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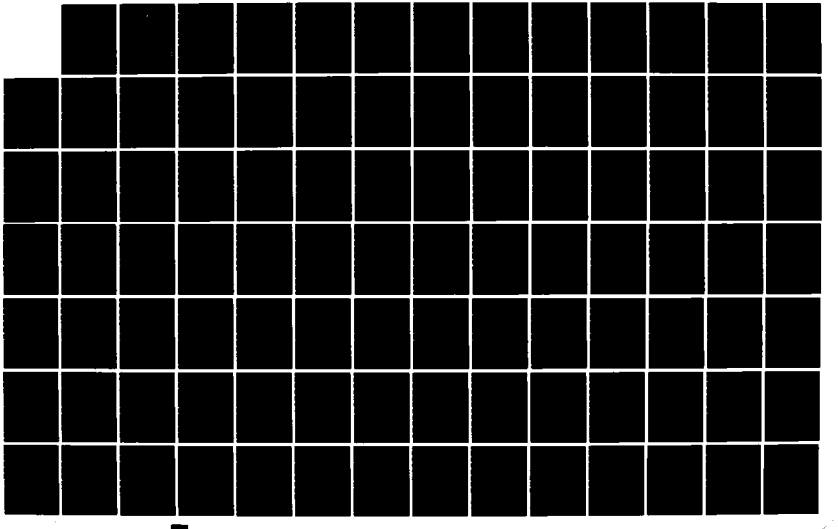

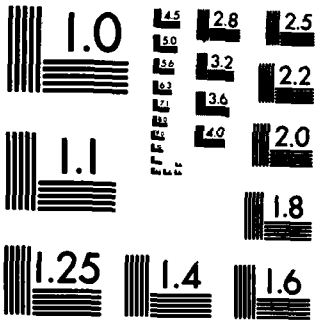
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AN ANALYSIS OF CAUSES OF CONTRACT PRICE CHANGE FOR COMPETITIVE PROCUREMENTS OF REPLENISHMENT SPARE PARTS

THESIS

William K. Bass
Captain, USAF

David J. Schmitt
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AFIT/GLM/LSM/84S-3

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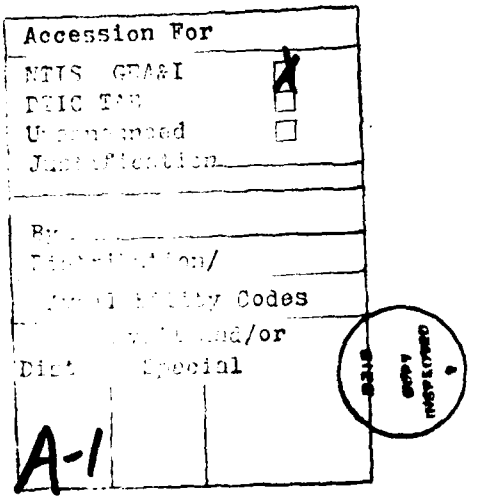

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AN ANALYSIS OF CAUSES OF CONTRACT PRICE CHANGE FOR COMPETITIVE PROCUREMENTS OF REPLENISHMENT SPARE PARTS

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

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September 1984

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Table of Contents

	Page
Acknowledgements	ii
List of Figures	vi
List of Tables	vii
Abstract	viii
I. Introduction	1
Chapter Overview	1
Background	1
Problem Statement	2
Research Objective	3
Scope of Research	4
Research Limitations	5
Potential Contributions	5
II. Literature Review	6
Chapter Overview	6
Replenishment Spare Parts	6
Number of Quotes Received	7
Extent and Kind of Competition	10
Contracting Authority	12
Contracting Priority	16
Criticality Designator	17
Price Evaluation	19
Purchase Quantity	20
Time Between Buys	22
Past Empirical Research Efforts	22
Research Study Number One	23
Research Study Number Two	24
Research Study Number Three	25
Research Study Number Four	27
Summary	28
III. Research Methodology	30
Chapter Overview	30
Data Collection	30
Sample Selection	35

Page

Data Adjustment 36

Adjustment for Inflation 36
Price Ratios 39
Time Between Buys 40

Conversion of Qualitative Variables 41
Data Segmentation 41
Description of Sample Data 43
Research Hypotheses 44

Research Hypothesis One 44
Research Hypothesis Two 45
Research Hypothesis Three 45
Research Hypothesis Four 45
Research Hypothesis Five 46
Research Hypothesis Six 46
Research Hypothesis Seven 46
Research Hypothesis Eight 47

Statistical Techniques 47
Summary 49

IV. Data Analysis and Findings 52

Introduction 52
Results of Hypothesis Tests and Regression Analysis 52

Results of Hypothesis One 53
Results of Hypothesis Two 54
Results of Hypothesis Three 56
Results of Hypothesis Four 56
Results of Hypothesis Five 58
Results of Hypothesis Six 59
Results of Hypothesis Seven 60
Results of Hypothesis Eight 61

V. Concluding Remarks 63

Research Summary 63
Further Research 67

Replication of This Study 67
Develop a Multivariate Regression Model 68
Identification of Other Price Influencing Factors 68

Concluding Remarks 68

Page

Appendix A: Seventeen Exceptions to Formal Advertising 70

Appendix B: Randomly Sampled Stock Numbers and Nomenclatures 71

Appendix C: Quantity Procured by Federal Stock Class and Year 72

Appendix D: Analysis of Quantitative Variables 74

Appendix E: Percentage Breakout of Qualitative Variables 75

Bibliography 84

Vita 88

List of Figures

Figure		Page
1.	Data Sample Screening Procedure	37
2.	Independent Variable Definitions	48
3.	Analysis of Variance F-test	50
4.	Students T-test of an Individual Parameter Coefficient in the Multiple Regression Model . .	51

List of Tables

Table		Page
1.	Example of the Adjustment for Inflation	39
2.	Example of the Normalization of Prices and Order Quantities	40
3.	Results of F-Tests	53
4.	Results of Hypothesis One	54
5.	Results of Hypothesis Two	55
6.	Results of Hypothesis Three	57
7.	Results of Hypothesis Four	58
8.	Results of Hypothesis Five	59
9.	Results of Hypothesis Six	60
10.	Results of Hypothesis Seven	61
11.	Results of Hypothesis Eight	62

Abstract

Aircraft replenishment spare parts procurement has become an increasingly important area of concern. This research project was undertaken as a result of several recent media and internal Air Force reports revealing the excessive costs of spare parts acquisition. The overall research objective was to determine what, if any, relationship exists between a number of selected quantitative and qualitative factors and the prices paid for spare parts. Multiple regression analysis and t-tests about the individual parameter coefficients in a multiple regression model were used to analyze four years worth of spare parts procurement history data from the Oklahoma City Air Logistics Center. Eight research hypotheses were developed to satisfy the research objective. The results of the research hypotheses are presented.

AN ANALYSIS OF CAUSES OF CONTRACT PRICE CHANGE FOR COMPETITIVE PROCUREMENTS OF REPLENISHMENT SPARE PARTS

I. Introduction

Chapter Overview

This chapter contains a statement of the general issues surrounding the factors affecting the acquisition costs of weapon system replenishment spare parts. The problems addressed by this research effort and the research objective are stated. Also included in the chapter are sections explaining the source of data to be used in answering the research question, limitations of the research and potential contributions of the research effort.

Background

The United States Air Force (USAF) force modernization and growth over the past six years has included an increasing requirement for replenishment spare parts (1:1.1). While the requirement for replenishment spare parts has been increasing, the nation's defense industrial base has been decreasing in capability and inflation rates have continued to escalate (1:1.2). Diminishing defense industrial production capability and an unanticipated high

rate of inflation, taken together, have resulted in sharp increases in the prices paid by Air Force Logistics Command (AFLC) for replenishment spare parts (1:1.2).

A study completed in October 1983 by the Air Force Management Analysis Group (AFMAG) revealed that the Air Force is vulnerable to overpricing on approximately 31 percent of the spare parts it buys (11:82). The result of overpricing is a yearly overexpenditure of $300 million or 6 percent of the total Air Force budget for spare parts (11:82). Due to the AFMAG study and news media reports of excess prices paid for such common items as stool caps and screwdrivers, increased attention is being focused by the Air Force on replenishment spare parts procurements (11:82).

Problem Statement

A report on spare parts in the September 1983 issue of Air Force Magazine begins by flatly stating that "the Air Force does not have enough spare parts to meet its wartime obligations [11:56]." The implication is that both readiness and sustainability of the USAF's warfighting assets have been undermined (1:2.11). The main reason for the lack of spare parts is that during the relatively low budgets of the late 1970s the Air Force was forced to choose between either buying new weapon systems or supporting an aging pre-Vietnam inventory (11:56). The Air Force chose to modernize. The choice left unfilled demand for

existing hardware and created an additional demand for weapon system spares to support newly activated squadrons of A-10, F-15, and F-16 aircraft (1:2.6) The requirement for new classes of spares, in addition to underestimating peacetime operating stock requirements for fiscal years 82, 83, and 84, led to a funding shortfall of approximately four billion dollars through fiscal year 1985 (11:56).

The price of spare parts has been increasing dramatically due to inflation, longer lead times, shortages of strategic materials and other factors (11:56). Price increases have also caused an increase in the funding shortfall. Price reductions, or control of price increases would contribute to controlling the spares acquisition shortfall.

The AFMAG study found that low competition rates is the major cause of spare parts price increases (1:2.13). However, there may be other factors which significantly effect the prices paid for replenishment spare parts in addition to those already mentioned. Identification and control of such factors could produce substantial benefit in spare parts acquisition.

Research Objective

The objective of the research is to determine what, if any, relationship exists between a number of selected quantitative and qualitative factors and the prices paid

for spare parts. The factors will be analyzed by testing their relationship to prices paid for a sample of AFLC replenishment spare parts.

Scope of Research

This investigation used a portion of AFLC replenishment spare parts procurement data which was considered by the authors to be relevant to the research objective. The data used for analysis was screened to include only competitive buys and only those competitive buys for which the number of quotes received had changed for subsequent purchases of a particular spare part. This resulted in a sample of 13,362 purchases, or approximately 10 percent of the raw data. Scoping the data in such a manner allowed for the measurement of the effect of the degree of competition, one of the factors thought to be influencing price. The other factors investigated were:

1. Advertised Negotiation Authority
2. Competition Code
3. Contracting Priority
4. Criticality Designator
5. Price Evaluation Method
6. Purchase Quantity
7. Time Between Buys

The definitions of these factors and their possible effect on the price paid for replenishment spare parts are presented in Chapters II and III.

Research Limitations

This research effort was limited to the analysis of replenishment spare parts procurements for one ALC available for the years 1980 through 1983. The analysis was limited to the factors outlined in the preceding section. No attempt was made to measure the effects of these factors on sole-source procurements or to measure the effect of transitioning from sole-source to competitive procurements.

Potential Contributions

This research effort will contribute to a greater understanding of the underlying factors influencing prices paid by the Air Force for replenishment spare parts. A better understanding of these factors could lead to increased readiness of Air Force assets and greater efficiency in the expenditure of public funds by enabling the Air Force to control factors that possibly influence price.

II. Literature Review

Chapter Overview

This chapter contains a brief definition of replenishment spare parts along with a review of the literature pertaining to factors considered in this study as possible influences on replenishment spare parts prices. The factors are: number of quotes received, extent and kind of competition, contracting authority, contracting priority, criticality designation, price evaluation, quantity procured and time between buys. Synopses of four past empirical research efforts related to this study are also presented.

Replenishment Spare Parts

Replenishment spare parts are defined as

> . . . items and equipment, both repairable and consumable, purchased by inventory control points, required to replenish stocks for use in the maintenance, overhaul, and repair of equipment, such as ships, tanks, guns, aircraft, engines, etc. [34:583].

