EXAMINING THE RELATIONSHIP OF BID DIFFERENCE AND DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION GOALS IN HIGHWAY CONSTRUCTION PROJECTS

by

Robert Thomas Ryan

A Dissertation

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Doctor of Philosophy

Department of Technology

West Lafayette, Indiana

December 2020

THE PURDUE UNIVERSITY GRADUATE SCHOOL
STATEMENT OF COMMITTEE APPROVAL

Dr. Randy Rapp, Chair
Department of Construction Management Technology

Dr. Mark Shaurette
Department of Construction Management Technology

Dr. Sarah M. Hubbard
Department of Aviation Technology

Dr. Emad Elwakil
Department of Construction Management Technology

Approved by:
Dr. Kathryne A. Newton

To Tess – Thank you. I cannot express the gratitude for the lost weekends, late nights, and absent vacations. I hope this work sets a statement to our children that anything is possible with a good attitude and some good old-fashioned persistence.

ACKNOWLEDGMENTS

Thank you to the members of my Graduate Advisory Committee for the knowledge gained throughout this entire process. Your well-practiced patience was greatly admired and appreciated.

Thanks to the members of the Purdue Statistical Consulting Services who graciously volunteered their time to make sure my data set and statistical tests were of a sound approach.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ANS	Aggregate National Sample
ARTBA	American Road & Transportation Builders Association
BLUE	Best Linear Unbiased Estimate
BLS	Bureau of Labor Statistics
CA	California
CBOE	Chicago Board of Options Exchange
CFR	Code of Federal Regulations
DBE	Disadvantaged Business Enterprise
DC	District of Columbia
DOJ	Department of Justice
DOT	Department of Transportation
EIA	U.S. Energy Information Administration
ENR	Engineering News Record
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
FRED	Federal Reserve Economic Data
FTA	Federal Transit Administration
GFE	Good Faith Efforts
GAO	Government Accountability Office
GDP	Gross Domestic Product
IDOT	Illinois Department of Transportation
IN	Indiana

INDOT	Indiana Department of Transpiration
LA	Louisiana
LOWESS	Locally Weighted Scatterplot Smoothing
MA	Massachusetts
MI	Michigan
MN	Minnesota
MO	Missouri
MS	Mississippi
MST	Mean Sum of Squares or Average Sum of Squares
NAICS	North American Industry Classification System
NAS	National Academy of Science
NC	North Carolina
NH	New Hampshire
OECD	Organization for Economic Co-operation and Development
OH	Ohio
OIG	Office of the Inspector General
OLS	Ordinary Least Squares
OR	Oregon
PNW	Personal Net Worth
PR	Puerto Rico
RI	Rhode Island
RVF Plot	Residuals vs Fitted Plot
SCS	Purdue Statistical Consulting Services
STA	State Transportation Agencies
SST	Total Sum of Squares

TDOT	Tennessee Department of Transportation
TX	Texas
UID	Unidentified State
UT	Utah
VIX	Volatility Index
WA	Washington

DEFINITIONS

Aggregate National Sample:	The summation statistics of all 18 states included in this study.
Average Net Explainable Deficit/Surplus:	The value calculated using the mean summary statistic multiplied by its OLS coefficient.
Bid Difference:	The percentile difference between the Engineer's Estimate and the Winning Bid.
Cost Vector:	The average value of a variable multiplied by its OLS regression coefficient. In some cases, where non-zero values are required, it is figured as n-1.
Engineer's Estimate:	An approximate estimate created to determine a reasonable construction cost for budgetary reasons.
General Contractor:	The contractor bidding for the complete scope of the project. Often referred to as Prime Contractor.
Goal:	A suggested or desired target for DBE Participation Goal.
High Bidder Concentration:	A Winning Bid with more than double the sample average.
Low Bidder Concentration:	A Winning Bid with only one bidder.
Responsible Bidder:	A bidder that has experience with the work.
Responsive Bidder:	A bidder who adheres to the contract documents and must not have any irregularities in the bid's unit pricing.
Sample:	Each group involved in this study, typically a state unless the Aggregate National Sample.
Quota:	A mandatory target for DBE Participation Goal.
Winning Bid:	The lowest responsive and responsible bid.

