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# ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

The Growth of the Navy Contracting Workforce and Its Impact on Levels of Contracting Activity

1 October 2018

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Acquisition Research Program Graduate School of Business & Public Policy Naval Postgraduate School

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## **Executive Summary**

The U.S. Department of the Navy (DoN) 2010 acquisition workforce (AWF) strategic plan noted that, since the 1990s, the value of DoN contracting had increased by more than 50% while the acquisition workforce had declined by almost 50%. In response, as a component of the Department of Defense (DoD), the DoN set an objective to in-source at least 3,500 civilian positions over the Future Years Defense Program period and hire an additional 1,590 civilians using funds from the Defense Acquisition Workforce Development Fund. These actions would lead to an increase of 8% in the civilian acquisition workforce over the subsequent six years. Given this increase in personnel, the following questions have been asked: *What has been the impact of this change in acquisition staffing within the DoN, and how is acquisition different now than with the previous smaller workforce?* Addressing these issues is not straightforward, due to the complex structure of both the acquisition workforce and of the acquisition activities themselves.

For this first phase of our research conducted during Fiscal Year 2018, we performed a series of parametric, nonparametric, and nonlinear regression analyses to attempt to correlate the growth of the size of the Navy contracting workforce with the total dollar value of contracts issued and the number of contracts during the period of 2008 to 2017. We found that an increase in the average dollar value of contracts, as well as a decrease in the number of contracts, was associated with the growth in the contracting workforce. We also found that contract obligations fluctuate over time, but on average the total dollar amount of contracts is increasing. However, the number of contracts issued is decreasing steadily, forcing the increase in average contract size, defined as the average dollar amount.

Interestingly, there is a negative relation between the total number of contracts and workforce size, indicating that some further analysis was required. We determined that 96.86% of the variation in the number of contracts can be determined by the time trend and workforce size. In practical terms, this indicates that for every full-time employee (FTE) added to the workforce, on average there is



an increase of 30.6 contracts after correcting for the reduction in contract size in the time trend (e.g., for every 100 employees added, there will be an increase of 3,064 contracts, or a 1.8% increase in workforce size will increase the number of contracts by 1% on average).

There are 13 career fields in the Navy acquisition workforce, although the auditing field does not currently have any employees. A potentially useful next phase of our work would involve carrying out the same type of analyses on these other career fields as was done for the contracting career field to determine any relationship between changes in the size of the career field's workforce and contracting activity.

Another fruitful avenue of research would be extending our work on the impact of the growth in the acquisition workforce to the area of program management, notably using the multiple databases made available through DAVE (Defense Acquisition Visibility Environment), a relatively recent service that incorporates DAMIR (Defense Acquisition Management Information Retrieval). The field of program management (PM) is much broader than contract management and arguably incorporates most contract management activity. Notably, PM involves participation by all the acquisition career fields and would have multiple measures of outputs and outcomes. Exploring the PM results of the growth in the acquisition workforce since 2008 represents an exciting avenue of future research.

Future work will also include applying a powerful range of statistical and analytical modeling that may provide a reasonable indication of the impact of the AWF growth initiative. These modeling activities might include the following:

- a. Statistical significance comparing before-and-after effects (using twosample dependent T tests and F tests, ANOVA, MANOVA)
- b. Linear and nonlinear correlation matrices with statistical significance
- c. Nonlinear econometric models to identify and determine the critical independent variables that are statistically significant, as well as quantifying their impact and results of the dependent variables and related metrics



- d. Creating new metrics beyond those mentioned previously, by collapsing multiple variables into composite measures that provide a more comprehensive and cohesive indication of the impact of the growth of the acquisition workforce
- e. Monte Carlo simulations to determine the final probability distribution and impact of changed manning levels. These distributions could serve as a benchmark for current and future metrics such as increases in acquisition complexity.

A key element of future work will be separating acquisition programs into levels of complexity; these categorizations could then be used to predict the turnover, schedule risk, and cost risk of new acquisition programs. The resulting models could be of great use to management in assisting with the direction of PM activity.





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Disclaimer: The views represented in this report are those of the authors and do not reflect the official policy position of the Navy, the Department of Defense, or the federal government.





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## Introduction

The U.S. Department of the Navy (DoN) 2010 acquisition workforce (AWF) strategic plan noted that, since the 1990s, the value of DoN contracting had increased by more than 50% while the acquisition workforce had declined by almost 50%. The cuts in workforce reflected the view then held in Congress that the defense acquisition workforce was too large for the acquisition budget and for the size of the uniformed force. Another trend had been the significant growth of contractor support positions, in part due to civil service hiring restrictions.

In response, as a component of the Department of Defense (DoD), the DoN set an objective to in-source at least 3,500 civilian positions over the Future Years Defense Program period and hire an additional 1,590 civilians using funds from the Defense Acquisition Workforce Development Fund. These actions would lead to an increase of 8% in the civilian acquisition workforce over the subsequent six years (DoN, 2010; Schwartz, Francis, & O'Connor, 2016).

Given this increase in personnel, the following questions have been asked: What has been the impact of this change in acquisition staffing within the DoN, and how is acquisition different now than with the previous smaller workforce? Addressing these issues is not straightforward, due to the complex structure of both the acquisition workforce and of the acquisition activities themselves (McKeithen, 2016).





## **Research Context**

Research involving public-sector procurement specialists revealed that these professionals were "skeptical about the possibility that performance measurements can be useful or can increase the quality of decision-making in public procurement" (Diggs & Roman, 2012, as cited in Rendon, 2015). Lewis (2016) expressed some concerns about availability and suitability of data as well as the challenges of relating inputs to outputs in a professional environment.

In a well-cited review of research into organizational performance, March and Sutton (1997) found that the structure and definition of performance were rarely explicitly justified, and that the appropriateness of performance is rarely questioned. Organizational performance is frequently used as a dependent variable, and researchers pay little attention to the complications of using such a formulation to characterize the behavior of organizational phenomena.

Part of the reason for this practice is that organizational research demands and rewards speculations about how to improve performance. March and Sutton (1997) further noted that it isn't clear that organizational purpose can be portrayed as unitary—a factor familiar to students of public administration—and that the multiple purposes of an organization aren't reliably consistent. In addition, March and Sutton suggested that organizational researchers live in two worlds; one demands speculations about how to improve performance, while the other requires adherence to rigorous standards of scholarship. Finally, seeking knowledge "about historically ambiguous phenomena such as organizational performance is more a necessary form of disciplined self-flagellation than a pursuit of happiness" (March & Sutton, 1997, p. 705).

Richard, Devinney, Yip, and Johnson (2009) found a limited effectiveness of commonly accepted measurement practices in tapping the multidimensionality of performance. The authors suggested that addressing these findings required researchers to possess a strong theoretical rationale on the nature of performance and to rely on strong theory as to the nature of measures. Further, Richard et al.



found little progress in the unquestioning assumptions about performance since what they termed March and Sutton's (1997) "call to virtue." Given the above research, it is difficult to contemplate how one would measure the addition of thousands of employees, particularly professionals doing complex work, to the Navy's acquisition workforce. On the input side, one is struck by the difficulties in measuring who worked where at what time, as well as what they did. From the output perspective, the "units of work," such as contracts, financial and other reporting documents, e-mails, meetings, and the like, vary significantly in size and importance.

It would also be necessary to account for differences in work hours caused by such factors as training and leave. Measuring the productivity of military acquisition personnel, who make up approximately 10% of the Navy's acquisition workforce, has its own set of challenges above and beyond those associated with civilian personnel. These include the impact of high turnover, promotions, centralized control over most training and development, and so on.

Part of the challenge of determining the increase in output caused by the change in size of the acquisition workforce is related to data limitations. Schwartz et al. (2016) found significant limitations in the data available to inform acquisition research, particularly with respect to reliability and comprehensiveness. The Federal Procurement Data System (FPDS), which is the central database of U.S. government procurement, contains data with limited "utility, accuracy, and completeness" (Government Accountability Office [GAO], 2012).

A DoD report on the performance of the defense acquisition system noted that defense acquisition "is complex, and each measure has its strengths and weaknesses, so attributing performance to a single measure is subject to the limitations of that measure," and that such data, even when combined with other information, constitute a "crude indicator of the effectiveness of these officials' decision making" (DoD, 2015, p. xv).



Nevertheless, it should be possible to discern some basic indicators that, while not definitive, do provide some indication of the impact of the increase in the workforce. As Gates (2009, p. 27) has suggested,

The AW [acquisition workforce] must be viewed as an input to a process operation, and thought should be given to concrete outcomes that the workforce could be expected to influence. These would not be the high-level outputs of on-time, on-budget systems, but they could include important process-oriented outcomes that reflect top-flight systems engineering practices and could ultimately lead to improvements in the key outcomes of interest. It is also critical to acknowledge that the AW is engaged in a wide range of procurement-related activities and that different types of activities are likely to require separate and distinct outcome measures.

DoN senior management has expressed the need for an improved understanding of measuring AWF productivity. As suggested above, one important caution in considering the impact of the mandated increase in the size of the AWF relates to traceability. Changes in the total number of employees at the DoD or DoN levels may not translate directly at lower levels such as individual offices. There is considerable fluctuation at the office level, due to normal turnover as well as directed changes in personnel billets that may not be related to the mandated increase in AWF size. Gates (2009, p. 4) commented on the challenges of measuring AWF productivity in the face of increasing demand for acquisition personnel:

Key drivers of the increasing demands include the complexity of service contracting, which is a growing share of all government contracting; the fact that the number of transactions is no longer a good measure of workload; and the fact that best-value procurement approaches are substantially more complex than lowest-price contracting approaches.

In addition, the methodology for counting members of the AWF is quite complex, and considerable data collection and analysis is required to count gains, losses, and switches (personnel moving into or out of the AWF to other positions). The extensive work performed by RAND on defining and analyzing the size and composition of the AWF should be used as a starting point for any analysis of the impact of the mandated increase in AWF to provide a common baseline of personnel resources (Gates, Roth, Srinivasan, & Dougherty, 2013; Powell, 2017).