The cost to the Air Force of aircraft replenishment spares alone was $784 million in fiscal year 1980, $1,588 million in 1981, $2,449 million in 1982 and $2,441 million in 1983 (1:2.5). The major responsibility for the procurement of replenishment spare parts rests with Air Force Logistics Command (AFLC) (5:56). AFLC is the central procurement activity responsible for providing parts, maintenance,

training, and general logistics support for Air Force weapon systems after they become operational (31:13). AFLC works primarily through its five Air Logistics Centers (ALC) responsible for performing central procurement actions in support of specific weapon systems (5:57). The five ALCs are: Ogden, Oklahoma City, Sacramento, San Antonio, and Warner-Robins.

Number of Quotes Received

Much emphasis has been placed on the effect of competition on contract prices. Typically, competition has been described by the number of quotes received. The number of quotes received on a procurement action could be considered as a quantitative estimate of the amount of competition received for that procurement action (30:18-19). As stated by Brechtel et al. in the Proceedings of the 1983 Federal Acquisition Research Symposium, "one defense product group that satisfies many of the criteria for using competition is weapon system replenishment spare parts [6:152]." However, in 1982 only 25 percent of the AFLC portion of funds allocated for spares were competitively awarded (6:152). Because of the large dollar value of replenishment spare parts procurements and the small percentage of replenishment spare parts contracts that are competitively awarded, this area of procurement is vulnerable to close scrutiny (1:1.1).

Competition is generally believed to be the most effective method of securing the lowest prices and the most satisfactory levels of service from the marketplace (26:v). The maximum use of competition in the acquisition of weapon systems and spares is frequently stressed by governmental decision makers (17; 10; 28; 30; 37). Evidence of competition enhancing policy is the large amount of legislation enacted through the years which closely regulates anti-competitive business practices that could, if left unchecked, have a detrimental effect on free market competition (36:15).

There has recently developed a renewed interest in increasing the use of competition in various areas of DoD acquisition. In 1981 Deputy Secretary of Defense Frank C. Carlucci drafted a Memorandum for Secretaries of the Military Departments in which he proposed thirty-two initiatives to improve the DoD acquisition process. Initiative Number 32 entitled simply "Competition" was designed to ". . . enhance competition in the acquisition process in order to reduce cost [10:Initiative No. 32]." Carlucci further stated:

> We believe that it [competition] reduces the cost of supplies and services, improves contractor performance, helps to combat rising costs, increases the industrial base, and ensures fairness of opportunity for award of government contracts [10].

McKeown, commenting on various DoD directives and service acquisition regulations, states that:

> OMB Circular A-109, DODD 5000.1, and DODI 5000.2 not only encourage competitive source selection, but also emphasize the active generation of competition even when it requires an added near-term financial investment [28:28].

DoD Directive 5000.1 requires that:

> Effective design and price competition for defense systems shall be obtained to the maximum extent practicable to ensure that defense systems are cost effective and responsive to mission needs [17:Paragraph 2].

In November of 1981, the Undersecretary of Defense for Research and Engineering sent a Memorandum to Secretaries of the Military Departments entitled "Increasing Competition in the Acquisition Process." In this Memorandum, the secretaries were directed to:

> [1] Designate advocates for competition at each procuring activity.
> [2] Establish goals for increasing competition.
> [3] Ensure commanders understand their responsibilities regarding competition [28:32].

In a 9 September 1982 Memorandum, Secretary of Defense Weinberger states that:

> The benefits derived from competition are well known. Competition serves to reduce cost, improve quality, and enhance the industrial base that is so critical to defense mobilization [37].

He further points out that:

> No type of purchase is automatically excluded from this direction to maximize competition and this direction applies regardless of the level of the requesting official or the importance of the subject matter of the contract [37].

However, there is evidence that increasing competition will not necessarily reduce prices. Increasing competition by introducing additional sources of production

could, at least in the early production states, cost additional dollars (23:40). Establishing additional sources could be costly for a variety of reasons. For example, some experts believe that since multiple sourcing splits the production quantity among several producers, any production economies of scale would be negated, resulting in higher costs to the buyer (23:40). A second factor to be considered in multiple sourcing is the investment in special tooling and test equipment that is required to get an additional producer started (23:41).

Extent and Kind of Competition

Competition is more than just the number of quotes received. The "extent and kind of competiton" is the degree of competition and the basis upon which firms compete. In the procurement of replenishment spare parts, AFLC classifies competition into five categories: formal advertised, price competition, design or technical competition, follow-on actions after price, design or technical competition and other noncompetitive (14:A1.8).

The awarding of contracts as a result of formal advertising is based on price competition alone. Price competition is defined as:

> (i) Offers are solicited; (ii) Two or more responsible offerors that can satisfy the Government's requirements submit priced offers responsive to the solicitation's expressed requirements; and (iii) These offerors compete independently for a contract to be awarded to the responsible offeror submitting the lowest evaluated price [16:15.804-3].

Price competition may also be considered in awarding contracts when negotiated procurement methods are used. For example, exception number 3 of the seventeen exceptions to formal advertising (small purchase procedures), is generally awarded on the basis of price competition.

Myers, et al. state that two conditions are necessary to obtain price competition (29:iii):

> [1] The product or service can be described with enough precision so that potential suppliers will understand exactly what the buyer wants.
> [2] More than one independent supplier with available know-how and facilities is willing to compete.

A fundamental aspect of price competition is that a rivalry exists among many suppliers to obtain a purchaser's business by offering the lowest price (29:ii). According to a study by Daly and Gates there are important benefits attributable to the use of price competition. Two are:

> 1. The use of price competition will reduce the profits (perhaps excessive) of contractors;
> 2. The rigors of competition will force contractors to utilize the most efficient techniques of production thus reducing contract price [12:14].

Another way in which price competition can influence unit prices is that contractors who have previously produced an item may be able to produce the same item again at a lower cost thereby charging a lower price (12:16).

Unlike price competition, design or technical competition can only be used as a source selection factor in negotiated acquisitions. Such competition exists when

> . . . two or more qualified sources of supply are invited to submit design or technical proposals, with the subsequent contract award based primarily on this factor rather than price [38:1.2].

The principle purpose for the use of design or technical competition is that the competitive marketplace forces are not sufficient for the establishment of prices. Therefore, selection of the supplier is made on the basis of design or technical proposals (38:1.1).

In addition to formal advertising, price competition and design or technical competition, follow-on procurement actions are included as a fifth kind of competition. According to White and Myers, a follow-on action is:

> . . . a new acquisition, either a separate contract or a supplemental agreement, when an earlier decision dictates placement with a particular contractor to continue or augment a specific military program. Follow-on contracts to initial contracts awarded after competition will be coded as follow-on after either price competition or design or technical competition [38:1.2].

Contracting Authority

In procuring replenishment spare parts from private industry, the DoD uses two basic contracting methods: formal advertising and negotiation (5:92). Formal advertising is described as:

1. Preparation of the invitation for bids.
2. Publicizing the invitation for bids.
3. Submission of bids by prospective contractors.
4. Awarding the contract (18:Ch 32.500).

Formal advertising is considered a price-directed strategy whereby the buyer attempts to take advantage of market forces to obtain the most reasonable price on a particular procurement (32:200). Formal advertising has, since the passage of the Procurement Act in 1809, been the preferred method for awarding government contracts (32:4). This preference was further strengthened with the passage of the Civil Sundry Appropriations Act in 1861 which "made formal advertising mandatory with two exceptions: for purchases of personal services and for procurements to meet public exigencies [32:4]." Later, a third exception was added allowing procurements using methods other than formal advertising when competition was considered to be impractical (32:4). Olson et al. state that formal advertising has been a preferred procurement method for three reasons: (1) it results in lower prices, (2) it strengthens the nation's defense industrial base, and (3) formal advertising increases the public's confidence in the government's expenditure of tax dollars (30:12).

However, the Federal Acquisition Regulation (FAR) lists seventeen exceptions to the use of formal advertising. The seventeen exceptions permitting negotiation were authorized because formal advertising is an inflexible procurement technique (5:92). The seventeen exceptions to formal advertising are listed in Appendix A. Negotiation provides more flexibility for bargaining between prospective

contractors and government purchasing agents (19:90). Negotiation, for example, permits the use of nonprice considerations as source selection criteria (32:200). Negotiation also allows discussion and bargaining between two parties in an attempt to reach an agreement on such topics as price and contract type (5:102). Contrary to most popularly held notions, negotiation does not automatically mean sole source contracting. Negotiation, as well as formal advertising, recognizes the importance of competition as a way of arriving at a fair and reasonable price (5:152).

One factor considered in negotiation is the socio-economic objectives of the federal government. A report from the Commission on Government Procurement states:

> Government contracts have been used to serve many interests and beneficiaries other than the contractor, to wit, big business, small business, materialmen, laborers, consumers, every race, color, creed, origin, sex, the old, the young, apprentices, prisoners, the blind, animals, safety, health, distressed areas, hard-core areas, disadvantaged enterprises, gold flow, the environment, the technological base, the production base, and geographical distribution [32:36].

The preceding quote points out that government procurement agents must take into consideration many variables in addition to competition when awarding contracts (16:15.1). It has, for many years, been DoD policy to actively promote the small business segment of the economy by placing "a fair proportion of its total purchases in contracts for supplies, services, and research and

development with small business concerns [5:15]." A fair proportion is considered to be "that which small business concerns can win in open competition when given an even chance to compete [5:15]." The Department of Defense FAR Supplement addresses this issue by stating: "When negotiation is conducted, consideration shall be given to the size and minority status of the business concerns, . . . [15:15.1-1]." However, under certain circumstances, small businesses are given exclusive preferential treatment when they compete for government contracts. In those cases the DoD is restricted to consider only small businesses in awarding contracts (5:15). Further refinement of this policy is noted in a section of the Small Business Act which stipulates that price differentials are to be paid to promote minority businesses (5:16). Giving preferential treatment to small businesses has been criticized. Mr. Derek Vander Schaaf, Deputy Inspector General for the DoD, speaking at the 1984 Worldwide Air Force Pricing Conference, said that one reason the DoD pays higher prices for some larger dollar value items is that ". . . we bought from small business under the 'set aside' program and paid an unreasonably high price [25:23]."

To date, very little conclusive empirical research measuring the impact of socioeconomic policies on government contract costs exists. However, in a research study conducted by Smith and Lowe, an attempt was made to

determine whether the contracting method used had any bearing on the price paid for helicopter spare parts (35:7). Of the thirty-nine data elements examined, three were found to have been procured under small purchase set-aside procedures rather than formal advertising. These three cases showed higher cost projections but prices did not differ to any great extent from the prices of parts in the overall population (35:7).

Contracting Priority

Contracting priority is used by AFLC to categorize requirements by the degree of urgency for which an item is needed (14:A1.11). A warning from the DoD FAR supplement states that: "Requirements issued on an urgent basis or with unrealistic delivery schedules should be avoided, since they generally increase prices . . . [15:15.1-1]." Urgent requirements may affect contract prices for a number of reasons. One influential factor may be the shorter lead times required of the vendor to expedite production of an item. Producers prefer long lead times to better enable them to control production planning (22:47). In the case of urgent requirements, a common technique used to acquire an item is to process an acceleration request to expedite deliveries thus reducing the producer's lead time (24).

In spares buying a second factor influencing price paid for urgent requirements is that more than likely the

items would be procured from the prime contractor because insufficient time was available to develop alternate sources of supply. New or especially technical items for which incomplete technical data is available would be particularly susceptible to this factor (24).

The DoD Inspector General Staff has identified seven categories of unreasonably priced spare parts (25:20). One of the seven is comprised of parts for which a higher price was paid to fulfill an urgent requirement. The Inspector General found that many times when an item is coded as urgent, competition is not sought on the rationale that the extra time spent competing the procurement would "take too long to fill the urgent requirement [25:22]." However, the Inspector General also noted that requirements coded as urgent are often known several months in advance but not acted upon "in a timely manner [25:22]."