FORMULAS

Bid Difference	$\frac{Winning\ Bid - Engineer's\ Estimate}{Winning\ Bid}$
Cost Vector	*Summary Statistic · OLS Coefficient*
Margin of Error	$\frac{Z * \sigma}{\sqrt{n}}$ *where n = sample size, σ = population standard deviation, z = z-score*
Net Explainable Surplus /Deficit	$Cost\ Vector \cdot \sum Sample\ Bidifference$
OLS Regression for ANS	$Bid\ Difference = \beta_1 DBE + \beta_2 Bidders + \beta_3 Wbsize + \beta_4 Duration + \beta_5 NatEmpl + \beta_6 Crude + \beta_7 SP + \beta_8 VIX + \beta_9 Q2dummy + \beta_{10} Q3dummy + \beta_{11} Q4dummy + \beta_{12} Y08dummy + \beta_{13} Y09dummy + \beta_{14} Y10dummy + \beta_{15} Y11dummy + \beta_{16} Y12dummy + \beta_{17} Y13dummy + \beta_{18} Y15dummy + \beta_{19} Y16dummy + \beta_{20} Y17dummy + \beta_{21} Y18dummy + \beta_{22} CO + \beta_{23} IN + \beta_{24} LA + \beta_{25} MA + \beta_{26} MI + \beta_{27} MN + \beta_{28} MO + \beta_{29} MS + \beta_{30} NC + \beta_{31} NH + \beta_{32} OH + \beta_{33} OR + \beta_{34} RI + \beta_{35} TX + \beta_{36} UID + \beta_{37} UT + \beta_{38} WA + \mu$, where μ = Constant.
OLS Regression for States	$Bid\ Difference = \beta_1 DBE + \beta_2 Bidders + \beta_3 Wbsize + \beta_4 Duration + \beta_5 NatEmpl + \beta_6 Crude + \beta_7 SP + \beta_8 VIX + \beta_9 Q2dummy + \beta_{10} Q3dummy + \beta_{11} Q4dummy + \beta_{12} Y09dummy + \beta_{13} Y10dummy + \beta_{14} Y11dummy + \beta_{15} Y12dummy + \beta_{16} Y13dummy + \beta_{17} Y14dummy + \beta_{18} Y15dummy + \beta_{19} Y16dummy + \beta_{20} Y17dummy + \beta_{21} Y18dummy + \mu$, where μ = Constant.

ABSTRACT

The Disadvantaged Business Enterprise (DBE) program began in the early 1980s and has been a point of contention for departments of transportation (DOTs) and prime contractors in the heavy-highway sector of the construction market. The program was created to assist those who are at a disadvantage in entering the heavy-highway industry. Controversy related to the administration of the DBE program has been at the forefront of the program. Controversies include fraud, inadequate government oversight, numerous lawsuits, legal rulings at all levels including the Supreme Court, and state legislation to reduce program goals.

This research analyzes over 60,000 awarded highway contracts from 18 states throughout the United States. Analysis was performed on the state and aggregate level. The contracts were awarded from the years 2008 through 2018. Statistical analysis utilizing Pearson's Correlation and Ordinary Least Squares regression model for each state was performed to identify each variable's relationship between the budget and awarded project dollar amounts.

Summary statistics observed Bid Difference at 8.5% below the Engineer's Estimate. The study observed DBE Participation Goals average 3.74% of the value of contracts, with an observed average number of bidders of nearly 4.5 per contract.

The research examined the effects of economic indicators, contract descriptors, and yearly/seasonal adjustments. These variables included the DBE Participation Goal, the Number of Bidders, Project Dollar Value, Project Duration, Unemployment Rate, S&P 500 Index, Volatility Index, quarter, and year of project. The results were examined by using a combination of simple statistical summaries and econometric models called a *cost vector*. Cost vectors were created to adequately weight the measure of each variables impact.

The research determined that 55% of observed states had a positive significant correlation with DBE Participation Goal and Bid Difference. This correlation translated to nearly $80 million in additional cost. In addition, the research found that all 19 groups involved in this study had a negative significant correlation with the Number of Bidders, which translated to a savings of nearly $500 million.

CHAPTER 1. INTRODUCTION

This chapter will provide background on the Disadvantaged Business Enterprise (DBE) program, identify the program's issues, illustrate reasons for the significance of the study, and present the research questions. In addition to the primary goals of this chapter, this chapter illuminates the assumptions and limitations of this study.

This research is not intended to curtail or eliminate any diversity initiatives.