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## **Proposed Approach**

Within this context, it would be possible to take a limited number of variables that are surrogates for activity levels and compare them to AWF headcounts before and after the increase in workforce size. Broadly speaking, activities could be divided into the program and contract management realms, although it is recognized that these two are not mutually exclusive. Within program management, measures such as number, dollar amount, and program categories (ACATs) under management may serve as useful measures. In contract management, the number and total dollar value of contracts, contract processing time, and some measure of contract complexity, if available, would be helpful.

One factor emphasized by Powell (2017) was the change in the composition of the AWF during the period of growth. For example, there were new hires from inside and outside the civil service with limited acquisition experience, as well as retiring military personnel, many of whom had a substantial acquisition background. It would be desirable to attempt some characterization of workforce demographics rather than reducing the Navy AWF to a single number in all analyses. Management may be particularly interested in measures of before-and-after productivity.





## **Data and Methodology**

### **Sources of Information**

The information required to conduct the above analyses can be grouped into two categories: independent and dependent variables. The dependent variables represent the output or outcome measures such as number of contracts issued, total dollars under management, and number of projects by ACAT. We are mindful of the comments by Gates (2009), cited above, that emphasize the need for processoriented measures such as desirable system engineering outcomes, rather than traditional output measures such as the number of contracts under management. We return to this issue later when we discuss dependent variables.

In contrast, independent variables are the inputs that (plausibly) lead to the results characterized by the dependent variables, most notably for our study, workforce size and composition.

Information about AWF size and composition is maintained on the website (http://www.hci.mil) of the Office of Human Capital Initiatives (HCI) within the Office of the Under Secretary of Defense for Acquisition and Sustainment. For example, during our initial research, data on total AWF workforce size as well as numbers by career field (there are 13 in the AWF) are available for Fiscal Year 2008 (FY08) through the first quarter of Fiscal Year 2017 (FY17Q1), as shown in Figure 5.

Other data available from HCI include level of educational attainment or certification under the Defense Acquisition Workforce Improvement Act (DAWIA), years of service, and retirement eligibility. Additionally, workforce information is available by gender and race. Overall, the DoD AWF has increased from 125,879 in FY08 to 161,712 as of FY17Q1, an increase of 28%. Navy AWF personnel as of FY17Q1 numbered 57,268, a 39% increase since FY08.

Dependent variables represent a significant challenge to the researcher in terms of availability, variety, and (perceived) relevance. These are other factors cited by McKernan et al. (2017), is that the contents of the information systems giving



access to these variables are constantly evolving due to factors such as policy and technology. The authors identified four public databases that provided DoD acquisition information: SAM, FSRS, USAspending.gov, and FPDS-NG. We reviewed the offerings of each system, and only the last of these appeared to contain relevant information for our work.

The Federal Procurement Data System–Next Generation (FPDS-NG) may provide some useful data for dependent variables. Established in 2005 and owned by the General Services Administration, this public source of information on contracting activity describes "who is procuring what, when, how, and from whom they are buying, and where the work is being done," including spending with prime contractors; is used by governments, contractors, and the general public; and is considered authoritative (McKernan et al., 2017; Rendon & Snider, 2014). Contract actions are covered since FY04, and FPDS-NG allows the user to generate both standard and customized (ad hoc) reports.

Another potential way of measuring AWF productivity is through financial information such as budget data. There may be a relationship between the number and type of acquisition personnel and expenditures on procurement. From the president's budget, we learn that the requested total DoN procurement funds in FY08 were \$38,718,200,000 for an AWF of 41,078 people, giving a figure of \$942,553 procured per employee. For FY17, a procurement request of \$49,585,801,000 and a Navy AWF of 57,278 result in an average of \$865,704 per employee, which is only a minor decrease (DoD, 2007, 2017).

## Methodology

We determined that an appropriate first approach would be to try to associate the growth in the contracting career field with levels of activity in Navy contracting. Specifically, we would examine the total dollars of contracts issued and number of contracts in FY08 and FY17 and compare these with the size of the contracting workforce using regression analysis.



There are two important limitations in conducting such work. First, the dollar value of a contract is not consistent with the amount of time involved in developing, drafting, circulating, and approving the document. Second, independent of dollar value, there are significant differences in contract length and complexity that also make the individual document a possibly problematic unit of measure for evaluating workload. However, we feel that dollar value and the number of contracts represent reasonable surrogates for total workload for the purposes of this first phase of our work.

We therefore conducted a series of regression analyses to try to correlate the above factors. Details are provided in the appendix. Data on acquisition workforce size (WORKFORCE) were obtained from the Office of Human Capital Initiatives in the Office of the Under Secretary of Defense for Acquisition and Sustainment. The number of contracts issued (CONTRACTS) and the average total dollar value of contracts issued during the fiscal year (AVG CONTRACT SIZE) were extracted from FPDS-NG. The variables CONTRACTS and AVG CONTRACT SIZE were tested as dependent variables against WORKFORCE and TIME.

The three variables were associated for the same given fiscal year, as well as for a time lag of one year to allow the increase in workforce size to take effect. In all, 16 separate regression models were run to determine the importance of the relationship between the variables.





## **Results and Findings**

Our analysis of the data indicated that while the size of the Navy acquisition workforce in the contracting career field increased over the period 2008–2017, the number of contracts issued have been decreasing over time. However, the growth in the contracting workforce tracks with the average contract size in dollars, both of which are increasing over time, as shown in Figure 1.



# Figure 1: Measuring Output Trends in Contract Numbers and Average Contract Size vs. Contracting Workforce, 2008–2017

We also found that contract obligations fluctuate over time, but on average, the total dollar amount of contracts is increasing. However, the *number* of contracts issued is decreasing steadily, forcing the average contract size to increase, as shown in Figure 2.



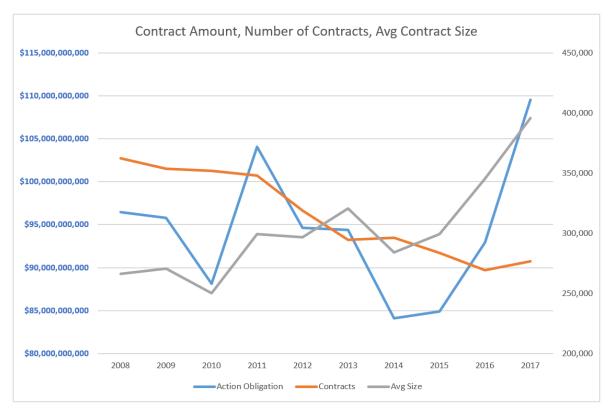


Figure 2: Decreasing Average Contract Size, 2008–2017

Given these trends, we set out to determine the degree of correlation between contracting workforce levels and total contract obligations. Linear and nonlinear correlations were computed, along with the statistical significance (pvalues) of the correlations—note that p-values  $\leq 0.05$  or 0.10 are considered significant. We also calculated correlation coefficients for workforce levels lagged one year, that is, associating the workforce levels in each fiscal year with contracting activity the following fiscal year to allow the impact of a change in workforce level to be felt. The results are shown in Figure 3, with the nonlinear, lagged correlations considered the most significant.



Linear	Nonlinear	p-value	p-value
0.0825	0.2242	0.8207	0.5334
0.2342	0.0182	0.5150	0.9602
-0.6632	-0.7576	0.0366	0.0111
0.7064	0.6727	0.0224	0.0330
Linear	Nonlinear	n value	p-value
			•
0.5572	0.4753	0.1191	0.1960
-0.6004	-0.7167	0.0873	0.0298
0.8263	0.8244	0.0060	0.0063
	0.0825 0.2342 -0.6632 0.7064 Linear 0.5572 -0.6004	0.0825 0.2242 0.2342 0.0182 -0.6632 -0.7576 0.7064 0.6727 Linear 0.6727 0.4753 -0.6004 -0.7167	0.0825         0.2242         0.8207           0.2342         0.0182         0.5150           -0.6632         -0.7576         0.0366           0.7064         0.6727         0.0224           Linear         Nonlinear         p-value           0.5572         0.4753         0.1191           -0.6004         -0.7167         0.0873

#### Figure 3: Linear and Nonlinear Correlation for Contracting Workforce, 2008–2017

Note that the correlations increase significantly (and the *p*-values decrease) due to the introduction of the one-year lag. Interestingly, there is a negative relation (-0.7167) between the total number of contracts and workforce size, indicating that some further analysis is required. As noted previously, there also seems to be a time trend reduction in the number of contracts and corresponding increase in average contract size.

After accounting for the time trend over the 10-year period under review, we found that the number of contracts is highly related to workforce size. The details are shown in Figure 4; 96.86% of the variation in the number of contracts can be determined by the time trend and workforce size, which is found to be statistically significant (p = 0.0259). In practical terms, this indicates that for every full-time employee (FTE) added to the workforce, on average there is an increase of 30.6 contracts after correcting for contract reductions in the time trend (e.g., for every 100 employees added, there will be an increase of 3,064 contracts, or a 1.8% increase in workforce size will increase the number of contracts by 1% on average).



#### **Ranked Models Summary**

CONTRACTS = $\alpha$ C = $\beta_0 + \beta_1 \omega + R^2$ : 96.86%	$x + β_1^*WORKFO$ $β_2 τ$	RCE + $\beta_2$ *TIME	AVG CONTRACT SIZE = $\alpha$ + $\beta$ *(WORKFORCE t-1) $\Sigma$ = $\beta_0$ + $\beta_1$ LN( $\omega_{t-1}$ ) R <sup>2</sup> : 68.28%				
Intercept:	214201		Intercept: -315275				
Coefficient:	30.6369	-14408	Coefficient: 106.7015				
P-value:	0.0259	0.0000	P-value: 0.0060				
$\begin{array}{l} \text{CONTRACTS} = 0 \\ \text{C} = \beta_0 + \beta_1 \text{LN}(\alpha \\ \text{R}^2: \textbf{96.79\%} \\ \text{Intercept:} \\ \text{Coefficient:} \\ \text{P-value:} \end{array}$		-14359 0.0000	AVG CONTRACT SIZE = $\alpha$ + $\beta$ *LN (WORKFORCE t-1) $\sum = \beta_0 + \beta_1 \ln(\omega_{t-1})$ R <sup>2</sup> : 66.48% Intercept: -4969148 Coefficient: 608577 P-value: 0.0074				

#### Figure 4: Ranked Models Summary for Number of Contracts and Workforce Size

As for average contract size, we found that workforce size contributes to the increase in average contract size over time. The average contract size for the past 10 fiscal years is \$306,866; one additional FTE contributes to an increase of \$106 in average contract size, or 100 FTEs contribute to, on average, a 3.5% increase in average contract size, or \$10,670 per contract.