Criticality Designator

From a historical perspective, Congress has addressed the problems associated with the United States' strategic dependency on foreign supplied raw materials by passing the Strategic and Critical Material Stockpiling Act of 1946 (21:68). This act allowed the stockpiling of certain designated raw mterials that would be used in a national emergency. A second Act, the Defense Production Act, passed in 1950, authorized the President to:

1. require that contracts or orders relating to certain approved defense or energy programs be accepted and performed on a preferential or priority basis over all other contracts;
2. to allocate materials and facilities in such a manner as to promote approved programs [33:F-2].

The Office of Industrial Mobilization, within the Department of Commerce, has developed the Defense Materials System (DMS) and the Defense Priorities System (DPS) (33:F-2). The DMS monitors the acquisition and production of four specific controlled materials--copper, aluminum, nickel, and steel (33:F-7). The DPS is a mechanism that provides the government with the capability to expedite delivery of certain "defense-rated" contract orders (21:67). There are two types of criticality ratings--DO ratings and DX ratings. DO rated orders take precedence over nonrated orders while DX rated orders take precedence over both nonrated orders and DO rated orders (33:F-3).

Criticality ratings are assigned by the Office of Industrial Mobilization to items needed for approved programs (33:F-3). Contractors accepting rated orders must comply with the required delivery date of the contract and schedule production operations accordingly (33:F-3). Writers such as Gansler have speculated on the cost effect of using criticality designators:

> The original intent of the Defense Production Act was to provide a priority system to be exercised during peacetime but intended primarily for periods of national emergency (during or before wars). However, it has also been used during peacetime to assist the Department of

> Defense in getting parts as rapidly as possible, and thus minimizing peacetime defense costs [by reducing lead times] [21:67].

Price Evaluation

Before a purchase can be completed, the contracting officer must determine that the offered price is fair and reasonable (15:15-26). Contracting officers in AFLC use several techniques to determine if the price for a particular spare part is fair and reasonable (14:A1.25).

The AFMAG study pointed out that some of these pricing strategies have severe limitations resulting in the occasional overpricing of common, inexpensive items such as $58 screwdrivers and $916 stoolcaps (1:2.30; 11:65). Limits on time and information were given as reasons for accepting unreasonable prices. The volume of the procurement actions in the low value category is extensive and the number of contracting personnel has been declining over the past several years (1:2.30). To compensate, the Command has adopted proceduralized pricing techniques such as "statistical pricing," "formula pricing," and comparison of prices with the previous price (1:2.30). The AFMAG study found that:

> While the use of formula pricing agreements facilitates spares ordering and does not require many contracting personnel resources, the method of cost allocation incorporated in most of these agreements does not result in unit price integrity [1:2.30].

Purchase Quantity

Quantity purchased may have a significant impact on the price paid for an item. To incentivize a buyer to purchase in particular quantities suppliers often offer quantity discounts usually stated as a percentage of the value of the order (3:44). Quantity discounts can be defined as the offering of lower prices for larger orders (3:111). Quantity discounts can benefit both the buyer and the seller of a good by reducing their costs. Buyer costs may decline for two reasons: (1) lower purchase prices, and (2) fewer purchases are made resulting in lower ordering costs (3:111). Seller costs may be reduced for a number of reasons, of which two are: (1) lower marketing expenses, and (2) lower production costs (20:116). Marketing expenses are reduced because it is usually no more expensive to sell a large order than a small one and packaging costs do not increase directly with the size of the order (20:117). Production costs are lowered because increased production rates spread direct costs such as tooling, fabrication, set-up and manpower utilization over more units.

In DoD procurement of replenishment spare parts, a number of unique constraints have been levied on purchasing agents that may undermine the advantages of quantity discounts. One was a directive limiting the purchase of an item to no less than a three-month and no more than a

three-year supply (2:4). A second, more constraining barrier to optimal purchase quantities, was the fiscal restrictions imposed by Congress on the procurement of replenishment spares. Funds to purchase this category of items were allocated separately on a yearly basis and federal law forbade this allocation to be exceeded (2:4). AFLC additionally imposed quarterly administrative restrictions on expenditures by each ALC (2:4). An example cited in Volume II of the AFMAG report showed that in fiscal year 1983 there was a projected shortfall of one billion dollars for the procurement of aircraft replenishment spare parts. To alleviate the problem AFLC authorized the various ALCs to procure "minimum pipeline quantities" which represented only 65 to 75 percent of the previously computed requirements (1:33). The AFMAG study goes on to say that:

> As a consequence of restrictive buy guidelines, the Air Force experienced many repetitive, small quantity buys. For the past few years, approximately 50% of the reparable spares purchased involved quantities of 5 or less; 39% of nonreparable spares ordered were for quantities of 20 or less [1:2.27].

In 1974 a team of Air Force Academy researchers under the auspices of Project EOQ attempted to determine the effect of solicitations for fewer, larger quantity contracts. On the average it was found that discounts up to four and one-half percent would be offered by suppliers if they were allowed to sell to the government in economic production quantities based on efficient production rates (2:4).

Time Between Buys

Another factor related to production efficiency is the time between buys. AFLC procurement specialists believe that the time between buys has a direct effect on the price paid for replenishment spare parts (13; 24). One factor which would support a relationship of time between buys and price is the fact that if items are procured on a routine basis the producer of the item is able to maintain a "warm" production capability (21:117). However, without an even flow of incoming orders the producer will be forced to seek other business which may require the acquisition of different equipment and/or retooling (13). Another factor having a significant impact on the time between buy and price relationship is the effect of labor learning. Learning curve theory states that as a worker performs the same job repetitively he becomes more efficient at the task allowing him to perform the task in less time with less waste of materials (28:29). Ultimately the increased level of skill results in lower costs.

Past Empirical Research Efforts

Due to the renewed emphasis on increasing competition in the weapon system acquisition process, a number of research efforts were undertaken which investigated the overall effects of competitive procurement on both complete weapon systems and replenishment spare parts. Four

empirical studies specifically analyzed the effects of introducing competition into the acquisition of replenishment spare parts previously procured on a sole source basis.

Research Study Number One. In 1974, three Air Force Institute of Technology (AFIT) students prepared a cost-benefit analysis comparing sole-source versus competitive procurements of aircraft replenishment spare parts. The research objective was to "determine the effect of competition on the cost of aircraft replenishment spare parts [30:Introduction]." Data for the research effort came from the J041.E9LL procurement history files maintained by Air Force Logistics Command (AFLC). From this data base a total of 356 items were selected as the sample for testing. To survive the screening process, the items had to switch from sole-source to competitive procurement. As a further screening measure, items lacking complete procurement histories were eliminated from consideration (30:28-32).

Actual analysis involved utilizing multiple regression techniques to measure the relationship between two independent variables; order quantity and a dummy variable representing the procurement method. The unit price of the item, adjusted for inflation, served as the dependent variable (30:38). Other factors such as order quantity

and the effects of learning were controlled for to make the model as accurate as possible (30:34-37).

A summary of the results showed that lower unit prices of from 10.8 to 17.5 percent occur when aircraft replenishment spare parts buys are solicited on a competitive rather than a sole source basis (30:62).

Research Study Number Two. A second research study involving the effects of competition on prices paid for replenishment spare parts was conducted at the Army Procurement Research Office in 1981. The main purpose of this research was to answer the following questions:

> 1. Is the rate of decline in price (constant dollars) more rapid under competitive procurement than under sole-source procurement? That is, does competitive procurement reflect a steeper learning (or experience) curve than sole source procurement.
> 2. What percentage savings is realized on the first competitive buy [35]?

Data for the research project consisted of a sample of 39 randomly selected procurement histories from a 1,300-item population of spare parts procured by the Aviation Material Readiness Command (35:2). The screening process consisted of picking only items that had been procured sole-source at least three times followed by three competitive purchases (35:2). A second selection criterion was to avoid choosing any item that had a gap of several years between consecutive buys in order to minimize any inflationary effect (35:12).

Nonparametric statistical techniques were used to determine whether a competitive procurement reflects a steeper learning curve than sole-source procurement. Nonparametric statistics were used in this case because of the great variability of the data, reflecting a nonspecific underlying distribution (35:3).

No significant difference was found between the learning curve slopes under sole-source conditions and the slope under competitive conditions. However, even though the sample size was small, the findings did show an overall tendency for competitive procurement learning curves to be steeper than sole-source procurement learning curves (35:5). In answering the second question, previously fitted regression lines were projected to obtain an estimated sole-source price for each buy. This estimated price was compared to the actual price and a sign test was applied. It was concluded that a percentage savings rate of from 15 to 25 percent was realized on the first competitive buy (35:8).

Research Study Number Three. In 1982, Mr. Edward Brost, then a graduate student at AFIT, completed a thesis which further analyzed the effects of sole-source versus competitive procurements of weapon system replenishment spare parts. Specifically, Brost's study was undertaken to provide a basis for determining what, if any,

circumstances enhance the competing of previously sole-source items (7:10).

In order to accomplish the research task, Brost formulated three research questions. They are as follows:

1. Is there a reduction in replenishment spare parts prices when competition is introduced?
2. Can a portion of any price change be attributed to the effects of competition?
3. Is the magnitude of any price change influenced by certain specified factors (i.e., type of item or number of solicitations) [17:11]?

Data from Brost's study was extracted from procurement history files of the five ALCs for a four-year period (FY 78-82) (7:13). The sample size consisted of thirty-six weapon system replenishment spare parts representing items that had been acquired sole-source at least three times and then procured competitively at least three times (7:41). To smooth out the effects of inflation, all prices in the sample were adjusted to constant year dollars using 1980 as the base year and the Producers Price Index (PPI) for special metals and metal products as the conversion factor (7:41).

Statistical techniques including multiple regression analysis, analysis of variance and large and small sample tests of hypotheses about population means were employed to analyze the data (7:42).

Findings from Brost's research project tend to contradict previous research efforts in the sole source

versus competition field of study. After analysis, Brost made three significant conclusions. They are:

> 1. The introduction of competition into the replenishment spare parts acquisition process does not guarantee lower prices;
> 2. For many items, competition accounts for a portion of the price change but the effect of competition is just as likely to result in price increases as price decreases; and
> 3. Price changes are similar among commodity groups and are not influenced by the number of solicitations [7:90].

However, on his third point, Brost mentioned that additional data should be analyzed to determine the influence on price of the number of solicitations (7:96).

Research Study Number Four. In 1983, Zamparelli undertook a study to either support or refute Brost's findings by using a similar methodology and a much larger data sample (39:102). To accomplish the task, two research hypotheses were formulated. They are:

> 1. A reduction in unit price is realized when competition is introduced into the acquisition of weapon system replenishment spare parts previously procured on a sole-source basis.
> 2. An increase in unit price is realized when weapon system replenishment spare parts previously procured through competitive means are purchased on a sole-source basis [39:10].

Four years of procurement history data from each of the five ALCs were screened to provide a representative sample of replenishment spare parts purchases that had a record of at least two consecutive sole-source procurements followed by at least two consecutive competitive

procurements (39:48). The 420 sample items were then adjusted using 1980 as the base year and the PPI for special metals and metal products as a conversion factor (39:50). Data analysis was accomplished by use of specific statistical techniques including the computation of median scores, large sample Z-tests for means, ONEWAY analysis of variance, and the Kruskal-Wallis H test (39:52).

The results suggested the following conclusions (39:104-107):

1. A reduction in unit price was generally experienced with the introduction of competition into the acquisition process.