1.1 Background and Overview of the Study

The Disadvantaged Business Enterprise (DBE) program is a comprehensive and complex policy in the heavy-highway construction sector. The program has existed for an excess of 35 years. Throughout this time, there have been misinterpretations regarding the program that have resulted in fraud, abuse, and federal legislation. Despite the number of issues related to this program, there has been little published about the program. This study aims to examine whether additional program costs are present at bid time.

Traditional highway procurement utilizes *Design-Bid-Build*. In Design-Bid-Build, the lowest responsive and responsible bidder wins. To be awarded a project, a contractor must create a bidding strategy that has all costs accurately and aggressively portrayed in the estimate. Design-Bid-Build is one of many facets that make heavy-highway construction unique from other sectors in the construction industry. In other sectors, such as the residential and commercial sectors, contractors may utilize preferred vendors and subcontractors based on previous relationships and partnering. This type of relationship is not common in heavy-highway construction. Heavy-highway contractors must use the cheapest and most responsible option to remain competitive and increase the likelihood of winning the bid. Being the lowest responsive and responsible bidder is the only way to guarantee a backlog of work.

By ignoring the opportunity to select a cheaper subcontractor or vendor, a widely accepted economic principle is ignored. With his Five Forces of Competition, economist Michael Porter analyzes the level of competition within sectors of an industry. By ignoring a lower price, the threat of new entry is ignored. According to Porter's (2008) views, ignoring the threat of new entry will enable an existing company's failure. This focus on driving down costs to remain competitive has made the heavy-highway sector into a task-driven, results-orientated business. To further complicate this process, this sector is full of highly complex scenarios involving tight deadlines, small budgets, and less-than-forgiving owners. Not only is it in the contractor's best interest to be as cheap as possible, but it is also in the best interest of each Department of Transportation (DOT), as well. These projects are funded with tax dollars, resulting in the taxpayer becoming a stakeholder in infrastructure investment. As such, it is in the public's interest to ensure that these projects are completed in as expeditious and economical manner as possible to maximize stakeholders' tax investments.

The term *Bid Difference* is often used in the industry to describe the difference between sum contract values. For this study, Bid Difference relates to the budget number and the lowest responsible bidder. By utilizing this measurement, the researcher can analyze how market factors, including the DBE Participation Goal, impact the Winning Bid. *Winning Bid* is a term that can be used interchangeably with the term *awarded contract*. Bid Difference provides the best objective measurement that could otherwise vary from contractor to contractor.

The history, intent, and the enrollment criteria for the program must be given to understand the complexity of the DBE program. The Federal Highway Administration (FHWA) created the DBE program in 1983 to help increase the diversity of construction company owners and prevent discrimination in the construction industry. The DBE program registers specific contractors and vendors as a DBE if they meet the program's criteria related to social and/or economic status. Such criteria include a maximum personal net worth (PNW) and yearly average revenue volume, and at least 51% of the company's owners need to be identified as socially or economically disadvantaged. Apart from one, the criteria that need to be established are clear. For instance, as of 2018, the allowable maximum personal net worth of owners was $1,320,000. In this case, PNW excludes ownership of the DBE company and equity in one's primary residence. Additionally, as of 2018, the DBE company must not exceed $22,410,000 in annual gross receipts from the previous three years (FHWA, 2015b). As supported by Chapter 2, clarification is needed on what constitutes someone as socially or economically disadvantaged. Historically, a DBE meets the criteria of being socially or economically disadvantaged if it is a minority- and/or woman-owned business.

Once a DBE is certified, it can participate in the program. DBE subcontractors and vendors are placed in a program category that gives their company the ability to distinguish themselves from non-DBEs. The program's method to increase diversity and eliminate discrimination creates a requirement for contractors to utilize certified DBEs. Bidding prime contractors are required to utilize a certain percentage of the contract price towards DBEs, which is referred to as a *DBE Participation Goal*. A DBE Participation Goal has previously been called a DBE Participation Quota. For clarification purposes, a quota requires a mandatory percentage of DBE participation, whereas a goal is a suggested percentage of DBE participation.