## **Conclusions and Further Research**

Our research efforts up to this point have of necessity been exploratory. As mentioned previously, research in the field of professional productivity warns against attempts to undertake large-scale measurement efforts. However, we have begun to determine some basic trends from before and after the increase in Navy acquisition personnel, including patterns that might indicate the impact of the change in workforce size on organizational performance.

The first phase of our work has examined the relationship between the growth of the Navy contracting workforce and the total dollar amount of contracts, and the number of contracts issued, from 2008 to 2017. We found that an increase in the average dollar value of contracts, as well as a decrease in the number of contracts, was associated with the growth in the contracting workforce. We also found that contract obligations fluctuate over time, but on average the total dollar amount of contracts is increasing. However, the *number* of contracts issued is decreasing steadily, forcing the average contract size to increase.

Interestingly, there is a negative relation (-0.7167) between the total number of contracts and workforce size, indicating that some further analysis is required. We determined that 96.86% of the variation in the number of contracts can be determined by the time trend and workforce size. In practical terms, this indicates that for every full-time employee (FTE) added to the workforce, on average there is an increase of 30.6 contracts after correcting for the reduction in contract size in the time trend (e.g., for every 100 employees added, there will be an increase of 3,064 contracts, or a 1.8% increase in workforce size will increase the number of contracts by 1% on average).

As shown in Figure 5, there are 13 career fields in the Navy acquisition workforce, although the auditing field does not currently have any employees. A potentially useful next phase of our work would involve carrying out the same type of analyses on these other career fields as was done for the contracting career field to



determine any relationship between changes in the size of the career field's workforce and contracting activity.

Another fruitful avenue of research would be extending our work on the impact of the growth in the acquisition workforce to the area of program management (PM), notably using the multiple databases made available through DAVE (Defense Acquisition Visibility Environment), a relatively recent service that incorporates DAMIR (Defense Acquisition Management Information Retrieval). The discipline of PM is much broader than contract management and arguably incorporates most contract management activity. Notably, PM involves participation by all the acquisition career fields and would have multiple measures of outputs and outcomes. Exploring the PM results of the growth in the acquisition workforce represents an exciting avenue of future research.

Future work will also include applying a powerful range of statistical and analytical modeling that may provide a reasonable indication of the impact of the AWF growth initiative as related to the other career fields and PM outputs and outcomes. These modeling activities might include the following (Mun, 2015):

- a. Statistical significance comparing before-and-after effects (using two-sample dependent T tests and F tests, ANOVA, MANOVA)
- b. Linear and nonlinear correlation matrices with statistical significance
- c. Nonlinear econometric models to identify and determine the critical independent variables that are statistically significant, as well as quantifying their impact and results of the dependent variables and related metrics
- d. Creating new metrics beyond those mentioned in the previous section by collapsing multiples variables into composite measures that provide a more comprehensive and cohesive indication of the impact of the growth of the acquisition workforce
- e. Monte Carlo simulations to determine the final probability distribution and impact of changed manning levels. These distributions could serve as a benchmark for current and future metrics such as increases in acquisition complexity.

A key element of future work will be separating acquisition programs into levels of complexity; these categorizations could then be used to predict the turnover, schedule risk, and cost risk of new acquisition programs. The resulting



models could be of great use to management in assisting with direction of PM activity.

Career Field	FY 2008	Dec 31, 2016	Change (%)
Auditing	0	0	0%
Business	1792	2405	34%
Contracting	4866	5859	20%
Engineering	16353	21652	32%
Facilities Engineering	3902	5481	40%
Information Technology	800	2868	259%
Life Cycle Logistics	4104	5981	46%
Production, Quality & Manufacturing	1980	3240	64%
Program Management	3485	5514	58%
Property Management	58	64	10%
Purchasing	478	417	-13%
Science & Technology Manager	190	559	194%
Test & Evaluation	2360	3227	37%
Unknown/Other	710	1	-100%
Total	41078	57268	39

### Figure 5: Department of the Navy Acquisition Workforce by Career Field

(Source: Office of the Under Secretary of Defense [Acquisition and Sustainment], Office of Human Capital Initiatives, January 2018)





## Appendix

### **Ranked Models Summary**

 CONTRACTS =  $\alpha + \beta_1$ \*WORKFORCE +  $\beta_2$ \*TIME

  $C = \beta_0 + \beta_1 \omega + \beta_2 \tau$ 
 $R^2$ :
 96.86%

 Intercept:
 214201

 Coefficient:
 30.6369
 -14408

 P-value:
 0.0259
 0.0000

$$\begin{split} & \text{CONTRACTS} = \alpha + \beta_1 * \text{LN}(\text{WORKFORCE}) + \beta_2 * \text{TIME} \\ & \text{C} = \beta_0 + \beta_1 \, \text{LN}(\omega) + \beta_2 \, \tau \\ & \text{R}^2: \qquad \textbf{96.79\%} \\ & \text{Intercept:} & -1139463 \\ & \text{Coefficient:} & 176726 & -14359 \\ & \text{P-value:} & \textbf{0.0281} & \textbf{0.0000} \end{split}$$

CONTRACTS =  $\alpha + \beta_1$ \*WORKFORCE<sub>t-1</sub> +  $\beta_2$ \*TIME C =  $\beta_0 + \beta_1 \omega_{t-1} + \beta_2 \tau$ R<sup>2</sup>: 93.91% Coefficient: 21.0977 -13661 P-value: 0.2054 0.0003

$$\begin{split} & \text{CONTRACTS} = \alpha + \beta_1 * \text{LN}(\text{WORKFORCE}_{t-1}) + \beta_2 * \text{TIME} \\ & \text{C} = \beta_0 + \beta_1 \text{LN}(\omega_{t-1}) + \beta_2 \tau \\ & \text{R}^2: \qquad 93.79\% \\ & \text{Coefficient:} \qquad 118419 \qquad -13608 \\ & \text{P-value:} \qquad 0.2216 \qquad 0.0003 \end{split}$$



CONTRACTS =  $\alpha + \beta$ \*WORKFORCE t-1

$C = \beta_0 + \beta_1 \omega_{t-1}$	
R <sup>2</sup> :	36.05%
Coefficient:	-60.6375
P-value:	0.0873

 $CONTRACTS = \alpha + \beta*LN(WORKFORCE_{t-1})$   $C = \beta_0 + \beta_1 LN(\omega_{t-1})$   $R^2: 36.51\%$  Coefficient: -352743 P-value: 0.0848

AVG CONTRACT SIZE =  $\alpha + \beta^*$ (WORKFORCE t-1)  $\sum_{t=0}^{\infty} = \beta_0 + \beta_1 LN(\omega_{t-1})$ R<sup>2</sup>.

<b>IX</b> .	00.2070
Intercept:	-315275
Coefficient:	106.7015
P-value:	0.0060

AVG CONTRACT SIZE =  $\alpha + \beta * LN$  (WORKFORCE t-1) $\sum = \beta_0 + \beta_1 \ln(\omega_{t-1})$  $R^2$ :66.48%Intercept:-4969148Coefficient:608577P-value:0.0074

### AVG CONTRACT SIZE = $\alpha + \beta$ \*WORKFORCE $\sum = \beta_0 + \beta_1 \omega$ R<sup>2</sup>: 49.90% Coefficient: 81.4716 P-value: 0.0224



AVG CONTRACT SIZE =  $\alpha + \beta * LN(WORKFORCE)$  $\sum = \beta_0 + \beta_1 LN(\omega)$  $\mathbf{R}^2$ : 48.12% Coefficient: 467967 P-value: 0.0261 AVG CONTRACT SIZE =  $\alpha + \beta_1 * WORKFORCE_{t-1} + \beta_2 * TIME$  $\sum = \beta_0 + \beta_1 \; \omega_{t\text{--}1} + \beta_2 \; \tau$  $R^2$ : 78.31% Coefficient: 63.1889 7272 P-value: 0.1284 0.1468 AVG CONTRACT SIZE =  $\alpha + \beta_1 * LN(WORKFORCE_{t-1}) + \beta_2 * TIME$  $\sum = \beta_0 + \beta_1 \operatorname{LN}(\omega_{t\text{-}1}) + \beta_2 \tau$  $\mathbf{R}^2$ : 77.23% Coefficient: 3475647539 P-value: 0.1523 0.1433 AVG CONTRACT SIZE =  $\alpha + \beta_1 * WORKFORCE + \beta_2 * TIME$  $\sum = \beta_0 + \beta_1 \, \omega + \beta_2 \, \tau$  $R^2$ : 68.39% Coefficient: 14.6540 10150 P-value: 0.7320 0.0827 AVG CONTRACT SIZE =  $\alpha + \beta_1 * LN(WORKFORCE) + \beta_2 * TIME$  $\sum = \beta_0 + \beta_1 \operatorname{LN}(\omega) + \beta_2 \tau$  $R^2$ : 68.14% Coefficient: 64004 10516 P-value: 0.7977 0.0741