2. Items that transition from competitive to sole source acquisitions experienced unit price increases.

3. Reductions in unit price were not found when competition was introduced into the acquisition of aircraft spare parts.

4. Replenishment spare parts with unit prices of $1,000 or less were more likely to show competitive savings than were replenishment spare parts with unit prices over $1,000.

Summary

This chapter presented a brief overview of replenishment spare parts and a review of the empirical evidence and theory relating to factors that may have an effect on spare parts prices. These factors are: number of quotes received,

extent and kind of competition, contracting authority, contracting priority, criticality designation, price evaluation method, purchase quantity, and time between buys.

III. Research Methodology

Chapter Overview

The objective of the research is to determine the relationship between a number of factors and the prices paid by the U.S. Air Force for replenishment spare parts. Chapter III discusses the specific research methodology employed to accomplish the research objective. The chapter also discusses data collection, sample selection, data adjustment and statistical techniques. Finally, in order to answer the research objective, eight research hypotheses were developed. The hypotheses are listed along with a brief explanation of the authors' reasoning for each hypothesis' expected outcome.

Data Collection

Whenever replenishment spare parts are purchased, the ALC responsible for procuring the part updates a procurement history file with a number of pertinent facts for each purchase (7:37). Data maintained in the procurement history files includes information such as national stock number, purchasing office, order quantity, price, contracting priority, procurement method code, number of solicitations and contract type. Procurement history files are maintained as part of the Acquisition Due-In System (J041) (7:38).

The data base used in the research was constructed by HQ AFLC Logistics Data Division from the J041. The data covers a four-year period from FY 1980 through FY 1983. Thirteen data attributes from the Oklahoma City ALC were transferred from the master J041 file to magnetic tape. The attributes and an overview of each are given below.

1. National Stock Number (NSN)--"A number assigned to provide a standard identification of every item cataloged in the federal cataloging system [34:286]."

2. Contract Line Item Number (CLIN)--"A CLIN is a four-digit code used for identifying an item of supply or service on a contractual document [34:165]."

3. Procurement Date--the date the contract was awarded (13).

4. Procurement Quantity--the number of items purchased for a specific procurement action.

5. Price Paid--the total contract price paid for a specific procurement action.

6. Criticality Designator--"Classification by the order of importance of contracts for purpose of contractor production and performance surveillance [14]." There are three criticality designators:

A--Critical or "DX" rated contracts.

B--Important. Contracts necessary to maintain a government or contractor's production or repair line.

C--Normal. All other contracts.

7. Competition Code--"The attribute competition code reflects the extent and kind of competition obtained when awarding contracts. It is comprised of seven codes reflecting a specific type of competition [14]." These are:

1--Price competition.

2--Design or technical competition.

3--Follow-on action after price competition.

4--Follow-on action after design or technical competition.

5--Other noncompetition.

8--Formal advertised.

This code is primarily used as further information on the competitive posture of an acquisition (13).

8. Advertised Negotiation Authority--the attribute advertised negotiation authority contains "the type of contracting authority used for contracts pursuant to the Defense Acquisition Regulation (DAR) [14]." Determination of the contracting method is made by the buyer and annotated on the buyer's data abstract document level (14). The attribute is divided into twenty-seven codes ranging from advertised regular to the seventeen exceptions listed

in the DAR allowing negotiation (13). The primary purpose of the attribute is to document the reasons for not using formal advertising. For the sake of brevity, the twenty-seven codes will not be individually listed. One example is the variety of codes used to designate small business set-asides. Possible codes include:

02--Small business set-aside (unilateral).

31--Section 2304(a)(2)--Reserved for exclusive Small Business participation.

23--Small business set-aside (joint).

9. Number of Sources Solicited--"The total number of sources solicited for a specific line item purchase [14]."

10. Offers of Quotations Received--the attribute represents the total number of offers of quotations received from sources solicited for a potential contract (14). The number of offers of quotations received is dependent upon the number of sources solicited. In order to assess the effects of competition on prices paid for replenishment spare parts it is necessary to quantify the degree of competition attained on a particular buy. In the study, the attribute "offers of quotations received" is used as a quantitative measure of competition.

11. Price Evaluation--"The attribute price evaluation consists of 13 codes indicating the principal basis upon which the price decision was made [14]." Again,

for the sake of brevity, the thirteen codes will not be listed. Two codes will be used as examples. Any line item coded with an "A" would indicate that adequate price competition was obtained on the procurement. An item coded with a "B" would show that the price decision was based on established catalog or market prices. Simply stated, the code, input by the buyer, explains how the procurement price was determined to be fair and reasonable (13). Price evaluation will be analyzed to show whether or not price determinations effect the procurement price.

12. Type Line Item--in the study, the data was screened to contain only type line items coded as "1," replenishment spare parts.

13. Contracting Priority--contracting priority consists of a code assigned to the Purchase Request/Military Interdepartmental Purchase Request line item denoting the priority for which the item is to be procured (14). There are seven contracting priorities:

R--Routine requirement.

A--Requirement justified by a MILSTRIP requisition.

B--Essential material or unprogrammed maintenance requirement.

C--Supplies/services needed at once because of disaster.

D--Material or services urgently needed for the health, welfare, or morale of personnel.

E--Requirements for which delivery is required in less than normal time.

F--Requirements designated as Electronics Warfare Quick Reaction Capability Priority (14).

Sample Selection

Replenishment spare part purchases were examined by use of NSN as the primary key. A primary key is "a data item that is used to identify a specific record from a data file [8:214]." For this study the primary key was used to identify groups of identical replenishment spare parts. The data base was first screened using Purchase Request/Military Interdepartmental Purchase Request (PR/MIPR) line item codes to select only items classified as replenishment spare parts. The data base was then screened to select only those replenishment spare parts which were procured more than once to allow for a comparison between buys of like spare parts. The data base was further screened to select those purchases in which the number of quotes received was greater than one to eliminate all noncompetitive procurements. The group of samples was again screened to select only those purchases in which the number of quotes received had changed at least once to ensure that each group of spare parts had a level

of competition which varied between buys. Figure 1 illustrates the data sample screening procedure.

The iterative screening procedure was accomplished by the use of FORTRAN programs that read, compared, and deleted lines. After screening the roughly 100,000 lines of raw data, 13,362 purchases were selected for statistical analysis. The data sample was separated and formatted for analysis using additional FORTRAN programs and the AFIT VAX 11/780 system text editor.

Data Adjustment

The data was adjusted to standardize the dependent variable price paid to consider the effects of inflation and differing part values. In addition, a new attribute was created to calculate the number of days between each buy of an individual spare part.

Adjustment for Inflation. The effects of inflation were accounted for by deflating the price paid for a spare part to the base month of January 1980. The adjustment was accomplished using the specific inflation factor from the Producer Price Indexes (PPI) for special metals and metal products (9). While it is recognized that not all replenishment spare parts fit directly into the category, there is no direct correlation between NSN (the key identifying attribute in the data) and the commodity codes contained in the PPI. It was therefore necessary to select

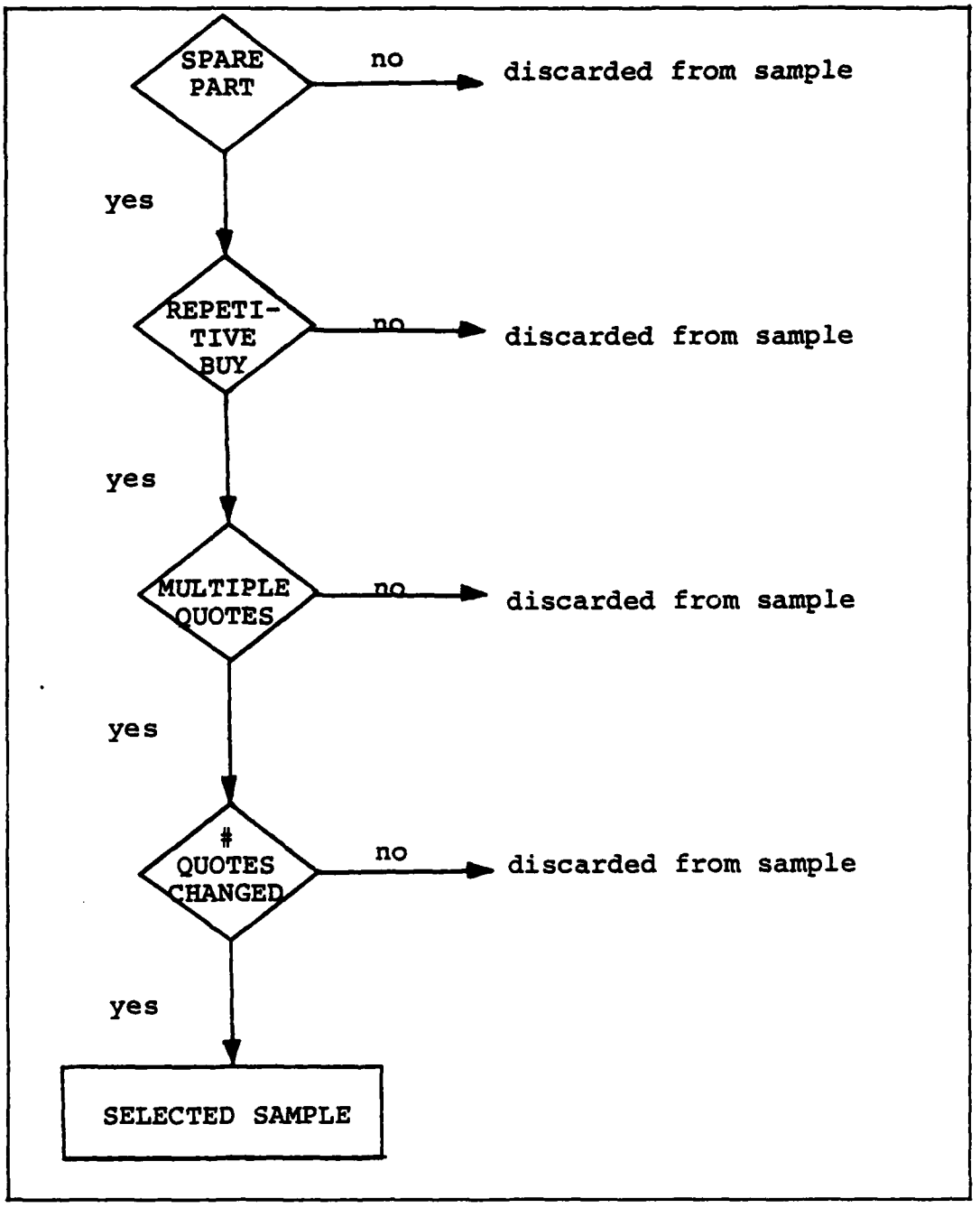


Fig. 1. Data Sample Screening Procedure

a "best" alternative because it would have been impractical, if not impossible, to identify a specific inflation factor for each of the 4,456 NSNs in the sample.

In order to identify the best single index, a random sample of forty NSNs was selected from the population. The sample was selected based on random numbers obtained using a CP/M S-BASIC program on a KAYPRO II minicomputer. The forty NSNs were then cross-referenced to Tables of Allowance maintained by the Wright-Patterson Air Force Base Supply Research Section to specifically determine each part's makeup. A listing of the sampled stock numbers and their nomenclatures is presented in Appendix B. Results showed that 92.5 percent of the items can best be classified as metal products which confirmed the special metals and metal products index as the inflation adjustment factor.

Because some spare parts were procured several times within a single year, it was necessary to adjust for inflation on a monthly basis. The following procedure to standardize the spare part prices was used: (1) the monthly inflation factors for the years 1980 through 1983 for special metals and metal products were obtained; (2) each factor was then divided by the factor for January 1980, the base month, to calculate forty-eight monthly price deflators; and (3) each spare part price was then divided

by the appropriate price deflator resulting in a standardized procurement price. Table 1 illustrates the procedure.