The FHWA serves as the governing agency for the DBE program over every state-level DOT. Traditionally, most DOT projects are related to the heavy-highway sector of the construction industry. Heavy-highway projects involve the construction of highways, bridges, airports, and dams. State DOTs rely on the FHWA to fund the design and construction of many of their infrastructure improvements. This funding can account for up to 80% of the total project cost (FHWA, 2017). The FHWA funds over $50 billion annually for infrastructure construction. The FHWA requires that a minimum of at least 10% of the funding supports the DBE program (FHWA, 2016). This requirement equals a total of $5 billion per year spent on DBE Participation. The DBE program is administered by three separate transportation agencies, including the FHWA, Federal Transit Administration (FTA), and the Federal Aviation Administration (FAA). The FHWA's Office of Civil Rights acts as the chief administrator in the program for all three transportation agencies.

As a requirement associated with the reception of FHWA funding, DOTs must meet specific regulations or they risk losing their funding. Some of these regulations include environmental restrictions, drug-free workplaces, adherence to the Davis-Bacon Act, and adherence to the DBE program. Until recently, the DBE program did not clarify whether a DBE Participation Goal was a goal or a quota, as the language in the program did not explicitly prohibit a quota. In February 2016, the FHWA issued a New Final Rule to the DBE program (FHWA, 2016). In this revision, the FHWA removed the term *quota* and replaced it with the term *goal*. The FHWA stated that the term *quota* was unconstitutional because it required a mandated amount of DBE Participation Goal.

DOTs are required to set an overall annual DBE Participation Goal to receive their program's funding. This goal is established as a percentage of dollars received from the FHWA. DOTs determine these project-specific goals using a method called a *disparity study*. Disparity studies are utilized to determine the availability of certified DBEs in the area surrounding the proposed construction project (FHWA DBE Participation Goal Setting, 2009). This study is performed every three years (FHWA, 2012). The results of the disparity study are applied on the project level in a non-uniform distribution. For example, if a state-wide goal is required to utilize a total of 15% DBE commitment, then they may increase the DBE Participation Goal on a specific project to 25% where it is expected that there is a high availability of DBEs willing to participate in submitting pricing. In turn, they may decrease the participation goal on a project where the disparity study may show the expected DBE Participation Goal to be less than 15%. The aggregate amount of participation should equal or exceed the disparity study

A long-standing assumption has been that, if these goals are not met on a program level, then the state DOT runs the risk of losing FHWA funding. As clarified in the February 2016 Final Rule, this long-standing assumption has impacted how the DBE program has been administered by DOTs, DBE firms, and prime contractors. The number of projects state-specific DOTs can advertise is regulated, and the award will be reduced if funding is reduced. DOTs run the risk of losing funding by not meeting a goal. DOTs must account for each project to meet its anticipated DBE Participation Goal. In other words, projects must meet the DBE Participation Goal set forth on a project-by-project level to meet the program's aggregate DBE Participation Goal. Project-level DBE Participation Goals could be as low as 3% and as high as 22% of the total contract value (Ryan et al., 2018). This research includes projects with DBE Participation Goals in excess of 35%.

If these goals are not met on a project level, then DOTs may consider a few options. These options include awarding the project to the next lowest bidder if that bidder has met the goal, re-advertising the project for bidding, or reviewing a Good Faith Effort (GFE) submitted by the apparent low bidder. The GFE serves as a last-ditch mechanism to determine whether the contractor in question put forth the effort to meet the DBE Participation Goal, or whether the DBE Participation Goal was too high to attain. The FHWA provides the basis for what establishes a GFE but leaves the judgment for approval or denial up to the DOT reviewing the GFE (FHWA 2013c). The major components of a GFE include determining how close the low-bidder DBE Participation Goal is compared to other bidders, researching the outreach efforts by the prime contractor, and reviewing why DBEs that quoted the project were not selected by the contractor who submitted the GFE. If DOTs do not meet their yearly goal, then they must submit documentation regarding their program operations that identifies and analyzes why they did not meet the goal. They must also create methods to prevent underutilization in the future (FHWA, 2009). In addition, DOTs establish their own DBE Participation Goal s. They are not mandated by the FHWA to meet a certain participation goal.

Legislation in 2016 provided clarification for the program to be goal-based instead of quota-based. Despite this legislation, there is still implied pressure. Implied pressure is supported by the language outlined in evaluating a contractor's GFE, as listed in the Code of Federal Regulations (CFR), Title 49, subtitle A, Part 26, which states, "a contractor is to utilize a DBE if they are less than or equal to 10% above the cost of a non-DBE" (eCFR, 2018). The GFE guidelines acknowledge that contractors should utilize a DBE if they are up to 10% above the cost of a non-DBE's cost to meet the goal. The 10% requirement listed in the GFE is important. 72% of contractors believe that DBEs are more expensive than their non-DBE competitors (Koehn, 1993). This requirement reinforces contractors' views that DBEs are costlier to utilize. The method for determining and accepting a GFE creates a paradox for contractors bidding on a project. Contractors need to weigh the risk of not meeting the goal because they need to provide the most competitive price. Additionally, they must also provide the most competitive pricing by not selecting the costlier DBE and thus not meeting the goal.

