang	0.000	.	.	.	.	.	
Pensacola FL	-3.157	0.680	-4.64	0.000	-4.490	-1.825	***
Philadelphia PA	0.000	.	.	.	.	.	
Philipsburg	0.000	.	.	.	.	.	
Phuket	0.000	.	.	.	.	.	
Piata	0.000	.	.	.	.	.	
Piraeus	-0.448	0.124	-3.61	0.000	-0.692	-0.205	***
Plymouth	-5.550	0.739	-7.51	0.000	-7.000	-4.101	***
Pohang	0.000	.	.	.	.	.	
Pohnpei	0.739	0.555	1.33	0.183	-0.349	1.827	
Pointe-a-Pitre	0.000	.	.	.	.	.	
Ponce	0.000	.	.	.	.	.	
Ponta Delgada	0.000	.	.	.	.	.	
Port Alucroix	0.000	.	.	.	.	.	
Port Canaveral FL	-1.952	0.407	-4.80	0.000	-2.750	-1.155	***
Port Everglades FL	-0.245	0.458	-0.54	0.593	-1.142	0.652	
Port Klang	0.000	.	.	.	.	.	
Port Lahat Datu	0.000	.	.	.	.	.	
Port Moresby	-0.285	1.359	-0.21	0.834	-2.949	2.380	
Port Victoria	-0.677	0.240	-2.83	0.005	-1.147	-0.207	***
Port of Spain	0.000	.	.	.	.	.	
Portland	0.000	.	.	.	.	.	
Portland OR	-0.604	0.365	-1.66	0.098	-1.320	0.111	*
Portsmouth	0.000	.	.	.	.	.	
Portsmouth NH	-1.328	0.653	-2.03	0.042	-2.608	-0.048	**
Poti	0.000	.	.	.	.	.	
Puerto Barrios	0.000	.	.	.	.	.	
Puerto Castilla	-2.038	0.608	-3.35	0.001	-3.231	-0.846	***
Puerto Cortes	0.000	.	.	.	.	.	
Puerto Princesa	0.134	0.353	0.38	0.704	-0.558	0.826	
Puerto Quetzal	0.000	.	.	.	.	.	
Puerto Vallarta	0.000	.	.	.	.	.	
Pusan (Busan)	-0.508	0.121	-4.19	0.000	-0.746	-0.271	***
Pyeongtaek	0.000	.	.	.	.	.	
Rabaul	0.000	.	.	.	.	.	
Reykjavik	0.000	.	.	.	.	.	
Rhodes	0.000	.	.	.	.	.	
Riga	0.000	.	.	.	.	.	
Rijeka	0.000	.	.	.	.	.	
Rio de Janeiro	0.000	.	.	.	.	.	
Riohacha	0.000	.	.	.	.	.	
Roatan	0.000	.	.	.	.	.	
Rockland ME	0.000	.	.	.	.	.	
Rodman	-0.936	0.173	-5.40	0.000	-1.275	-0.596	***
Ronne	0.000	.	.	.	.	.	
Rostock	0.000	.	.	.	.	.	
Rotterdam	0.000	.	.	.	.	.	
Royal Jordanian Naval Base, Aqaba	0.000	.	.	.	.	.	
Safaga	-2.031	0.341	-5.96	0.000	-2.699	-1.363	***
Saipan	0.759	0.184	4.13	0.000	0.399	1.119	***
Salalah	0.338	0.096	3.52	0.000	0.149	0.526	***
Salamis	0.000	.	.	.	.	.	
Salvador	0.000	.	.	.	.	.	