TABLE 1

EXAMPLE OF THE ADJUSTMENT FOR INFLATION

Month/Yr	Index	Deflation Factor	Price	Adjusted Price
Jan 1980	253.7	253.7/253.7=1	$100	$100/1=$100.00
Feb 1980	256.0	256.0/253.7=1.009	$100	$100/1.009=$99.11
Mar 1980	255.1	255.1/253.7=1.005	$100	$100/1.005=$99.50

Note 1: The actual calculations were taken to seven significant digits.

Note 2: All prices are stated in January 1980 dollars.

Price Ratios. To allow the comparison of relative price changes for items with different selling prices, the price paid was converted to a ratio which reflects the actual price paid for an item relative to the lowest price paid for the item. The resulting ratio is a measure of the change in the price paid for an item. The ratio was determined using the following procedure. First, the deflated total line item price was divided by the total quantity procured resulting in a unit price. The unit price was then divided by the lowest unit price resulting in a ratio of actual price paid to the relative price paid for each

specific item. Table 2 demonstrates the procedure. The price ratios obtained ranged from 1 to 35.8.

TABLE 2

EXAMPLE OF THE NORMALIZATION OF PRICES AND ORDER QUANTITIES

Price		Quantity		Unit Price		Lowest Unit Price		Ratio
$100	/	2	=	$50	/	$40	=	1.25
$150	/	3	=	$50	/	$40	=	1.25
$200	/	5	=	$40	/	$40	=	1.00

Time Between Buys. Interviews with AFLC personnel (13; 24) identified a general belief that the time between buys, which was not contained in the original data set, would likely have a significant effect on price paid. It was therefore necessary to create the attribute, "time between buys," which measured the days elapsed between purchases of particular spare parts. The attribute was created by the following procedure: (1) using the sort routine maintained on the AFIT VAX 11/780 computer, each purchase was rank ordered from earliest to latest by procurement date within each NSN; and (2) using a FORTRAN algorithm that tallied days between buys an ordered list of times between buys was obtained.

Conversion of Qualitative Variables

In order to complete regression analysis of the data, the qualitative variables were created as binary "dummy variables." The qualitative variables were converted as follows:

1. Advertised negotiation authority--"1" for small business set-asides (coded 02, 31, or 23) and "0" for everything else.

2. Competition code--"1" for follow-on actions after price, design, or technical competition (coded 3 or 4) and "0" for everything else.

3. Criticality designator--"1" for critical (coded as A) and "0" for everything else.

4. Price evaluation--"1" if price determination was made on adequate price competition (coded A) and "0" for everything else.

5. Priority--"1" for urgent procurements (coded A, B, C, D, E, or F) and "0" for routine procurements.

Data Segmentation

After the raw data had been screened, adjusted for inflation, and the contract price converted to a ratio, the resulting sample of 13,362 purchases, with unit prices ranging from $4.90 to $3,189,610, was segmented into three subsets for statistical analysis.

The first subset (subset 1) was drawn from spare parts which experienced relatively large price changes during the four years of the sample. Subset 1 was assembled to determine if the influence of the independent variables was related to level of price change over the sample period. The data set was constructed by identifying the 500 largest price ratios in the full data set (i.e., those with the greatest change). Since each part was subject to multiple procurements over the four-year period, each of the 500 selected ratios identifies a number of purchases. The resulting data set consisted of 351 NSNs representing 1,242 purchases.

The second subset (subset 2) included low dollar value items (items less than $1,000) from the full data set. Subset 2 was assembled by selecting NSNs associated with parts that had at any time cost less than $1,000. This resulted in a subset of 1,063 NSNs consisting of 2871 procurement actions. Subset 2 was assembled to determine if the influences are constant for differing part values. Such a breakout was found to be useful in at least one other related study (39:107).

The third subset (subset 3) was developed to determine the effects of the independent variables on data segmented to reflect both high variability and low cost. The subset included low dollar value items with highly variable price ratios (i.e., a low dollar value breakout

of subset 02). Subset 3 contained 82 NSNs representing 254 purchases.

The results of the statistical analyses from the three data subsets were then compared to the results of the statistical analysis from the full data set. By segmenting the data and comparing the statistical analysis results for each "cut" of the data, it was possible to gain an understanding of the relationships between the selected quantitative and qualitative factors and the variability of prices paid for spare parts.

Description of Sample Data

In order to be able to make inferences about variables which may influence price paid, a better understanding of the underlying characteristics of the data base was required. To achieve the understanding, several data analyses were performed. First, a calculation of the total number of parts procured by year and by Federal Stock Class was obtained. The Federal Stock Class is comprised of the first four digits of the NSN. The total number of parts procured was calculated to get a feel for the magnitude of the spares buys over the various stock classes and the four years in question. The results of the calculations are presented in Appendix C.

For each of the quantitative variables; price ratio, time between buys, quantity and quotes received, four values were calculated: range, mean, median and

and standard deviation. The range is the highest and lowest value found for the attribute. The mean is the sum of the variables divided by the number of occurrences of the variable (27:56). The median is the value of the variable such that half of the measurements fall below the median and half above (27:59). The standard deviation is used to measure the variability of the values in the population (27:72). The results of these calculations are presented in Appendix D.

For each of the qualitative variables; advertised negotiation authority, competition code, contracting priority, criticality designator, and price evaluation method, the percentage breakout of all possible conditions was obtained. The results for the four data sets are contained in Appendix E.

Research Hypotheses

The following section discusses the research hypotheses that were developed to satisfy the research objective.

Research Hypothesis One.

As the number of quotations received increase, the relative price paid for the item will decline.

Simply put, the expectation is that the more quotes to choose from, the better the deal which can be obtained. Therefore, the authors expect that as the number of quotes

received increases, the relative price quoted will decrease. Another explanation for this hypothesis is that the number of quotes is a proxy for the amount of competition obtained. Economic theory states that the more competition obtained, the lower will be the price paid for the good.

Research Hypothesis Two.

As the quantity procured of an item increases, the relative price of the item will decline.

The authors expect that the relative price will decrease as the quantity procured increases due to the effects of quantity discounts and the effects of learning.

Research Hypothesis Three.

As time between buys of an item decreases, the relative price of the item will decline.

The authors expect if the time between buys is relatively short there will be less of a difference in price due to the ability to keep the buyer current in the required needs of the government and the availability of qualified producers.

Research Hypothesis Four.

The relative price of the item will increase when contracts are set-aside for small business.

As socioeconomic objectives become more important in the government's decision to award contracts, the authors expect the relative price to increase due to the

lessening of competition and a greater reliance on socio-economic objectives.

Research Hypothesis Five.

> The relative price of the item will decrease when contracts are awarded on a follow-on basis.

The authors expect that the relative price will decrease if a contract is awarded as a follow-on procurement because the same contractor supplies the part. Therefore, the production line can be kept "warm" and the effects of learning will be realized.

Research Hypothesis Six.

> For a procurement action designated as critical, the relative price of the item will be higher.

If an item to be procured is designated "critical," the authors expect the relative price to increase due to the increased costs to the contractor to produce the item. Two reasons could be the premium prices the contractor must pay his suppliers for material and the extra wages the contractor must pay his workforce for extra manhours.

Research Hypothesis Seven.

> If the price of an item was found to be "fair and reasonable" on the basis of adequate price competition (vice cost analysis, etc.), the relative price of the item will be lower.

The authors expect the relative price to decrease because acceptance of the price on a price competition basis

implies a competitive market, and the more competitive the market the lower the expected selling price.

Research Hypothesis Eight.

> An increase in the relative price of the item will be observed when procurement actions are coded urgent.

As in the case of "criticality" the authors expect that the relative price will increase due to the increased costs of the contractor to produce the item. This is due to the practice of awarding the contract to the previous supplier in order to save time, therefore limiting the amount of competition for the contract.

Statistical Techniques

The statistical techniques used in the research study were multiple regression analysis, analysis of variance F-tests, and hypothesis tests about the coefficients in a regression model. The statistical package "S," maintained on the VAX 11/780 computer was used as the analysis tool (4). Regression analysis, in general, involves building a model to relate the mean value of a dependent variable to an independent variable (27:395). Multiple regression analysis is an estimation and prediction device that models the value of a dependent variable against the values of two or more independent variables (27:455).

The general form of the multiple regression model is:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon$$

In this model, the dependent variable, represented by "y" is written as a function of k independent variables, X_1, X_2, ..., X_k (27:456). The random error term "ε" is included to convert the model from a deterministic to a probabilistic form (27:456). The term β_0 is the y-intercept and the coefficients of β_1, β_2, to β_k determine the contribution of the independent variables in the model (27:456).

The regression model used in the data analysis consists of three quantitative independent variables and five qualitative independent variables. The dependent variable is a price ratio which reflects the actual price paid for a spare part relative to the lowest price paid for a spare part. The eight independent variables and their definitions are listed in Figure 2.

X_2 - Number of offers of quotations received
X_3 - Quantity procured
X_4 - Time between buys
X_5 - Advertised negotiation authority (small business set-aside)
X_6 - Competition code (follow-on action)
X_7 - Criticality designator (critical)
X_8 - Price evaluation (adequate price competition)
X_9 - Priority (urgent)

Fig. 2. Independent Variable Definitions

The analysis of variance F-test was used to test the utility of the multiple regression model (27:473). This test is considered a global test because it takes into account all of the coefficients in the model. The analysis of variance F-test is illustrated in Figure 3.

After regression analysis and analysis of the variance F-tests were performed on the full data set and the three segmented data sets, the hypotheses were tested by use of a Student's t-test to determine the significance of each independent variable (27:464). The test of an individual parameter coefficient in the multiple regression model is illustrated in Figure 4.

As is a common practice for this type of research, all statistical tests were performed at the .10 level of significance in order to reasonably minimize the possibility of rejecting the null hypotheses (H_0) when they were true.

Summary

Chapter III discussed the source of data from which the sample was extracted and defined each attribute included in the analysis. The sample selection, data adjustment, and data analysis techniques were described along with a statement and discussion of the research hypotheses developed for analysis.

H_o: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$

H_a: At least one of the coefficients is nonzero.

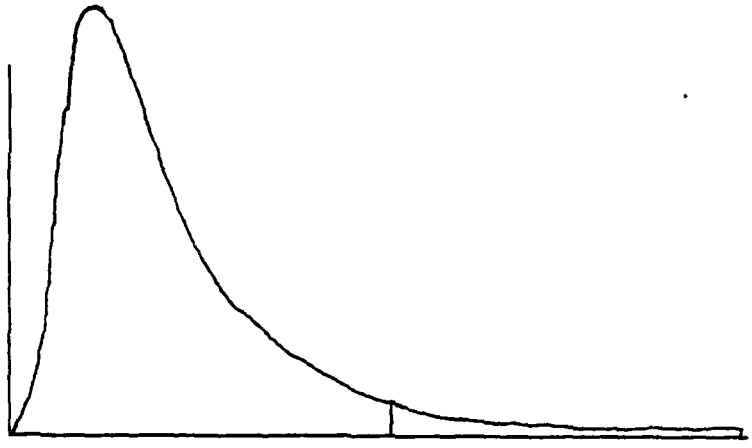
$$\text{Test Statistic: } F = \frac{R^2/k}{(1-R^2)/[n-(k+1)]}$$

where: n = the number of data points

k = the number of parameters in the model excluding β_0

v_1 = k degrees of freedom (numerator)

v_2 = n - (k+1) degrees of freedom (denominator)



$F_{.10} = 1.67$

(when v_1 is at least 8, as in the data sets for this study)

F alpha = .10

Reject H_0 if F > F alpha

Fig. 3. Analysis of Variance F-test

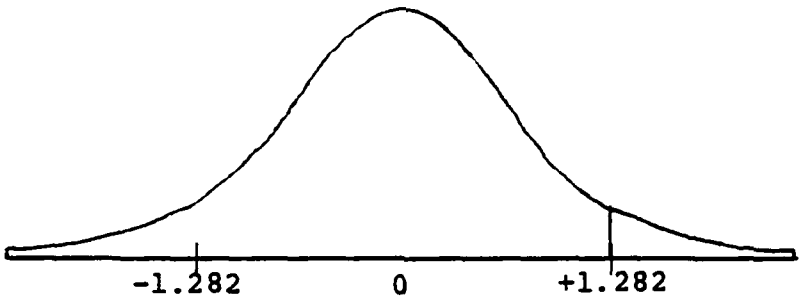
H_o: $\beta_i = 0$

H_a: $\beta_i > 0$

Test Statistic: $t = \frac{\hat{\beta}_2}{s_{\hat{\beta}_2}}$

where: $\hat{\beta}_2$ = the sample estimate of the parameter β_2

s = the sample standard deviation of $\hat{\beta}_2$



t alpha = .10

Rejection Region: t > t alpha or t < t alpha depending on the hypothesis

Fig. 4. Students T-test of an Individual Parameter Coefficient in the Multiple Regression Model

Note: Negative one-tailed t-tests were also used in this study.