The GFE guideline recommendation to use a costlier subcontractor or supplier based on DBE status places additional pressure on the taxpayer. For instance, the Illinois DOT's (IDOT) disparity study claimed a 17.6% base figure of DBE availability throughout the state despite never reaching above 15% in previous years. Furthermore, IDOT increased its goal above the base figure availability and set the overall DBE Participation Goal at 18.7% for 2018 (Saint, 2018). In this case, the disparity study recommended that the DBE Participation Goal increase by 12.5% (2.6 percentage points) for a state that is yet to meet its DBE Participation Goal. Based on IDOT's 2017 contracting budget of $8 billion, this increase aimed to add $300 million in additional DBE funding. If costlier DBEs were used to avoid a GFE, this increase would be deducted from the Illinois transportation budget. As of 2016, IDOT's transportation budget had a $43 billion deficit (Skosey 2016), resulting in finding funding for needed improvements throughout the state more difficult. Although Illinois' intent to increase the DBE Participation Goal may be considered noble, careful attention to the GFE recommendation would increase Illinois' deficits.

1.2 Statement of the Problem

The 10% GFE requirement establishes a suspicion that DBEs are more expensive than non-DBEs. The 10% requirement opens opposition to those who have anecdotally experienced portions of the program. This suspicion is limited by the lack of study on the subject. Logic dictates that a direct relationship between the DBE Participation Goal on a DOT-program level and the DBE Participation Goal on a project level exists. If projects do not meet the project-established DBE Participation Goal, then the aggregate result will not meet the program's DBE Participation Goal. There is an implied pressure on each project to meet the DBE Participation Goal. Through the distributive property of multiplication, the "parts" of the project-specific goals must meet the "whole" of the program goal. This pressure allows the economic principle of supply and demand to take effect. By limiting the choices of subcontractor and vendor selection through conscious measures to meet the project's established percentage goal, the likelihood of increased prices due to limited competition arises (Porter, 2008).

The DBE program is a well-intended program because it provides the opportunity for increased diversity in a traditionally white, male-dominated industry. The 2018 Bureau of Labor Statistics (BLS, 2018) determined that 88.8% of those in the construction industry are male, and 62.2% are white. Advocates of the program state that the program provides social benefits to those who are socially and economically disadvantaged. Critics state that the program is not only unconstitutional, but it also creates additional and unnecessary costs to taxpayers (Ichniowski, 1998). Regardless of these opinions, the DBE program is a multi-billion-dollar program that has been in effect for over 35 years. The program's history is associated with administrative issues. These issues include federal investigations, civil and constitutional litigation, legislature to modify or eliminate the program, and numerous fraud cases. Despite the program's size and history, there has been limited research to determine whether there are additional estimated construction costs associated with the DBE program.

Although these informal interviews have proven helpful, they provide a minimal basis for academically sound research. The observations of the interviewees can present selective memory bias, meaning that they may unintentionally take a specific scenario and apply it to multiple scenarios. The observations of the participants before the research process are based on limited observations and provide a limited quantitative and substantive basis for analysis. Although the results of these informal interviews provided no academic merit to prove or disprove a hypothesis, they do provide a basis for the research.

The DBE program is an extensive program with an annual budget of nearly $5 billion (McVicker, 2016). The DBE program spends a great deal of financial and human resources. However, despite the size and many issues, there have been limited studies to determine the cost-benefit analysis of the program. This research intends to determine whether there is an association between DBE Participation Goals and increased estimated construction costs. Increased estimated construction costs will be determined using Bid Difference. Additional economic factors will be examined to compare the effects of typical market variables and a federally mandated regulation to provide a complete representation of the DOT procurement environment at bid time. Inclusion of these additional variables will provide an order of magnitude of DBE Participation Goal impact. This comparison will ensure that the DBE Participation Goal is statistically sound and avoids bias. Comparisons will be made through levels of significance and linear regression coefficients. This examination will be performed on a state-by-state basis along with an aggregate basis. By utilizing this method, the research will discover whether the DBE program has additional economic costs and the depth of the cost. This analysis will reveal whether these issues are sporadic or systematic by this dual method. To date, there have been few studies regarding the DBE program. In these cases, the period of study and number of states have been limited, each study examining one state, each for one to three years. These findings are limited and do not adequately represent the status of the DBE program on a national level. To date, no research has examined the DBE program on a program level. Furthermore, there has been no published research to determine participants' experiences with the program. Bid Difference is used to provide a uniform constant to eliminate these variables that fluctuate across data points.