## $CONTRACTS = \alpha + \beta^*(WORKFORCE)$

VAR		VAR2	VAR		R Basic Econometr	ics					_		×	н.	
Contra		/orkforce	Avg Si		subside contributied									k	
362,2		5,245	\$266,21			ol is used to run basic econometric models by first transforming the input variables before the multivariate regression analysis. You can enter in multiple econometric model									
353,6		5,516	\$270,72		running the multivaria specifications to test.	te re	gression analysi	is. `	You can enter in	multiple econom	etric mod	lel via the			
351,8		6,001	\$250,347		dependent variable fol								ons.		
347,8		6,041	\$299,10		In the following examp	ole, L	N(VAR1) and VA	AR3	are dependent	variables in two r					
318,8		5,771	\$296,707			items are independent variables in the two econometric models: R1); LN(VAR2); VAR3+VAR4; TIME									
294,3		5,716	\$320,602			LAG(VAR2,3); DIFF(VAR1); RESIDUAL(VAR3,VAR4)									
296,1		5,725	\$284,034												
283,7		6,114	\$299,133		VAR1	VAF	R2	V/	AR3				^		
269,2		6,347	\$345,183		362221	524	15	26	6211.14230068	9					
276,5	000	6,443	\$395,958	3.22	353698	551	.6	27	0721.62722237	6					
000 0		5.045	0050.045		351869	600	1	L R	<b>D</b>	D 11				_	×
269,2		5,245	\$250,347		347871	604	11	1 4	Reconometrie	cs Results			_		~
362,2	21	6,443	\$395,958	5.22	318874	577	/1								
					294389	571	.6		R-Squared (Co	efficient of Detern	nination):				0.4399
FY15	FY16	FY17	% Change		296188	572	25		Adjusted R-Squ	iared:					0.3698
			Since FY08	Since	<ul> <li>Single Model</li> </ul>					tiple Correlation (		nt):			0.6632
21,181	21,977	22,638	37%	3%	Single Model				Standard Error	of the Estimates (	(SEy):			2838	3.8181
6.114		6,443	23%		Dependent Variable:		Independent Va		ANOVA F Statis ANOVA p-Value						6.2820 0.0366
0,114	0,347	0,445	2370	2%	VAR1		(VAR2)		ANOVA p-Value	o.					
6, 160	6,556	6,531	50%	0%	e.g., LN(VAR1) Functions:				0 10 1	Intercept	(VAR2)				
6,335	6,362	6,213	52%	-29	+,-,*,/,LN,LOG,LAG		e.g., LOG(VAR2+VAR (VAR1,VAR3); TIME;		Coefficients Standard Error	693792.7441 151211.5347	-64.21 25.619	1			
2,810	3,249	3,370	68%	4%	O Multiple Models				t-Statistic p-Value	4.5882 0.0018	-2.5064				
3,328	3,372	3,356	36%	0%				10							
2,000	2,021	2,149	11%	6%					Dependent Varia	able:		Сор		Cl	ose
5,261	5,490	5,571	43%	1%				L '	VAR1			COP	y .	Ch	0.00
5,201								_							
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max	_		Adjusted R-Squa					
-	-	-			INTEGER2: Min		Max Max	_	Shift D		Down	Tim			
495	476	457	-16%	-49	INTEGERS: MIN		Max		Shift D		Down	Tim	es	-	
570	588	570		-39						OK		Canc	el		
														Sec. 1	



## CONTRACTS = $\alpha + \beta^*$ (WORKFORCE t-1)

VAR1	VAR2	VAR3
Contracts Lag 1	Workforce	Avg Size Lag 1
353,698	5,245	\$270,721.63
351,869	5,516	\$250,347.99
347,871	6,001	\$299,101.83
318,874	6,041	\$296,707.02
294,389	5,771	\$320,602.46
296,188	5,716	\$284,034.29
283,740	5,725	\$299,133.74
269,250	6,114	\$345,183.80
276,566	6,347	\$395,958.22

🕅 Basic Econo	ometrics		- 🗆	×	
running the mult specifications to dependent varia In the following remaining items LN(VAR1); LN	ivariate regression an o test. Each model is o ble followed by at leas example, LN(VAR1) ar are independent varia I(VAR2); VAR3+VAR4;	etric models by first transforming the inpu alysis. You can enter in multiple econom n a new line and within each line, the firs it one or more independent variables sep nd VAR3 are dependent variables in two r bles in the two econometric models: TIME RESIDUAL(VAR3,VAR4)	etric model t variable is the arated by semicolo		
VAR1	VAR2	VAR3		^	
353698	5245	270721.627222376			
351869	5516	250347.992991284			
347871	6001	299101.830947046			
318874	6041	296707.020709246			
294389	5771	320602.463739916			
296188	5716	284034.285885789			
283740	5725	299133.738324593		~	
i )	4	R Econometrics Results	_		
Dependent Var	iable: Independe				
VAR1	VAR2	R-Squared (Coefficient of Determin	ation):		0.3
e.g., LN(VAR1)		Adjusted R-Squared: Multiple R (Multiple Correlation Co	off signt).		0.2
Functions:	e.g., LOG(VAR	2+1		287	96.6

ange FY16
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	010071	0011	2000000020000	210				
	294389	5771	320602.463739	9916				
	296188	5716	284034.285885	5789				
	283740	5725	299133.738324	1593			v	
Correlation Coeffi Contract Amount to			R Econometr	ics Results		_		×
Contract Amount to Number of Contract	Dependent Variable:	Independent						
Workforce to Avera	14004	VAR2		pefficient of Deter	mination):			0.3605
WORKINCE TO AVEIA	e.g., LN(VAR1)		Adjusted R-Sq					0.2692
Correlation Coeffi	Functions:	e.g., LOG(VAR2+)		Itiple Correlation			20	796.6810
Contract Amount to	1 +-*/INLOGIAG	(VAR1,VAR3); TI		of the Estimates	(SEy):		20	3.9464
Number of Contract			ANOVA F Stat					0.0873
Workforce to Avera			ANOVA p-Valu	ie:				0.0075
	]			Intercept	VAR2			
			Coefficients	663828.5884	-60.6375			
			Standard Error	178233.7882	30.5240			
			t-Statistic p-Value	3.7245 0.0074	-1.9866 0.0873			
6,600	INTEGER1: Min	Max	p-value	0.0074	0.0075			
6,400	INTEGER2: Min	Max	Dependent Vari	able:				
•	INTEGER3: Min	Max	VAR1			Сору	(	Close
6,200							_	
6,000	-			C	K	Cancel		280,000



### **CONTRACTS** = $\alpha + \beta_1$ \*WORKFORCE + $\beta_2$ \*TIME

VAR	1	VAR2	VAR3	3	R Basic Economet										×		
Contra		/orkforce	Avg Siz	ze	Basic Economet	rics							_			k	
362,22		5,245	\$266,211	1.14	This tool is used to ru	un ba	sic econor	metric	mo	dels by first tran	nsfo	rmina the input	variable	es before			
353,69		5,516	\$270,721		running the multivaria	ate re	gression a	analysi	s.'	You can enter in	mui	Itiple econome	tric mod	lel			
351,86		6,001	\$250,347		specifications to test. dependent variable for										one		
347,87		6,041	\$299,101		In the following exam	ple, L	N(VAR1)	and VA	R3	are dependent	vari	iables in two m			ona.		
318,87		5,771	\$296,707		remaining items are i					the two econome	etric	c models:					
294,38		5,716	\$320,602		LN(VAR1); LN(VAP VAR3; LAG(VAR2,						3						
296,18		5,725	\$284,034			-/					·						
283,74		6,114	\$299,133		VAR1	VAF	R2		V	AR3					^		
269,25		6,347	\$345,183		362221	524	5		26	6211.142300689	9						
276,56	66	6,443	\$395,958	3.22	353698	551	.6		27	0721.62722237	6						
					351869	600	1		25	0347.992991284	4						
269,25		5,245	\$250,347		347871	604	1		29	9101.83094704	6						
362,22	21	6,443	\$395,958	3.22	318874	577	'1		F			2 11			_	-	×
					294389	571	.6		Ľ	R Econometri	ICS H	Results			-		~
FY15	FY16	FY17	% Change		296188	572	5										
			Since FY08	Since						R-Squared (Co	effi	cient of Determ	ination)	:			0.9686
21,181	21,977	22,638	37%	3%	Single Model					Adjusted R-Squ							0.9596
21,101	21,977	22,000	3/70	37	Dependent Variable:		Independ	dent Va		Multiple R (Mul				nt):			0.9842
6,114	6,347	6,443	23%	2%	VAR1		VAR2: T	IME	H	Standard Error			SEy):				85.0172
6 460	6.556	6,531	50%	0%		_	VADZ, I			ANOVA F Statis		c				1	07.9408
6, 160	6,556	6,531	50%	0%	e.g., LN(VAR1) Functions:		e.g., LOG(V/			ANOVA p-Value	e:						0.0000
6,335	6,362	6,213	52%	-29	+,-,*,/,LN,LOG,LAG		(VAR1,VAR3	3); TIME; P	Г		In	tercept	VAR2		TIM	F	
2.04.0		0.070	6.004		-				H	Coefficients		14201.2287	30.63			08.0830	
2,810	3,249	3,370	68%	4%	<ul> <li>Multiple Models</li> </ul>					Standard Error		8454.4025	10.88			7.2357	
3,328	3,372	3,356	36%	0%				_		t-Statistic		.6644	2.815		-10.8		
										p-Value	0.	.0080	0.025	9	0.00	00	
2,000	2,021	2,149	11%	6%					Ľ								
5,261	5,490	5,571	43%	1%						Dependent Varia	able	e:					_
		-			WITCOSD4 M			_		VAR1				Co	ру	C	ose
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max		Ļ							_	
-	-	-			INTEGER2: Min		Max			Shift Da	ata	Rows I	Jp	Tin	nes	-	
					INTEGER3: Min		Max			Shift Da	ata	Rows [	Down	Tin	nes		
495	476	457	-16%	-49													
570	588	570		-39								ОК		Can	-el		
5.0		5.5										UK		Call	101	· ·····	_
			4.0444	-					-								1944 - L