IV. Data Analysis and Findings

Introduction

Chapter IV presents the results of the analysis of variance F-tests performed on the regression models for the four data sets. Also, the t-test result and coefficients are presented for each of the hypotheses described in Chapter III. The authors' interpretations of the results are also included.

Results of Hypothesis Tests and Regression Analysis

Each of the research hypotheses was tested on the four data sets. As mentioned in Chapter III, the data sets are:

1. Full data set--all 13,362 line items in the sample.

2. Subset 1--the 1,242 line items with relatively large unit price changes.

3. Subset 2--the 2,871 line items that had been procured for less than $1,000 at least once.

4. Subset 3--the 254 line items which had both relatively large unit price changes and were procured for less than $1,000 at least once.

First, a global analysis of variance F-test was used to determine the utility of the complete regression

model for predicting the dependent variable. Then, hypothesis tests about the individual coefficients in the model were conducted. Results of the F-tests on the four data sets are presented in Table 3. The results showed that for each of the four sets of data the F-test statistic exceeded the rejection region so it is concluded that at least one of the model coefficients is nonzero. Therefore, the F-test indicates that the regression model has utility in predicting relative item prices.

TABLE 3

RESULTS OF F-TESTS

Data Set	Degrees of Freedom	Test Statistic	Rejection Region	Result
Full Data Set	$v_1 = 8$ $v_2 = 13352$	33.54	1.67	Reject H_o
Subset 1	$v_1 = 8$ $v_2 = 1233$	11.89	1.67	Reject H_o
Subset 2	$v_1 = 8$ $v_2 = 2862$	7.68	1.67	Reject H_o
Subset 3	$v_1 = 8$ $v_2 = 245$	3.14	1.67	Reject H_o

Results of Hypothesis One.

As the number of quotations received increase, the relative price paid for the item will decline.

T-tests of hypothesis one showed that as variable quotations received changes, a change in the relative price for the part was observed. This result was consistent for

the four data sets. Furthermore, the coefficients for the variable were negative for all four data sets which substantiates the authors' hypothesis that an increase in the variable decreases the dependent variable. The results suggest that the independent variable, quotations received, had a statistically significant influence on the dependent variable regardless of the cost of the part and regardless of whether the part experienced large price changes. The t-tests and coefficients are presented in Table 4.

TABLE 4

RESULTS OF HYPOTHESIS ONE

Data Set	t-score	Result	Coefficient
Full	-9.38	Reject H_o	-0.0125
Subset 1	-5.77	Reject H_o	-0.0723
Subset 2	-5.11	Reject H_o	-0.0155
Subset 3	-2.81	Reject H_o	-0.0864

H_o: The number of quotes does not influence the relative price.
H_a: The number of quotes reduces the relative price.
Rejection Region: $t < -1.282$.

Results of Hypothesis Two.

As the quantity procured of an item increases, the relative price of the item will decline.

T-tests of hypothesis two revealed that as the variable quantity procured changes, a change in the relative price of the part was observed. This result was consistent for

the four data sets. The coefficients for the variable were negative for all four data sets which substantiates the authors' hypothesis that an increase in quantity procured will lead to a decrease in the dependent variable. The results suggest that the independent variable, quantity procured, had a statistically significant influence on the dependent variable regardless of the cost of the part and regardless of whether the part experienced large price changes. The actual t-tests and coefficients are presented in Table 5.

TABLE 5

RESULTS OF HYPOTHESIS TWO

Data Set	t-score	Result	Coefficient
Full	-1.51	Reject H_o	-0.000002
Subset 1	-1.43	Reject H_o	-0.00006
Subset 2	-1.71	Reject H_o	-0.000003
Subset 3	-1.49	Reject H_o	-0.0001

H_o: Quantity procured does not influence the relative price.
H_a: Quantity procured reduces the relative price.
Rejection Region: $t < -1.282$.

Results of Hypothesis Three.

As time between buys of an item decreases, the relative price of the item will decline.

T-tests of hypothesis three results in a failure to reject H_o in favor of H_a for all four data sets. Therefore, the test results provide insufficient evidence to prove that as time between buys of an item decreases, a decrease in the relative price paid will be observed. In fact, the results suggest that the increases in the variable time between buys actually decreases the relative price paid. Furthermore, the independent variable had a statistically significant influence, opposite from that stated in the hypothesis, on the dependent variable regardless of the cost of the part and regardless of whether the part experienced large price changes. However, these results might be attributable to the effects of multicollinearity. The actual t-tests and coefficients are presented in Table 6.

Results of Hypothesis Four.

The relative price of the item will increase when contracts are set-aside for small business.

T-tests of hypothesis four resulted in a failure to reject H_o in favor of H_a for all four data sets. Therefore, the test results provide insufficient evidence to prove that relative prices increase when contracts are set-aside for small businesses. In fact, for the full data set, subset 1 and subset 3, the coefficients for the independent variable

TABLE 6

RESULTS OF HYPOTHESIS THREE

Data Set	t-score	Result	Coefficient
Full	-10.92	Fail to reject H_o	-0.0004
Subset 1	- 4.67	Fail to reject H_o	-0.0017
Subset 2	- 4.97	Fail to reject H_o	-0.0005
Subset 3	- 1.64	Fail to reject H_o	-0.0019

H_o: Time between buys does not influence the relative price.
H_a: Time between buys increases the relative price.
Rejection Region: $t > 1.282$.

were negative, suggesting that the influence of this variable would actually be to reduce the price ratio. The coefficient for subset 2 (the low unit price subset) showed a slight positive influence. The results suggest that the independent variable did not have a statistically significant influence, as stated in the hypothesis, on the dependent variable regardless of the cost of the part and regardless of whether the part experienced large price changes. However, for subset 1, comprised of parts which had experienced relatively large price changes, the results suggest that a statistically signficant negative influence on the relative price exists. The actual t-tests and coefficients are presented in Table 7.

TABLE 7

RESULTS OF HYPOTHESIS FOUR

Data Set	t-score	Result	Coefficient
Full	-0.42	Fail to reject H_o	-0.0109
Subset 1	-2.23	Fail to reject H_o	-0.3321
Subset 2	0.02	Fail to reject H_o	0.0018
Subset 3	-0.36	Fail to reject H_o	-0.1724

H_o: Small business set-asides do not influence the relative price.
H_a: Small business set-asides increases the relative price.
Rejection Region: $t > 1.282$

Results of Hypothesis Five.

The relative price of the item will decrease when contracts are awarded on a follow-on basis.

T-tests of hypothesis five resulted in the failure to reject H_o in favor of H_a for all four data sets. Therefore, the test results provide insufficient evidence to prove that the relative price will decrease when contracts are awarded on a follow-on basis. The coefficients for the independent variable were positive for the full data set, subset 1, and subset 3 and negative for subset 2. The results suggest that the independent variable did not have a statistically significant influence, as stated in the hypothesis, on the dependent variable regardless of the cost of the part and regardless of whether the part experienced large price changes. However, the signs of the coefficients suggest the unexpected effect of

increasing the price ratio for all of the data sets except the low unit price subset. In fact, had the hypothesis been stated as such, the result would have been statistically significant for the full data set. The actual t-tests and coefficients are presented in Table 8.

TABLE 8

RESULTS OF HYPOTHESIS FIVE

Data Set	t-score	Result	Coefficient
Full	2.21	Fail to reject H_o	0.10155
Subset 1	0.04	Fail to reject H_o	0.0105
Subset 2	-0.14	Fail to reject H_o	-0.02521
Subset 3	0.11	Fail to reject H_o	0.1111

H_o: Contracts awarded on a follow-on basis do not influence the relative price.
H_a: Contracts awarded on a follow-on basis reduce the relative price.
Rejection Region: $t < -1.282$.

Results of Hypothesis Six.

For a procurement action designated as critical, the relative price of the item will be higher.

T-tests of hypothesis six showed that as a procurement action is designated as critical, a change in the relative price will be observed for the full data set, subset 1, and subset 3. The coefficients for the independent variable are positive for these three data sets which substantiates the hypothesis that procurement actions designated as critical will increase the relative price. For

subset 2, low dollar value items, the t-test resulted in a failure to reject H_o in favor of H_a which provides insufficient evidence to prove the hypothesis for that data set. The actual t-tests and coefficients are presented in Table 9.

TABLE 9

RESULTS OF HYPOTHESIS SIX

Data Set	t-score	Result	Coefficient
Full	2.18	Reject H_o	0.07747
Subset 1	1.67	Reject H_o	0.4486
Subset 2	0.20	Fail to reject H_o	0.03175
Subset 3	2.49	Reject H_o	2.5479

H_o: Contracts designated as critical do not influence the relative price.
H_a: Contracts designated as critical increase the relative price.
Rejection Region: $t > 1.282$.

Results of Hypothesis Seven.

If the price of an item was found to be "fair and reasonable" on the basis of adequate price competition (vice cost analysis, etc.), the relative price of the item will be lower.

T-tests of hypothesis seven showed that if the price of an item was determined to be "fair and reasonable" on the basis of adequate price competition, a change in the relative price was statistically significant only for the full data set. The coefficient for independent variable

in the full data set was negative which substantiates the hypothesis that a fair and reasonable price determination decreases the dependent variable. However, t-tests for subset 1, subset 2, and subset 3 resulted in a failure to reject H_o in favor of H_a. The test results for data sets 1, 2, and 3 provide insufficient evidence to prove the hypothesis. The actual t-tests and coefficients are presented in Table 10.

TABLE 10

RESULTS OF HYPOTHESIS SEVEN

Data Set	t-score	Result	Coefficient
Full	-2.92	Reject H_o	-0.0839
Subset 1	0.19	Fail to reject H_o	0.0323
Subset 2	-0.95	Fail to reject H_o	-0.1234
Subset 3	-0.90	Fail to reject H_o	-0.5620

H_o: Contracts found to be fair and reasonable on the basis of price competition do not influence the relative price.
H_a: Contracts found to be fair and reasonable on the basis of price competition reduce the relative price.
Rejection Region: $t < -1.282$.

Results of Hypothesis Eight.

An increase in the relative price of the item will be observed when procurement actions are coded urgent.

T-tests of hypothesis eight showed that if procurement actions are coded urgent a change in the relative price

will be observed for the full data set, subset 1, and subset 3. The coefficients for the independent variable were positive in these data sets which further substantiates the hypothesis that as procurement actions are coded urgent an increase in the price paid will occur. However, the t-test for subset 2 resulted in a failure to reject H_o in favor of H_a. This test result provided insufficient evidence to prove the hypothesis which suggests that urgent requirements for low unit cost parts rarely exist. The actual t-tests and coefficients are presented in Table 11.