San Diego CA	0.565	0.240	2.35	0.019	0.094	1.036	**
San Fernando	0.000	.	.	.	.	.	
San Francisco CA	0.000	.	.	.	.	.	
San Juan	-0.886	0.384	-2.31	0.021	-1.639	-0.133	**
Santa Marta	0.169	0.710	0.24	0.812	-1.222	1.561	
Santo Domingo	0.000	.	.	.	.	.	
Santorini	0.000	.	.	.	.	.	
Sasebo	-0.701	0.080	-8.73	0.000	-0.858	-0.543	***
Sattahip	0.000	.	.	.	.	.	
Seattle WA	0.836	0.198	4.22	0.000	0.448	1.225	***
Sekondi	0.000	.	.	.	.	.	
Sembawang	0.000	.	.	.	.	.	
Sepangar	0.000	.	.	.	.	.	
Setubal	0.000	.	.	.	.	.	
Seward AK	0.000	.	.	.	.	.	
Shimoda	-0.114	0.416	-0.28	0.783	-0.930	0.701	
Shuaiba	0.000	.	.	.	.	.	
Sihanoukville	0.000	.	.	.	.	.	
Singapore	0.354	0.527	0.67	0.501	-0.678	1.387	
Sitra	-0.681	0.511	-1.33	0.183	-1.682	0.321	
Souda Bay	-0.431	0.306	-1.41	0.158	-1.030	0.168	
Spillum	0.000	.	.	.	.	.	
Split	0.000	.	.	.	.	.	
Sriracha	0.000	.	.	.	.	.	
St. John's	0.000	.	.	.	.	.	
St. Thomas	-0.410	0.502	-0.82	0.414	-1.394	0.574	
Staten Island, NY	0.000	.	.	.	.	.	
Staten Island, NYC, NY	0.000	.	.	.	.	.	
Stirling	0.000	.	.	.	.	.	
Stockholm	0.000	.	.	.	.	.	
Stornoway	0.000	.	.	.	.	.	
Suape	0.000	.	.	.	.	.	
Subic Bay	0.000	.	.	.	.	.	
Surbaya (Port of Surabaya)	0.000	.	.	.	.	.	
Suva	-0.875	0.361	-2.42	0.015	-1.583	-0.167	**
Svendborg	0.000	.	.	.	.	.	
Swinoujscie	0.000	.	.	.	.	.	
Sydney	0.000	.	.	.	.	.	
Syros	0.000	.	.	.	.	.	
Talcahuano	0.000	.	.	.	.	.	
Tallinn	0.000	.	.	.	.	.	
Tanger (Tangier)	0.000	.	.	.	.	.	
Tanung Wangi	0.000	.	.	.	.	.	
Taranto	0.000	.	.	.	.	.	
Tawau	0.000	.	.	.	.	.	
Tema	0.000	.	.	.	.	.	
Theoule-Sur-Mer	0.000	.	.	.	.	.	
Thessaloniki	0.000	.	.	.	.	.	
Thilawa	0.000	.	.	.	.	.	
Tokyo	0.000	.	.	.	.	.	
Toulon	-0.248	0.345	-0.72	0.472	-0.925	0.428	
Townsville	0.124	0.179	0.69	0.491	-0.228	0.475	
Trieste	0.000	.	.	.	.	.	
Trincomalee	-0.399	0.653	-0.61	0.541	-1.679	0.881	
Tromso	-0.518	0.275	-1.89	0.060	-1.058	0.021	*

Trondheim	0.000	.	.	.	.	.	
Tunis	0.000	.	.	.	.	.	
Turbo	0.000	.	.	.	.	.	
Valencia	0.000	.	.	.	.	.	
Valletta	0.000	.	.	.	.	.	
Valparaiso	-1.137	0.315	-3.61	0.000	-1.754	-0.520	***
Vancouver	0.000	.	.	.	.	.	
Varna	0.000	.	.	.	.	.	
Venice	0.000	.	.	.	.	.	
Villerfranche	0.000	.	.	.	.	.	
Visakhapatnam	0.000	.	.	.	.	.	
Volos	0.000	.	.	.	.	.	
Welland	0.000	.	.	.	.	.	
White Beach Okinawa	0.000	.	.	.	.	.	
Wilhelmshaven	0.000	.	.	.	.	.	
Willemstad	0.000	.	.	.	.	.	
Wudam Naval Base	0.000	.	.	.	.	.	
Yap	0.000	.	.	.	.	.	
Yeosu	0.000	.	.	.	.	.	
Yokosuka	-0.781	0.126	-6.20	0.000	-1.027	-0.534	***
Zeebrugge	0.000	.	.	.	.	.	
logqty	-0.354	0.007	-47.37	0.000	-0.369	-0.339	***
exchange	-0.004	0.002	-1.76	0.078	-0.009	0.000	*
Constant	6.016	0.290	20.76	0.000	5.448	6.584	***

*** $p<0.01$, ** $p<0.05$, * $p<0.1$*

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