## $\text{CONTRACTS} = \alpha + \beta_1 * \text{WORKFORCE}_{t-1} + \beta_2 * \text{TIME}$

VAR1 Contracts Lag 1	VAR2 Workforce	VAR Avg Size	-	🔞 Basic Econome	etrics				_		$\times$
353,698 351,869 347,871 318,874 294,389 296,188 283,740	5,245 5,516 6,001 6,041 5,771 5,716 5,725	\$270,72 \$250,34 \$299,10 \$296,70 \$320,60 \$284,03 \$299,13	1.63 7.99 1.83 7.02 2.46 4.29	This tool is used to running the multivar specifications to tes dependent variable In the following exa remaining items are LN(VAR1); LN(V/ VAR3; LAG(VAR)	riate reg st. Each followed mple, LN e indeper AR2): V/	ression analysis. model is on a new d by at least one of N(VAR1) and VAR ndent variables in AR3+VAR4: TIME	You can enter in r v line and within ex r more independen 3 are dependent v the two econome	nultiple econom ach line, the firs nt variables sep ariables in two r	etric mod t variable arated by	el is the semicolo	
269,250	6,114	\$345,18	3.80	VAR1	VAR	2 V	'AR3				^
276,566	6,347	\$395,95	8.22	353698	5245	; 2	70721.627222376				
				351869	5516	; 2	50347.992991284				
				347871	6001	. 2	99101.830947046				
				318874	6041	. 2	96707.020709246				
				294389	5771	L 3	20602.463739916				
_				296188	5716	i 2	84034.285885789				
nge				283740	5725	5 2	99133.738324593				~
Y 16		Correlation									
		Contract Ar		Single Model							
·		Contract Ar Number of		Dependent Variabl	e:	Independent Vari	ables:				
		Workforce t	to Avera	VAR1		VAR2; TIME					
5		Correlation		e.g., LN(VAR1) Functions: +,-,*,/,LN,LOG,LAC	3	R Economet	rics Results		_		×
		Number of Workforce		O Multiple Models		Adjusted R-Se	oefficient of Deten quared: ultiple Correlation				0.9391 0.9188 0.9691
-						Standard Erro ANOVA F Sta ANOVA p-Val		(SEy):		4	8.7029 6.2607 0.0002
		6,600	_	INTEGER1: Min			Internet	VAR2	TH		
				INTEGER2: Min		Coefficients	Intercept 255564.3849	21.0977	TIM	61.3066	
		6,400	•			Standard Error	80334.5129	14.8566		9.4445	
		6,200		INTEGER3: Min		t-Statistic	3.1813	1.4201	-7.5		
		0,200				p-Value	0.0190	0.2054	0.00	03	
5		6,000									
			l		_	Dependent Var	iable:				
·		5,800				VAR1	Iddig.	C	Сору	Clo	se
		5 600		•							



## CONTRACTS = $\alpha$ + $\beta$ \*LN(WORKFORCE)

VAR1	1	VAR2	VAR3												
Contra	cts V	/orkforce	Avg Siz	ze	🖪 Basic Econometri	CS					_		$\times$	k	
362,22	21	5,245	\$266,211	.14	This tool is used to run	hae	sic econometric		odale by first tra	neforming the inpu	ut variabl	ee hefore			
353,69	98	5,516	\$270,721	.63	running the multivariat	e reg	gression analys	sis	. You can enter in	n multiple econom	etric mod	lel	·		
351,86	59	6,001	\$250,347	.99	specifications to test. dependent variable foll										
347,87	71	6,041	\$299,101	.83	In the following examp								ons.		
318,87	74	5,771	\$296,707	.02	remaining items are in	depe	endent variables	s i	n the two econon						
294,38	89	5,716	\$320,602		LN(VAR1); LN(VAR2 VAR3; LAG(VAR2,3)					0					
296,18		5,725	\$284,034		VAINS, EAG(VAINE,S)	. 01				•/					
283,74		6,114	\$299,133		VAR1	VAR	2		VAR3				^		
269,25		6,347	\$345,183		362221	524	5		266211.14230068	39					
276,56	56	6,443	\$395,958	.22	353698	551	6		270721.6272223	76					
					351869	600	1		250347.99299128	34					
269,25		5,245	\$250,347		347871	604	1		299101.83094704	46					
362,22	21	6,443	\$395,958	.22	318874	577	1	Г	R Econometri	cc Poculto			_		Х
				-	294389	571	6		ry Econometri	CS RESULTS					^
FY15	FY16	FY17	% Change		296188	572	5	L							
			Since FY08	Since				L		efficient of Determ	ination):				0.4382
21,181	21,977	22,638	37%	3%	Single Model			L	Adjusted R-Squ						0.3680
21,101	21,5//	22,038	3770	37	Dependent Variable:		Independent V	6		tiple Correlation (		t):		2042	0.6620
6,114	6,347	6,443	23%	2%	VAR1		LN(VAR2)	Ł		of the Estimates (	SEy):			2042	6.2394
6,160	6,556	6,531	50%	0%	e.g., LN(VAR1)	_	LIN(VAINZ)	L	ANOVA F Stati						0.0371
0,100	0,550	0,001	30%	07	E.g., LN(VART)		e.g., LOG(VAR2+VA		ANOVA p-Valu	e:					0.0371
6,335	6,362	6,213	52%	-29	+,-,*,/,LN,LOG,LAG		(VAR1,VAR3); TIME			Intercept	LN(VAF	R2)			
2.040	2 240	3,370	68%	4%	<u> </u>			L	Coefficients	3569207.5944	-37487				
2,810	3,249	5,570	00%	47	<ul> <li>Multiple Models</li> </ul>			L	Standard Error	1302629.1987	150076				
3,328	3,372	3,356	36%	0%				L	t-Statistic	2.7400 0.0254	-2.4979	)			
2,000	2,021	2,149	11%	6%				L	p-Value	0.0254	0.0371				
2,000	2,021	2,149	1170	07				L							
5,261	5,490	5,571	43%	1%					Dependent Varia	able:		Сор		CL	ose
2.765	2.044	3,135	247%	3%	INTEGER1: Min		Max	Ł	VAR1			Cop	У	Cit	036
2,765	3,044	3,133	24/70	37				-							
-	-	-			INTEGER2: Min		Max		Shift D		UP	Tin	les	-	
495	476	457	-16%	-49	INTEGER3: Min		Max		Shift E	Data Rows	Down	Tim	nes		
490	470	437	-1076	-47											
570	588	570		-39						OK		Cano	el		
														Sec. 1	



### CONTRACTS = $\alpha + \beta * LN(WORKFORCE_{t-1})$

VAR1	VAR2	VAR3	R Basic Economet	trics		_		×
Contracts Lag 1	Workforce	Avg Size Lag 1	N Dasie Leonomen	uics				$\sim$
353,698	5,245	\$270,721.63	This tool is used to r	un basic econometrio	models by first transf	forming the input variable	s before	
351,869	5,516	\$250,347.99	running the multivari	ate regression analys	sis. You can enter in m	ultiple econometric mode	el	
347,871	6,001	\$299,101.83				ch line, the first variable t variables separated by		
318,874	6,041	\$296,707.02				ariables in two models an		3.
294,389	5,771	\$320,602.46			s in the two economet	ric models:		
296,188	5,716	\$284,034.29		R2); VAR3+VAR4; TII 3): DIFE(VAR1): RE9	ME SIDUAL(VAR3,VAR4)			
283,740	5,725	\$299,133.74		,oj, bii i (vaiti), iie.	0100AE(1A110,1A114)			
269,250	6,114	\$345,183.80	VAR1	VAR2	VAR3			~
276,566	6,347	\$395,958.22	353698	5245	270721.627222376			
			351869	5516	250347.992991284			
			347871	6001	299101.830947046			
			318874	6041	296707.020709246			
			294389	5771	320602.463739916			
_			296188	5716	284034.285885789			

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	234303	3//	1	320002.403739910			
	296188	571	6	284034.285885789			
	283740	572	5	299133.738324593			~
Correlation Coeff	Conte Model						
oonnaor / anoant re	Single Model						
Contract Amount to Number of Contract	Dependent Variable:		Independent Var	riables:			
Workforce to Avera	VAR1		LN(VAR2)				_
Correlation Coeff	e.g., LN(VAR1) Functions: +,-,*,/,LN,LOG,LAG		R Econome	trics Results	-		×
Number of Contract Workforce to Avera	O Multiple Models		Adjusted R-S Multiple R (N	Aultiple Correlation C	Coefficient):	200	0.3651 0.2744 0.6042 93.3459
			ANOVA E St	or of the Estimates (	SEy):	200	4.0254
							0.0848
			ANOVA p-Va	alue:			0.0040
6,600	INTEGER1: Min			Intercept	LN(VAR2)		
6.400	INTEGER2: Min		Coefficients	3368353.6067	-352743.7161		
•	INTEGER3: Min		Standard Error		175815.0431		
6,200			t-Statistic p-Value	2.2099 0.0628	-2.0063 0.0848		
			p value	0.0020	0.0040		
6,000			-				
5,800	••		Dependent Va VAR1	ariable:	Сору	С	lose
			-			1	



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## **CONTRACTS** = $\alpha$ + $\beta_1$ \*LN(WORKFORCE) + $\beta_2$ \*TIME