TABLE 11

RESULTS OF HYPOTHESIS EIGHT

Data Set	t-score	Result	Coefficient
Full	2.07	Reject H_o	0.0538
Subset 1	1.81	Reject H_o	0.4580
Subset 2	-0.31	Fail to reject H_o	0.034839
Subset 3	2.06	Reject H_o	2.0328

H_o: Procurement actions coded as urgent do not influence the relative price.
H_a: Procurement actions coded as urgent increase the relative price.
Rejection Region: $t > 1.282$.

V. Concluding Remarks

Research Summary

The objective of the research has been to determine what, if any, relationship exists between a number of selected quantitative and qualitative factors and the prices paid for replenishment spare parts. To accomplish the research objective, eight hypotheses were developed and tested.

Hypothesis one states that as the number of quotations received increases, a decrease in the relative price will be observed. Since H_o was rejected in each of the four tests of this hypothesis, the empirical evidence supports the authors' belief that the relative price will decrease when the number of quotes received increases.

The authors consider this finding to mean that more competition on a procurement action will result in lower prices paid by the government. This result suggests that beyond the benefits of competing previously sole-source contracts (30; 39), the more competition the better. However, how much more remains an unanswered question. Implications of this finding would tend to favor the continued emphasis on increasing competition for the procurement of replenishment spare parts.

Hypothesis two states that as the quantity procured of an item increases, a decrease in the relative price will be observed. Since H_o was rejected in each of the four tests of this hypothesis, the empirical evidence supports the authors' belief that the relative price will decrease when the quantity procured increases.

The implication of this finding would be to procure items in quantities large enough to enable the supplier to make use of economic production rates. By buying in larger quantities, the Air Force could take advantage of price discounts. The Project EOQ study, completed in 1974, showed that price discounts could be realized if items were procured in sufficient quantity (2). This study further supports the benefits of larger quantity buys.

Hypothesis three states that as time between buys of an item decreases, a decrease in the relative price will be observed. Since H_o was not rejected in any of the four tests of this hypothesis, it could not be concluded that the price ratio will decrease when the time between buys decreases.

However, the results do indicate a potentially beneficial effect from increasing the time between buys. This suggests that the importance of keeping production lines warm was overemphasized. Implications of this result suggest that other factors might be more important, such as allowing time for improvements in manufacturing technology.

Hypothesis four states that relative price increases will be observed when contracts are set-aside for small business. Since H_o was not rejected in any of the four tests of this hypothesis, it could be concluded that the relative price will increase when contracts are set-aside for small business.

The implication of this finding is that contracts set-aside for small businesses may not necessarily cause the price of spare parts to be higher than would be the case if the contracts were not set-aside. In fact, the research suggests that contracts set-aside for small businesses experience lower price fluctuations (the data set consisting of large ratios was the only one of the four which contained less than 50 percent small business set-aside). This finding is not consistent with the general belief that contracts awarded to small business cost the government more. The authors' explanation of this result is that small businesses may have a tendency to bid on lower risk, lower value spare parts.

Hypothesis five states that the relative price will decrease when contracts are awarded on a follow-on basis. Since H_o was not rejected in any of the four tests of this hypothesis, it could not be concluded that the relative price will decrease when contracts are awarded on a follow-on basis. The implication of this finding is

that a current producer of a spare part does not have an inherent advantage in competing for contracts.

Hypothesis six states that if a procurement action is designated as critical, an increase in the relative price will be observed. The empirical results of the t-tests for the hypothesis were mixed. Findings from three of the four data sets suggest that relative prices increase when procurement actions are designated critical. For the fourth data set (low dollar value items) no conclusion could be drawn because the results were not statistically significant. The implication of this finding is that criticality designations be examined carefully and downrated whenever possible.

Hypothesis seven states that if the price of an item was found to be "fair and reasonable" on the basis of adequate price competition (vice cost analysis, etc.) there will be a reduction in the relative price. Only the findings from the full data set suggest that relative prices decrease when the price of the item was found to be fair and reasonable on the basis of price competition. For the other three data sets results were not statistically significant. The implications of the finding are that method of determining a price to be fair and reasonable does not effect low value parts and is not a factor in causing large price changes.

Hypothesis eight states than an increase in the relative price of a part will be observed when procurement actions are coded urgent. Findings from three of the four data sets suggest that relative prices increase when procurement actions are coded urgent. For the fourth data set (low dollar value parts) no conclusion could be drawn because the results were not statistically significant. The implication of this finding is that designating procurement actions as urgent (as is the case more often with higher value parts) causes relative prices to rise. The obvious implication of this finding is that spare part requirements should be met before the need for an item becomes urgent, particularly for higher value spare parts.

Further Research

During the course of this research effort, it became apparent that replenishment spare parts acquisition is a complex activity. Due to the fact that this study was not able to encompass the entire spectrum of spares acquisition data or address all of the possible analysis methodologies, further research in this area is warranted. This section outlines some of the research possibilities which the authors feel would benefit spare parts procurement.

Replication of This Study. The results of this study were based on data made available for one ALC, Oklahoma City. Each ALC is responsible for procuring

specific classes of replenishment spare parts. To determine if the methodology of this study is valid for the other ALCs, a replication of this study using data from one of the other four ALCs would be beneficial.

Develop a Multivariate Regression Model. This study made no attempt to refine the linear model used to describe the effects of the independent variables on the dependent price ratio. Development of a more accurate model using stepwise regression or another statistical technique may result in a more accurate description of the interactions between the independent and dependent variables.

Identification of Other Price Influencing Factors. This study was limited to analyzing the variables considered significant by the authors early in the development of the methodology. It is not inconceivable that there are other (perhaps many) useful attributes contained in the AFLC J041 data that would be useful for an analysis of the type performed in this study.

Concluding Remarks

The authors hope that this research effort will contribute to a greater understanding of the underlying factors influencing prices paid by the Air Force for replenishment spare parts and, hence, lead to increased

readiness of Air Force assets and greater care in the expenditure of public funds.

Appendix A: Seventeen Exceptions to Formal Advertising

1. National emergency
2. Public exigency
3. Purchases under the small purchase limitation (currently not more than $25,000)
4. Personal or professional services
5. Services of educational institutions
6. Purchases outside the United States
7. Medicines or medical supplies
8. Supplies purchased for authorized resale
9. Subsistence supplies
10. Impractical to secure competition by formal advertising
11. Experimental, developmental, or research work
12. Purchases not publicly disclosed
13. Technical equipment requiring standardization and interchangeability of parts
14. Technical or specialized supplies requiring substantial initial investment
15. Negotiation after advertising
16. Purchases in the interest of national defense or industrial mobilization
17. Otherwise authorized by law

Appendix B: Randomly Sampled Stock Numbers and Nomenclatures

Rnd Num	Stock Number	Nomenclature
10397	4710-00-790-4269FG	tube assembly/metal
10979	5305-00-849-8478PQ	screw/machine
1098	1560-00-556-0853FL	plate/structural
11205	5306-00-854-0687PQ	bolt/machine
11399	5315-00-432-5416PL	pin/shoulder headle
11875	5340-00-741-8397RV	coupling
11946	5340-00-931-5752PQ	bracket/double angle
12455	6610-00-055-5395	wedge/light
12795	6610-01-049-8747	accelerometer
12913	6615-00-304-6968	time delay assembly
1863	1560-00-630-4244FL	cylinder assembly
1980	1560-00-651-3643FG	receptacle assembly
2041	1560-00-652-7500FL	bracket, boom fork
2334	1560-00-675-8468FL	shaft, shouldered
2423	1560-00-703-3431FG	bushing, entry door
3055	1560-00-790-1434FG	bracket, fuel strai
3517	1560-00-870-5558FL	tube assembly, pneu
3551	1560-00-873-4231FL	block, engine mount
393	1560-00-235-7443FG	tip, wing flap
412	1560-00-261-5403FL	fairing, fuselage, AI
4308	1560-01-094-3803FG	channel, stiffener
436	1560-00-306-9894FG	boot assembly, SPOI
5133	1650-00-886-0348	piston, linear actua
5255	1650-01-073-1107	cylinder block, hydraulic
533	1560-00-327-0638FL	pannel, inner wing, LE
6913	2840-00-755-1121RV	clamp assy, anti icing
6932	2840-00-758-2193RV	plate, combustion ch
7077	2840-00-778-6569RV	bracket assy, angle
7280	2840-00-798-8359PL	plate, port
744	1560-00-394-6095FL	pannel, outboard flap
7629	2840-00-897-3324PL	bracket, hinge AB MA
7660	2840-00-911-3075RV	hub, compressor rotor
7886	2840-00-923-6914PL	spacer, vane
8018	2840-00-941-0981PQ	tube, bleed
8291	2840-00-966-8085RV	spacer, compressor R
8435	2840-00-988-4876PQ	bracket, angle, engine
8562	2840-01-012-6414RT	counterweight, turbine
88	1560-00-015-8436FL	ring, nose cowl atta
9319	2915-00-962-9016PL	ring, fuel nozzle
9519	2995-00-425-7730	parts kit, starter

Appendix C: Quantity Procured by Federal Stock Class and Year

FSC	Total	1980	1981	1982	1983
1420	6143	0	1561	1332	3250
1430	72	0	34	34	4
1440	3645	0	513	1125	2007
1450	281	0	10	106	165
1560	652757	4551	358631	218698	260877
1620	621	0	195	136	290
1650	150182	1500	57648	54401	36633
1660	71579	7216	21804	18934	23625
1680	10707	36	2902	2837	4932
1730	1121	30	474	255	362
2840	4492618	2522	1048194	1170427	1971475
2915	256634	5250	88024	41909	121451
2925	1761	0	1136	612	13
2935	1331	0	625	706	0
2945	20815	0	19198	1617	0
2995	101784	314	33446	34368	33656
3010	331	0	0	0	331
3020	7099	0	701	965	5433
3040	18693	208	3508	5613	9364
3110	6237	545	4709	235	748
3120	51048	70	45883	4612	483
3130	1251	0	1229	22	0
4010	2789	0	648	1067	1074
4140	220	0	0	220	0
4320	13706	0	3225	6600	3881
4460	245	0	0	69	176
4510	752	0	194	181	377
4710	56782	963	12598	19185	24036
4720	15698	0	2136	3500	10062
4730	13478	0	2883	4046	6549
4810	8267	101	1715	2245	4206
4820	20803	393	7139	5742	7529
4920	72	0	15	37	20
4935	250	3	64	111	72
5120	1786	202	327	448	809
5305	79069	0	15971	23501	39597
5306	557473	1725	136615	118591	250542
5307	17326	0	1718	2477	13131

FSC	Total	1980	1981	1982	1983
5310	243943	3207	114350	78387	47999
5315	219780	1148	38457	55480	124695
5320	534589	0	100390	195319	238880
5325	10475	0	5035	0	5440
5330	599601	4529	191238	135353	228481
5340	1438908	283	468352	370089	523184
5355	971	0	54	917	0
5360	60735	0	14079	27608	19048
5365	225240	7035	44093	61288	112824
5841	402	0	402	0	0
5905	398	162	0	236	0
5930	2096	0	756	733	607
5935	2466	103	565	691	1107
5945	343	0	144	82	117
5950	173	0	51	94	28
5960	1540	0	1157	383	0
5961	696	0	336	360	0
5975	481	0	54	249	178
6105	1059	496	116	168	279
6110	53	0	12	15	26
6130	490	152	136	202	0
6220	1942	0	0	1021	921
6605	63859	63	30098	18347	15351
6610	76518	853	23196	18072	34397
6615	246701	139	71036	96675	78851
6620	38970	965	17064	11226	9715
6680	101	0	88	13	0
6685	322	0	94	88	140
8145	390	0	308	82	0
9905	4225	0	453	1201	2571
Totals	.10623e+08	1.52176e+06	.29978e+07	.28213e+07	.42820e+07