VAR	1	VAR2	VAR	3									1	
Contra	icts V	/orkforce	Avg Si	ze	R Basic Econometr	ICS						$\times$	k	
362,22	21	5,245	\$266,21	1.14	This tool is used to ru	in bas	ic econometric n	odels by first tran	sforming the input	variable	s before			
353,69	98	5,516	\$270,72	1.63	running the multivaria	ite reg	pression analysis	. You can enter in	multiple economet	ric mod	el			
351,86		6,001	\$250,34		specifications to test. dependent variable fo							ne		
347,87	71	6,041	\$299,10	1.83	In the following exam							115.		
318,87	74	5,771	\$296,70		remaining items are i				tric models:					
294,38		5,716	\$320,60		LN(VAR1); LN(VAR VAR3; LAG(VAR2.3									
296,18		5,725	\$284,03				. (	,,,,						
283,74		6,114	\$299,13		VAR1	VAR	2	VAR3				^		
269,25		6,347	\$345,18		362221	524	5	266211.142300689						
276,56	66	6,443	\$395,95	8.22	353698	551	6	270721.627222376	i					
					351869	600	1	250347.992991284	ł					
269,25		5,245	\$250,34		347871	604	1	299101.830947046						
362,22	21	6,443	\$395,95	8.22	318874	577	1	296707.020709246	i i					
					294389	571	6	320602.463739916	i					
FY15	FY16	FY17	% Change Since FY08	% Cha	296188	572	5	284034.285885789				U		
21.181	21,977	22,638	37%	3%	Single Model			R Econometri	ics Results			-		×
21,101	21,377	22,000	3170	3/	Dependent Variable:		Independent Var	R-Squared (Co	efficient of Determ	nination)	).			0.9679
6,114	6,347	6,443	23%	2%	VAR1		LN(VAR2): TIME			manon	,.			0.9587
6,160	6,556	6,531	50%	0%	e.g., LN(VAR1)		211(17112), 11112		Itiple Correlation (	Coefficie	ent):			0.9838
0,100	0,550	0,001			Functions:		e.g., LOG(VAR2+VAR3		of the Estimates (				726	2.0061
6,335	6,362	6,213	52%	-29	+,-,*,/,LN,LOG,LAG		(VAR1,VAR3); TIME; F	ANOVA F Stati	istic:				10	5.5904
2,810	3,249	3,370	68%	4%	O Multiple Models			ANOVA p-Valu	ie:					0.0000
3,328	3,372	3,356	36%	0%					Intercept	LN(V/	AR2)	TIM	E	
2,000	2,021	2,149	11%	6%				Coefficients Standard Error	-1139463.6308 550068.1734	64050	26.6432	1335	59.5195 5.6776	
5,261	5,490	5,571	43%	1%				t-Statistic p-Value	-2.0715 0.0770	2.759 0.028		-10.7	7507 00	
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max							
-	-	_			INTEGER2: Min		Max	Dependent Vari	able:		Cop	DV/	Cle	ose
			4.000		INTEGER3: Min		Max	VAR1			CO	27	CIU	~~
495	476	457	-16%	-49										
570	588	570		-39					ОК		Cance	el		_
													and the second	



### CONTRACTS = $\alpha + \beta_1 * LN(WORKFORCE_{t-1}) + \beta_2 TIME$

Workforce to Avera

6,600

6,400

6,200

6,000

5,800

5,600

•

MADA	MADO	14.02							
VAR1	VAR2	VAR3	R Basic Econometr	rics					$\times$
Contracts Lag 1	Workforce	Avg Size Lag 1	_						
353,698	5,245	\$270,721.63	This tool is used to ru						fore
351,869	5,516	\$250,347.99	running the multivaria						
347,871	6,001	\$299,101.83	specifications to test. dependent variable for						
318,874	6,041	\$296,707.02	In the following examp						
294,389	5,771	\$320,602.46	remaining items are in				c models:		
296,188	5,716	\$284,034.29	LN(VAR1); LN(VAR VAR3; LAG(VAR2,3						
283,740	5,725	\$299,133.74	VANJ, LAG(VANZ,J	J, Dii	I (VAILI), ILES	DOAL(VAI (J, VAI (4)			
269,250	6,114	\$345,183.80	VAR1	VAR2	2	VAR3			^
276,566	6,347	\$395,958.22	353698	5245		270721.627222376			
			351869	5516		250347.992991284			
			347871	6001		299101.830947046			
			318874	6041		296707.020709246			
			294389	5771		320602,463739916			
			296188	5716		284034.285885789			
			283740	5725		299133.738324593			
ange FY16		Correlation Coeff	203740	5725	1	299155./50524595			¥
		Contract Amount to	Single Model						
6		Contract Amount to	Dependent Variable:		Independent Va	ariables:			
6		Number of Contract Workforce to Avera	VAR1		LN(VAR2); TIM	E		]	
6			e.g., LN(VAR1)						
*		Correlation Coeff	Functions: +,-,*,/,LN,LOG,LAG		📧 Econome	etrics Results	_		×
		Contract Amount to	111111111111111111111111111111111111111						
6		Number of Contract	O Multiple Models		R-Squared (	Coefficient of Determi	nation):		0.9379
		Workforce to Avera			1 (				

INTEGER1: Min

INTEGER2: Min

INTEGER3: Min

...

Multiple R (Multiple Correlation Coefficient):

Intercept

0.4183

-648315.8102 746191.5043 -0.8688

LN(VAR2)

0.2216

118419.9668 86837.6097 1.3637

Standard Error of the Estimates (SEy):

Adjusted R-Squared:

ANOVA F Statistic:

ANOVA p-Value:

Coefficients

t-Statistic p-Value

VAR1

Standard Error

Dependent Variable:

(

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PRAESTANTIA PERSCIENTIAM	Naval

0.9172

0.9684

9694.0951

Close

TIME

0.0003

Сору

-13608.8905 1829.6053 -7.4382

45.2960

0.0002

## AVG CONTRACT SIZE = $\alpha$ + $\beta$ \*(WORKFORCE)

VAR	1	VAR2	VAR	3											
Contra	cts W	/orkforce	Avg Si	ze	R Basic Economet	rics							$\times$	k	
362,22	21	5,245	\$266,21	1.14	This tool is used to ru	ın ba	sic econometric	m	odels by first trans	forming the input	t variable	s befor	e		
353,69	98	5,516	\$270,72	1.63	running the multivaria	ate re	gression analys	is.	You can enter in	multiple econome	tric mod	el	-		
351,86	59	6,001	\$250,34	7.99	specifications to test. dependent variable for								lone		
347,87	71	6,041	\$299,10	1.83	In the following exam								ions.		
318,87		5,771	\$296,70		remaining items are i				the two econome	tric models:					
294,38		5,716	\$320,60		LN(VAR1); LN(VAP VAR3; LAG(VAR2,				UAL (VAR3 VAR4)						
296,18		5,725	\$284,03												
283,74		6,114	\$299,13		VAR1	VA	R2	۷	AR3				^		
269,25		6,347	\$345,18		362221	524	15	2	66211.142300689						
276,56	56	6,443	\$395,95	8.22	353698	551	.6	2	70721.627222376						
					351869	600	)1	2	50347.992991284						
269,25		5,245	\$250,34		347871	604	1	Г	R Econometrie	e Posulte			_		Х
362,22	21	6,443	\$395,95	8.22	318874	577	71		r econometric	is Nesults					^
					294389	571	.6								0.4000
FY15	FY16	FY17	% Change Since FY08	% Cha	296188	572	25			efficient of Detern	nination):				0.4990
			Since Frue	Since	<ul> <li>Single Model</li> </ul>				Adjusted R-Squ						0.4364
21,181	21,977	22,638	37%	3%	<ul> <li>Single Model</li> </ul>					iple Correlation (		nt):		210	0.7064
21,101	21,577	22,000	3770	37	Dependent Variable:		Independent Va	a	ANOVA E Statis	of the Estimates (	SEy):			313/	7.9687
6,114	6,347	6,443	23%	2%	VAR3		(VAR2)								0.0224
6,160	6,556	6,531	50%	0%	e.g., LN(VAR1)	_	(*/ (12)	L	ANOVA p-Value	E					0.0224
0,100	0,000	0,331	3070		Functions:		e.g., LOG(VAR2+VAR	R		Intercept	(VAR2	)			
6,335	6,362	6,213	52%	-29	+,-,*,/,LN,LOG,LAG		(VAR1,VAR3); TIME;	1	Coefficients	-177222.1175	81.471	6			
2,810	3,249	3,370	68%	4%	0 M K 1 M 11				Standard Error	170347.0763	28.861				
2,010	3,245	3,370	0070	47	<ul> <li>Multiple Models</li> </ul>				t-Statistic p-Value	-1.0404 0.3286	2.8229				
3,328	3,372	3,356	36%	0%					p-value	0.3200	0.0224	•			
2,000	2,021	2,149	11%	6%					L						
2,000	2,021	2,145	11/0	0/					Dependent Varia	ble:		C	DDV	CL	ose
5,261	5,490	5,571	43%	1%				-	VAR3				γPy		030
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max	-	Sort by	Adjusted R-Squa	red				
2,105	3,044	3,133	24770		INTEGER2: Min		Max		Shift Da	· · · ·		Tie	nes		
-	-	-									· _				
495	476	457	-16%	-49	INTEGER3: Min		Max		Shift Da	ta Rows	Down	Tir	nes		
		1.57	10/0												
570	588	570		-39						OK		Can	cel	-	
														Provide State	



### AVG CONTRACT SIZE = $\alpha + \beta * (WORKFORCE_{t-1})$

VAR1	VAR2	VAR3	R Basic Economet	rice					$\times$
Contracts Lag 1	Workforce	Avg Size Lag 1	N basic contonice						$\sim$
353,698	5,245	\$270,721.63	This tool is used to r	un basic econometri	c models by first transf	orming the input v	/ariables	before	
351,869	5,516	\$250,347.99	running the multivaria	ate regression analy	sis. You can enter in m	ultiple econometr	ic model		
347,871	6,001	\$299,101.83			new line and within ea ne or more independen				_
318,874	6,041	\$296,707.02			VAR3 are dependent va				5.
294,389	5,771	\$320,602.46	remaining items are i	independent variable	es in the two economet				
296,188	5,716	\$284,034.29		R2); VAR3+VAR4; TI	ME SIDUAL(VAR3,VAR4)				
283,740	5,725	\$299,133.74	VANJ, LAG(VANZ,	3), DIFF(VART), RE	SIDUAL(VANS, VAN4)				
269,250	6,114	\$345,183.80	VAR1	VAR2	VAR3				~
276,566	6,347	\$395,958.22	353698	5245	270721.627222376				
			351869	5516	250347.992991284				
			347871	6001	299101.830947046				
			318874	6041	296707.020709246				

ange FY16
%
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	134/0/1	0001		33101.030347040				
	318874	6041	. 29	96707.020709246				
	294389	5771	33	20602.463739916				
	296188	5716	2	84034.285885789				
	283740	5725	29	99133.738324593				~
Correlation Coeff Contract Amount to	<ul> <li>Single Model</li> </ul>							
Contract Amount to Number of Contract	Dependent Variable:		Independent Varia	bles:				
Workforce to Avera	VAR3		VAR2					
Correlation Coeff Contract Amount to	e.g., LN(VAR1) Functions: +,-,*,/,LN,LOG,LAG		R Econometri	ics Results	-	-		×
Number of Contract Workforce to Avera	O Multiple Models		Adjusted R-Sq Multiple R (Mu	Itiple Correlation (	Coefficient):		050	0.6828 0.6375 0.8263
6.699			Standard Error ANOVA F Stat ANOVA p-Valu		(SEy):			29.8621 15.0710 0.0060
6,600	INTEGER1: Min			Intercept	VAR2			
6,400	INTEGER2: Min		Coefficients Standard Error	-315275.0511 160489.9384	106.7015 27.4852			
6,200			t-Statistic p-Value	-1.9645 0.0902	3.8821 0.0060			
6,000								
5,800	••		Dependent Vari VAR3	able:	Сор	у	Cl	ose
E 600								



## AVG CONTRACT SIZE = $\alpha$ + $\beta_1*WORKFORCE$ + $\beta_2*TIME$

VAR	1	VAR2	VAR	3											
Contra	cts W	/orkforce	Avg Si	ze	R Basic Economet	trics					_		×	ĸ	
362,22	21	5,245	\$266,21	1.14	This tool is used to r	un has	ic econo	metric n	odels by first tran	sforming the input	variable	s hefore			
353,69	98	5,516	\$270,72	1.63	running the multivari	iate req	ression	analysis	. You can enter in	multiple econome	tric mode	el			
351,86	69	6,001	\$250,34	7.99	specifications to test dependent variable for										
347,87	71	6,041	\$299,10	1.83	In the following exam								15.		
318,87	74	5,771	\$296,70	7.02	remaining items are	indepe	ndent va	riables i	in the two econome						
294,38	39	5,716	\$320,60	2.46	LN(VAR1); LN(VA VAR3; LAG(VAR2										
296,18		5,725	\$284,03		17, 10, 17, 17, 17, 17, 17, 17, 17, 17, 17, 17	.0,. 01	(Waiti	,							
283,74		6,114	\$299,13		VAR1	VAR	2		VAR3				^		
269,25		6,347	\$345,18		362221	5245	5		266211.142300689						
276,56	66	6,443	\$395,95	8.22	353698	5516	<b>i</b>		270721.627222376						
					351869	6001	L		250347.992991284	•					
269,25		5,245	\$250,34		347871	6041	1		299101.830947046						
362,22	21	6,443	\$395,95	8.22	318874	5771	1		296707.020709246						
					294389	5716	5		320602.463739916						
FY15	FY16	FY17	% Change Since FY08	% Cha	296188	5725	5		R Econometri	cs Results			_		×
					<ul> <li>Single Model</li> </ul>										
21,181	21,977	22,638	37%	3%	Dependent Variable		Indepen	dont \/or	R-Squared (Co	efficient of Deterr	nination):	:			0.6839
6,114	6,347	6,443	23%	2%			· · ·		Adjusted R-Sq						0.5936
					VAR3		(VAR2);	TIME		tiple Correlation (		nt):			0.8270
6,160	6,556	6,531	50%	0%	e.g., LN(VAR1)			_		of the Estimates	(SEy):				1.3162
6,335	6,362	6,213	52%	-29	Functions: +,-,*,/,LN,LOG,LAG		e.g., LOG(V. (VAR1,VAR	AR2+VAR3 3); TIME; F							7.5738
									ANOVA p-Valu	e:					0.0177
2,810	3,249	3,370	68%	4%	O Multiple Models					Intercept	(VAR2	)	TIME		
3,328	3,372	3,356	36%	0%				_	Coefficients	160635.1452	14.654			0.0451	
2,000	2.021	2,149	11%	6%					Standard Error t-Statistic	220892.1598 0.7272	41.117	-	5015 2.023	4642	
2,000	2,021	2,143	11/0						p-Value	0.4907	0.3364		0.082		
5,261	5,490	5,571	43%	1%				_							
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max		Dependent Vari	able:		0			
-	-	-			INTEGER2: Min		Max		VAR3			Сор	У	Clo	ose
495	476	457	-16%	-49	INTEGER3: Min		Max			taRows L	Jown	lime	S	-	
570	588	570		-39						014		0			
570	288	570		-39						OK		Cance			
				=											



### AVG CONTRACT SIZE = $\alpha + \beta_1$ \*WORKFORCE t-1 + $\beta_2$ \*TIME

VAR1	VAR2	VAR3
Contracts Lag 1	Workforce	Avg Size Lag 1
353,698	5,245	\$270,721.63
351,869	5,516	\$250,347.99
347,871	6,001	\$299,101.83
318,874	6,041	\$296,707.02
294,389	5,771	\$320,602.46
296,188	5,716	\$284,034.29
283,740	5,725	\$299,133.74
269,250	6,114	\$345,183.80
276,566	6,347	\$395,958.22

#### R Basic Econometrics

This tool is used to run basic econometric models by first transforming the input variables before running the multivariate regression analysis. You can enter in multiple econometric model specifications to test. Each model is on a new line and within each line, the first variable is the dependent variable followed by at least one or more independent variables separated by semicolons. In the following example, LN(VAR1) and VAR3 are dependent variables in two models and the remaining items are independent variables in the two econometric models: LN(VAR1); LN(VAR2); VAR3+VAR4; TIME VAR3; LAG(VAR2,3); DIFF(VAR1); RESIDUAL(VAR3,VAR4)

 $\times$ 

\$299,133.74							
\$345,183.80	VAR1	VAR	2	VAR3			^
\$395,958.22	353698	5245	5	270721.627222376			
	351869	5516	5	250347.992991284			
	347871	600	1	299101.830947046			
	318874	604:	1	296707.020709246			
	294389	577	1	320602.463739916			
	296188	5716	5	284034.285885789			
	283740	5725	5	299133.738324593			~
Correlation Coeff Contract Amount to	<ul> <li>Single Model</li> </ul>						
Contract Amount to Number of Contract	Dependent Variable:		Independent Va	riables:			
Workforce to Avera	VAR3		VAR2; TIME				
Correlation Coeff Contract Amount to	e.g., LN(VAR1) Functions: +,-,*,/,LN,LOG,LAG		Econome	trics Results		- 0	×
Number of Contract Workforce to Avera	O Multiple Models		Adjusted R-S Multiple R (M Standard Err ANOVA F St	Multiple Correlation or of the Estimates atistic:	Coefficient):	23	0.7831 0.7109 0.8850 3159.1252 10.8340 0.0102
6,600	INTEGER1: Min	_	ANOVA p-Va	ilue:			0.0102
0,000		_		Intercept	VAR2	TIME	
6,400	INTEGER2: Min INTEGER3: Min		Coefficients Standard Error		63.1889 35.8450	7272.7303	
6,200			t-Statistic p-Value	-0.5053 0.6314	1.7628 0.1284	1.6659 0.1468	
5,800	••		Dependent Va VAR3	ariable:	С	Сору	Close





## AVG CONTRACT SIZE = $\alpha + \beta * LN(WORKFORCE)$

VAR1	1	VAR2	VAR	3									~		
Contra		orkforce	Avg Si	ze	R Basic Econome	trics							$\times$	k	
362,22		5,245	\$266,21	1.14	This tool is used to	run ba:	sic econon	netric m	nodels by first tran	sforming the input	variable	s before			
353,69	98	5,516	\$270,72	1.63	running the multivar	iate re	gression a	nalysis	. You can enter in	multiple econome	tric mode	el			
351,86	59	6,001	\$250,34		specifications to tes dependent variable								ne		
347,87		6,041	\$299,10		In the following exar	mple, L	.N(VAR1) a	and VAF	R3 are dependent	variables in two m			JII3.		
318,87		5,771	\$296,70		remaining items are					etric models:					
294,38		5,716	\$320,60		LN(VAR1); LN(VA VAR3: LAG(VAR2				: )UAL(VAR3,VAR4)						
296,18		5,725	\$284,03			,			,,,,,,						
283,74		6,114	\$299,13		VAR1	VAF	22		VAR3				^		
269,25		6,347	\$345,18		362221	524	5	:	266211.142300689	)					
276,56	66	6,443	\$395,95	8.22	353698	551	6	1	270721.627222376	j					
					351869	600	1		250347.992991284	ŧ					
269,25		5,245	\$250,34		347871	604	1		299101.830947046	i					
362,22	21	6,443	\$395,95	8.22	318874	577	1	:	296707.020709246	i					
					294389	571	-	:	320602.463739916	5					
FY15	FY16	FY17	% Change Since FY08		296188	572	5	-	284034.285885789	)					
21,181	21,977	22,638	37%	3%	Single Model				R Econometri	cs Results			-		×
21,101	21,377		31/0		Dependent Variable	в:	Independ	ent Vai	R-Squared (Co	efficient of Determ	ination).				0.4812
6,114	6,347	6,443	23%	2%	VAR3		LN(VAR2	)	Adjusted R-Sq						0.4164
6, 160	6,556	6,531	50%	0%	e.g., LN(VAR1)				Multiple R (Mu	tiple Correlation C	Coefficier	nt):			0.6937
6,335	6.362	6,213	52%	-29	Functions: +*./.LN.LOG.LAG		e.g., LOG(VA (VAR1,VAR3)	R2+VARS		of the Estimates (	SEy):			325	39.2063
0,335	0,302	0,213	3270	-27	+,-, ,/,LN,LOG,LAG	,	(100),000		ANOVA F Stati						7.4204 0.0261
2,810	3,249	3,370	68%	4%	O Multiple Models				ANOVA p-Valu	e:					0.0261
3,328	3,372	3,356	36%	0%						Intercept	LN(VA				
2,000	2,021	2,149	11%	6%					Coefficients Standard Error	-3758950.1142 1491108.4501	46796				
									t-Statistic	-2.5209	2.7240				
5,261	5,490	5,571	43%	1%				-	p-Value	0.0358	0.0261				
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max								
-	-	-			INTEGER2: Min		Max		Dependent Vari	able:		Cor		0	ose
					INTEGER3: Min		Max		VAR3			Cop	Jy .		036
495	476	457	-16%	-49		_									
570	588	570		-39						OK		Canc	el		
														Sec. 1	