Appendix D: Analysis of Quantitative Variables

Full Data Set

	Range	Mean	Median	Std Dev
Ratio	1.0 to 35.8	1.331008	1.08	0.88485
Quotes	2 to 33	6.61188	4	5.82897
Quantity	1 to 199600	795.010	82	4778.61
Time	0 to 1281	154.4921	86	194.799

Subset 1

	Range	Mean	Median	Std Dev
Ratio	1.0 to 35.8	2.526306	1.745	2.42942
Quotes	2 to 33	6.087762	4	5.64341
Quantity	1 to 26050	328.307	46	1586.531
Time	0 to 891	142.4823	74.5	186.7142

Subset 2

	Range	Mean	Median	Std Dev
Ratio	1.0 to 35.8	1.350706	1.072089	1.201824
Quotes	2 to 33	9.32567	7	7.4077
Quantity	3 to 199600	3197.03	612	9895.27
Time	0 to 1036	169.1867	97	204.8188

Subset 3

	Range	Mean	Median	Std Dev
Ratio	1.0 to 35.8	2.75332	1.528249	3.62695
Quotes	2 to 33	8.47638	5	7.45616
Quantity	7 to 26050	1278.36	249.5	3324.265
Time	0 to 860	152.7953	95.5	190.7321

Appendix E: Percentage Breakout of Qualitative Variables

Full Data Set

Analysis of Advertised Negotiation Authority

	Frequency	% of Total
"32" - Not reserved for small business	4845	36.25
"02" - Small business set-asides	2792	21.00
"31" - Reserved for small business	4253	32.00
"16" - Not formal advertised	920	6.80
"19" - Technical equipment	8	.06
"07" - Public exigency	326	2.44
"50" - Advertised regular	102	.76
"23" - Joint small business set-asides	36	.27
"01" - Labor surplus area set-asides	10	.07
"08" - Small purchase procedures	2	.01
"38" - Experimental, developmental or research	34	.25
"11" - Purchases outside the U.S.	5	.03
"03" - Disaster area set-aside	5	.03
"21" - Otherwise authorized by law	6	.04
"18" - Purchases not publicly disclosed	3	.02
"12" - Small purchase procedures	5	.03
"06" - Balance of payments program	2	.01
"24" - Other	3	.02
"13" - Medicines or medical supplies	1	.00
"14" - Authorized for resale	1	.00
Reserved for small business (02, 31 & 23)	7081	52.99
Not reserved for small business	6281	47.01

Full Data Set

Analysis of Competition Code

	Frequency	% of Total
1 - Price competition	12097	90.35
2 - Design or tech. competition	131	.98
3 - Follow-on after price competition	610	4.56
4 - Follow-on after design or tech. comp.	287	2.15
5 - Other noncompetition	154	1.15
8 - Formal advertised	83	.62
Follow-on (3 & 4)	897	6.71
Not follow-on	12465	93.29

Full Data Set

Analysis of Criticality Designator

	Frequency	% of Total
A - Critical/DX rated contracts	2330	17.44
B - Important	779	5.83
C - Normal	10253	76.73
Critical (A)	2330	17.44
Not critical	11032	82.56

Full Data Set

Analysis of Price Evaluation

	Frequency	% of Total
A - Adequate price competition	11153	83.46
B - Price comparison	353	2.64
C - Established catalog	24	.18
D - Government estimate	2	.01
E - Value analysis	48	.36
F - Price comparison	130	.97
G - Cost analysis	246	1.84
H - Government catalog	9	.07
J - Formula price	28	.21
N - No evaluation (prior 1969)	44	.33

	Frequency	% of Total
S - Surplus item	1101	8.24
Y - Statistical method	152	1.14
Z - Price not a major factor	32	.24
Adequate price competition (A)	11153	83.47
Other	2209	16.53

Full Data Set

Analysis of Contracting Priority

	Frequency	% of Total
"R" - Routine requirement	10672	79.87
"A" - MILSTRIP requirement	14	.10
"B" - Essential unprogrammed	39	.29
"C" - Preclude degradation	32	.24
"D" - Urgently required	26	.19
"E" - Short lead time	2571	19.24
"F" - QRC priority	8	.06
Urgent (A, B, C, D, E & F)	2690	20.13
Routine	10672	79.87

Subset 1

Analysis of Advertised Negotiation Authority

	Frequency	% of Total
"32" - Not reserved for small business	487	39.21
"02" - Small business set-asides	258	20.77
"31" - Reserved for small business	300	24.15
"16" - Not formal advertised	123	9.90
"07" - Public exigency	35	2.81
"50" - Advertised regular	28	2.25
"23" - Joint small business set-asides	1	0.00
"01" - Labor surplus area set-asides	1	0.00
"08" - Small purchase procedures	1	0.00
"21" - Otherwise authorized by law	3	0.02
"18" - Purchases not publicly disclosed	1	0.00
"12" - Small purchase procedures	2	0.01
"06" - Balance of payments program	1	0.00
- Not defined	1	0.00
Reserved for small business (02, 31 & 23)	559	45.01
Not reserved for small business	683	54.99

Subset 1

Analysis of Competition Code

	Frequency	% of Total
1 - Price competition	1082	87.11
2 - Design or tech. competition	13	1.05
3 - Follow-on after price competition	57	4.59
4 - Follow-on after design or tech. comp.	42	3.38
5 - Other noncompetition	20	1.61
8 - Formal advertised	28	2.25
Follow-on (3 & 4)	70	5.64
Not follow-on	1172	94.36

Subset 1

Analysis of Criticality Designator

	Frequency	% of Total
A - Critical/DX rated contracts	270	21.74
B - Important	78	6.28
C - Normal	894	71.98
Critical (A)	270	21.74
Not critical	972	78.26

Subset 1

Analysis of Price Evaluation

A - Adequate price competition	929	74.80
B - Price comparison	39	3.14
C - Established catalog	2	0.16
E - Value analysis	15	1.21
F - Price comparison	19	1.53
G - Cost analysis	41	3.30
J - Formula price	4	0.32
N - No evaluation (prior 1969)	7	0.56
S - Surplus item	160	12.88
Y - Statistical method	23	1.85
Z - Price not a major factor	3	0.24
Adequate price competition (A)	929	74.80
Other	313	25.20

Subset 1

Analysis of Contracting Priority

	Frequency	% of Total
"R" - Routine requirement	926	74.56
"C" - Preclude degradation	6	0.48
"E" - Short lead time	310	24.96
Urgent (C & E)	316	25.44
Not urgent	926	74.56

Subset 2

Analysis of Advertised Negotiation Authority

	Frequency	% of Total
"32" - Not reserved for small business	1224	42.63
"02" - Small business set-asides	351	12.22
"31" - Reserved for small business	1171	40.82
"16" - Not formal advertised	77	2.68
"19" - Technical equipment	1	0.03
"07" - Public exigency	11	0.38
"50" - Advertised regular	2	0.06
"23" - Joint small business set-asides	7	0.20
"01" - Labor surplus area set-asides	3	0.10
"38" - Experimental, developmental or research	14	0.49
"03" - Disaster area set-aside	2	0.06
"21" - Otherwise authorized by law	2	0.06
"12" - Small purchase procedures	1	0.03
"24" - Other	2	0.06
"14" - Authorized for resale	1	0.03
- Not defiend	1	0.03
Reserved for small business (02, 31 & 23)	1529	53.26
Not reserved for small business	1342	46.74

Subset 2

Analysis of Competition Code

	Frequency	% of Total
1 - Price competition	2655	92.47
2 - Design or tech. competition	31	1.10
3 - Follow-on after price competition	99	3.45
4 - Follow-on after design or tech. comp.	67	2.33
5 - Other noncompetition	17	0.59
8 - Formal advertised	2	0.06
Follow-on (3 & 4)	166	5.78
Not follow-on	2705	94.22

Subset 2

Analysis of Criticality Designator

	Frequency	% of Total
A - Critical/DX rated contracts	338	11.77
B - Important	244	8.49
C - Normal	2289	79.72
Critical (A)	338	11.77
Not critical	2533	88.23

Subset 2

Analysis of Price Evaluation

	Frequency	% of Total
A - Adequate price competition	2575	89.69
B - Price comparison	46	1.60
C - Established catalog	4	0.13
E - Value analysis	3	0.10
F - Price comparison	22	0.76
G - Cost analysis	26	0.91
H - Government catalog	2	0.06
J - Formula price	2	0.06
N - No evaluation (prior 1969)	23	0.80
S - Surplus item	122	4.20
Y - Statistical method	44	1.53
Z - Price not a major factor	2	0.06
Adequate price competition (A)	2575	89.69
Other	296	10.31

Subset 2

Analysis of Contracting Priority

	Frequency	% of Total
"R" - Routine requirement	2469	86.00
"C" - Preclude degradation	2	0.07
"E" - Short lead time	400	13.93
Urgent (C & E)	402	14.00
Not urgent	2469	86.00

Subset 3

Analysis of Advertised Negotiation Authority

	Frequency	% of Total
"32" - Not reserved for small business	115	45.28
"02" - Small business set-asides	34	13.29
"31" - Reserved for small business	93	36.61
"16" - Not formal advertised	9	3.54
"07" - Public exigency	1	0.39
"21" - Otherwise authorized by law	1	0.39
- Not defined	1	0.39
Reserved for small business (02, 31 & 23)	127	50.00
Not reserved for small business	127	50.00

Subset 3

Analysis of Competition Code

	Frequency	% of Total
1 - Price competition	236	92.91
2 - Design or tech. competition	4	1.57
3 - Follow-on after price competition	5	1.97
4 - Follow-on after design or tech. comp.	8	3.15
5 - Other noncompetition	1	0.39
Follow-on (3 & 4)	13	5.12
Not follow-on	141	94.88

Subset 3

Analysis of Criticality Designator

	Frequency	% of Total
A - Critical/DX rated contracts	39	15.35
B - Important	18	7.09
C - Normal	197	77.56
Critical (A)	39	15.35
Not critical	215	84.65

Subset 3

Analysis of Price Evaluation

	Frequency	% of Total
A - Adequate price competition	209	82.28
B - Price comparison	5	1.97
C - Established catalog	1	0.39
E - Value analysis	1	0.39
F - Price comparison	4	1.57
G - Cost analysis	4	1.57
J - Formula price	1	0.39
N - No evaluation (prior 1969)	2	0.79
S - Surplus item	15	5.91
Y - Statistical method	11	4.33
Z - Price not a major factor	1	0.39
Adequate price competition (A)	209	82.28
Other	45	17.72

Subset 3

Analysis of Contracting Priority

	Frequency	% of Total
"R" - Routine requirement	211	83.07
"E" - Short lead time	43	16.93
Urgent (C & E)	43	16.93
Not urgent	211	83.07

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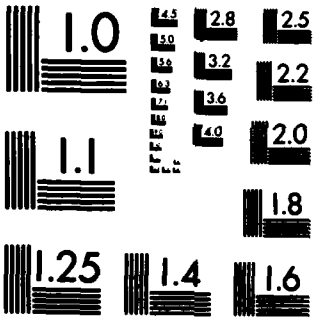
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Aircraft replenishment spare parts procurement has become an increasingly important area of concern. This thesis research project was undertaken as a result of several recent media and internal Air Force reports revealing the excessive costs of spare parts acquisition. The overall research objective was to determine what, if any, relationship exists between a number of selected quantitative and qualitative factors and the prices paid for spare parts. Multiple regression analysis and t-tests about the individual parameter coefficients in a multiple regression model were used to analyze four years worth of spare parts procurement history data from the Oklahoma City Air Logistics Center. Eight research hypotheses were developed to satisfy the research objective. The results of the research hypotheses are presented.

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