### AVG CONTRACT SIZE = $\alpha + \beta * LN(WORKFORCE_{t-1})$

VAR1	VAR2	VAR3
Contracts Lag 1	Workforce	Avg Size Lag 1
353,698	5,245	\$270,721.63
351,869	5,516	\$250,347.99
347,871	6,001	\$299,101.83
318,874	6,041	\$296,707.02
294,389	5,771	\$320,602.46
296,188	5,716	\$284,034.29
283,740	5,725	\$299,133.74
269,250	6,114	\$345,183.80
276,566	6,347	\$395,958.22

# R Basic Econometrics $\times$ This tool is used to run basic econometric models by first transforming the input variables before running the multivariate regression analysis. You can enter in multiple econometric model specifications to test. Each model is on a new line and within each line, the first variable is the dependent variable followed by at least one or more independent variables separated by semicolons. In the following example, LN(VAR1) and VAR3 are dependent variables in two models and the remaining items are independent variables in the two econometric models: LN(VAR1); LN(VAR2); VAR3+VAR4; TIME VAR3; LAG(VAR2,3); DIFF(VAR1); RESIDUAL(VAR3,VAR4)

VAR1	VAR2	VAR3
353698	5245	270721.627222376
351869	5516	250347.992991284
347871	6001	299101.830947046
318874	6041	296707.020709246
294389	5771	320602.463739916
296188	5716	284034.285885789
283740	5725	299133.738324593

# 6 % 6 6 6 6 6 % % %

	294389	577	1 32	0602.463739916			
	296188	571	6 28	4034.285885789			
	283740	572	5 29	9133.738324593			~
Correlation Coeff Contract Amount to	<ul> <li>Single Model</li> </ul>						
Contract Amount to Number of Contract	Dependent Variable:		Independent Varia	bles:			
Workforce to Avera	VAR3		LN(VAR2)				
	e.g., LN(VAR1)						
Correlation Coeffi Contract Amount to	Functions: +,-,*,/,LN,LOG,LAG		e.g., LOG(VAR2+VAR3); \ (VAR1,VAR3); TIME; FOR	/AR3*VAR4; LAG(VAR5,2 RECAST(VAR3,VAR4); DI	(); VAR6; RESIDUAL FF(VAR5); RATE(VAR6)	Show	Result
Number of Contract Workforce to Avera	O Multiple Models		R Econometri	cs Results		- 0	×
			R-Sauared (Co	efficient of Determ	ination):		0.6648
			Adjusted R-Sa		induony.		0.6169
				Itiple Correlation (	Coefficient):		0.8153
				of the Estimates (		26	659.1267
6,600	INTEGER1: Min		ANOVA F Stati				13.8800
6,400	INTEGER2: Min		ANOVA p-Valu	e:			0.0074
•	INTEGER3: Min		1	Intercept	LN(VAR2)		
6,200			Coefficients	-4969148.1241	608577.7773		
6.000			Standard Error	1416182.2237	163350.6084		
0,000			t-Statistic	-3.5088	3.7256		
5,800			p-Value	0.0099	0.0074		
5,600	••		Dependent Vari VAR3	able:	Cop	y (	Close
5,400			-				



## AVG CONTRACT SIZE = $\alpha + \beta_1 * LN(WORKFORCE) + \beta_2 * TIME$

VAR1	1	VAR2	VAR	3										
Contra	cts V	Vorkforce	Avg Si	ze	<b>R</b> Basic Economet	rics				_		$\times$	k	
362,22			\$266,21	1.14	This tool is used to run basic econometric models by first transforming the input variables before									
353,698 5,516		\$270,72	1.63	running the multivariate regression analysis. You can enter in multiple econometric model										
351,86	59	6,001	\$250,34	7.99	specifications to test. Each model is on a new line and within each line, the first variable is the									
347,87	71	6,041	\$299,10	1.83	dependent variable followed by at least one or more independent variables separated by semicolons. In the following example, LN(VAR1) and VAR3 are dependent variables in two models and the									
318,87	74	5,771	\$296,70	7.02	remaining items are independent variables in the two econometric models:									
294,38	39	5,716	\$320,60	2.46	LN(VAR1); LN(VAR2); VAR3+VAR4; TIME VAR3; LAG(VAR2.3); DIFF(VAR1); RESIDUAL(VAR3,VAR4)									
296,18	38	5,725	\$284,034	4.29	VARIS, LAG(VARIZ, S), UIFF(VARI); RESIDUAL(VARIS, VAR4)									
283,74	10	6,114	\$299,13	3.74	VAR1	VA	R2 1	VAR3				~		
269,25		6,347	\$345,18		362221	524	5	266211.142300689						
276,56	6	6,443	\$395,95	8.22	353698			270721.627222376						
					351869	600	1	250347.992991284	ł.					
269,25		5,245	\$250,34		347871	604	1	299101.830947046						
362,22	21	6,443	\$395,958	8.22	318874	577	'1	296707.020709246						
					294389	571	.6	320602.463739916						
FY15	FY16	FY17	% Change		296188	572	5	284034.285885789						
			Since FY08		<ul> <li>Single Model</li> </ul>			R Econometri	ics Results			-		×
21,181 6,114	21,977 6.347	22,638 6,443	37%	3%	Dependent Variable:		Independent Var		pefficient of Detern	nination	1):			0.6814
0,114	0,347	0,445	2.3%	27	VAR3		LN(VAR2); TIME							0.5904
6,160	6,556	6,531	50%	0%	e.g., LN(VAR1)				Itiple Correlation (		ent):		272	0.8255
6,335	6,362	6,213	52%	-29	Functions: +,-,*,/,LN,LOG,LAG		e.g., LOG(VAR2+VAR3 (VAR1,VAR3); TIME; F		of the Estimates ( istic:	SEy):			2723	7.4866
2,810	3,249	3,370	68%	4%	O Multiple Models			ANOVA p-Valu	ie:					0.0182
3,328	3,372	3,356	36%	0%					Intercept	LN(V	/AR2)	TIM	E	
								Coefficients	-310567.1644		4.3057		6.1562	
2,000	2,021	2,149	11%	6%				Standard Error t-Statistic	2064753.1440 -0.1504	2404	22.4347	2 09	3.6412	
5,261	5,490	5,571	43%	1%				p-Value	0.8847	0.79		0.07		
2,765	3,044	3,135	247%	3%	INTEGER1: Min		Max							
-	-	-			INTEGER2: Min		Max	Dependent Vari VAR3	able:		Co	ру	CI	ose
495	476	457	-16%	-49	INTEGER3: Min		Max			_			_	
570	588	570		-39					OK		Cance	el		



## AVG CONTRACT SIZE = $\alpha + \beta_1 * LN(WORKFORCE_{t-1}) + \beta_2 * TIME$

VAR1	VAR2	VAR3	R Basic Econometr					×
Contracts Lag 1	Workforce	Avg Size Lag 1	Basic Econometr	ICS				
353,698	5,245	\$270,721.63	This tool is used to ru	n basic econom	etric models by first transfo	rming the input var	iables befo	re
351,869	5,516	\$250,347.99	running the multivaria	te regression ar	nalysis. You can enter in mu	Itiple econometric	model	
347,871	6,001	\$299,101.83			on a new line and within eac st one or more independent			alana
318,874	6,041	\$296,707.02			nd VAR3 are dependent var			orons.
294,389	5,771	\$320,602.46	remaining items are in	ndependent vari	ables in the two econometric	c models:		
296,188	5,716	\$284,034.29	LN(VAR1); LN(VAR VAR3: LAG(VAR2 3		; TIME RESIDUAL(VAR3,VAR4)			
283,740	5,725	\$299,133.74	VAI10, EAG(VAI12,0	y, birr (varci).				
269,250	6,114	\$345,183.80	VAR1	VAR2	VAR3			^
276,566	6,347	\$395,958.22	353698	5245	270721.627222376			
			351869	5516	250347.992991284			
			347871	6001	299101.830947046			
			318874	6041	296707.020709246			
			294389	5771	320602.463739916			
_			296188	5716	284034.285885789			
ange			283740	5725	299133.738324593			~
ange FY16		Correlation Coeff	-					•
		Contract Amount to						
%		Contract Amount to Number of Contract	Dependent Variable:	Independe	ent Variables:			
%		Workforce to Avera		LN(VAR2)	; TIME			
%			e.g., LN(VAR1)					
%		Correlation Coeff	+-*/INLOG LAG	e.g., LOG(VAP (VAR1,VAR3)	2+VAR3); VAR3*VAR4; LAG(VAR5,2); TIME; FORECAST(VAR3,VAR4); DIF	VAR6; RESIDUAL F(VAR5); RATE(VAR6)	Show F	Result
%		Contract Amount to Number of Contract		R Eco	nometrics Results	-		×
		Workforce to Avera						
%				R-Squ	ared (Coefficient of Determin	nation):		0.7723
*				Adjust	ed R-Squared:			0.6964

INTEGER1: Min

INTEGER2: Min

INTEGER3: Min

...

Multiple R (Multiple Correlation Coefficient):

Intercept

0.1838

-2744009.1269 1826770.8119 -1.5021 LN(VAR2)

0.1532

347564.3416 212589.4089 1.6349

Standard Error of the Estimates (SEy):

ANOVA F Statistic:

Dependent Variable:

ANOVA p-Value:

Coefficients Standard Error t-Statistic

p-Value

VAR3



6,600

6,400

6,200

6,000

5,800

5,600

5 400

•

0.8788

0.0118

23732.3661 10.1738

Close

TIME

0.1433

Сору

7539.0006 4479.1042 1.6831 THIS PAGE LEFT INTENTIONALLY BLANK



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# **Biographies**

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### EDUCATION

Arizona State University, Doctor of Philosophy (Logistics and Operations Management), 1992

University of Ottawa, Master of Business Administration, 1982

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### EXPERIENCE

1998–Present	Associate Professor of Logistics, Naval Postgraduate School, Monterey, California
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### EXPERIENCE

2005–Present:	Research Professor, Naval Postgraduate School, Monterey, California
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2001–2010:	Visiting Professor, University of Applied Sciences and Swiss School of Management, Switzerland
2001–2004:	Vice President of Analytics, Decisioneering-Oracle, Denver, Colorado
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