1.3 Theoretical and Conceptual Framework

The framework for this study comes from the works of two separate but similar studies. In October 2007, Justin Marion published "How Costly Is Affirmative Action? Government Contracting and California's Proposition 209." In this study, Marion examined highway contracts in the State of California from May 1996 to December 1999. Marion's work was the first article to be published that examined additional economic costs associated with the DBE program. Marion (2007) was able to quantify the costs of various levels of DBE Participation Goal required in non-FHWA funded projects against the costs of FHWA funded projects of similar size, time, and location.

Research is also based on the work of Edward Taylor Lee, who, in May of 2009, published "The Shadow Cost of Disadvantaged Business Enterprise Project Participation Goals in Tennessee Highway Construction." Lee's (2009) work modifies Marion's (2007) model and applies it to bid data from three years of Tennessee DOT lettings. Lee (2009) includes a sample of 1,085 bid results, with only 207 of those results having DBE Participation Goals. Lee (2009) expands on Marion's (2007) work by adding additional variables under the "vector of project-specific characteristics," which illustrated the Winning Bidder's competitive position. These variables included backlog, competitor's backlog, and distance to the project.

Marion (2007) and Lee (2009) provide a sound basis for the study. Marion's (2007) work well represents the economics behind highway contracting. Lee (2009) provides insight into the practicality of highway letting. However, both works do not provide complete insight on the topic. Marion (2007) covered a small sample, approximately 2,300 bid results, which, although helpful, provides only a partial representation of the DBE program. He does not examine the DBE program on a national level. In addition to this limitation, Marion (2007) offers four separate models to capture various scenarios related to "make vs. buy" that contractors will face. His models are complex. The complexity of the models limits the audience's understanding of the issue as he adds additional complexity to an already complex issue. This approach creates some confusion to the depth and understanding of the relationship between cost and DBE Participation Goals. By using only one of Marion's models, Lee (2009) provides a more straightforward approach. However, this straightforward approach is limited by not focusing on the relationship between DBE Participation Goal and Bid Difference. Like Marion, Lee's (2009) sample lacks an adequate sample size to examine the DBE program on state or federal levels. Marion's research covers two-and-a-half years of data for one state, and Lee's covers one year of data for a different state. Although identified as a variable for each study, the Engineer's Estimate seems to take a back seat in the analysis.

This research will have secondary impacts. This research will highlight the importance of an accurate and complete Engineer's Estimate. The Engineer's Estimate acts as the baseline for the project as competitive factors and regulations are often ignored (Shane et al., 2009). The Engineer's Estimate provides the most basic form of cost as expressed by Shane et al. (2009). By utilizing Bid Difference, the "as-planned" cost associated with the Engineer's Estimate can be compared with the pricing reflective of the current market of the Winning Bid. When these two are compared, the impact of competitive factors and regulations can be isolated/explained. This study will advance the subject matter by increasing the depth of analysis. Instead of examining only a specific state over a short period of time, this research aims to examine as many states as possible in a cross-sectional manner, including over 11 years of data.

The study will examine 18 selected state DOTs to determine whether the program incurs increased estimated construction costs. Analysis will be performed on a state level and at a system level. For introductory purposes, the system level will be referred to as the Aggregate National Sample (ANS). For clarity purposes, the term *state* and *sample* will be used interchangeably. Sample will include the Aggregate National Sample in conjunction with each state. These states' published bid data from 2008 to 2018 will be statistically analyzed to determine whether there is a relationship with Bid Difference and DBE Participation Goal percentage. Bid Difference is expressed as the relationship between the Engineer's Estimate and the Winning Bid value. Bid Difference is often expressed as a percentage based on the following formula: $\frac{Winning\ Bid - Engineer's\ Estimate}{Winning\ Bid}$.

There is a specific reason for the selection of these 11 years of bid data. During this period, there have been significant changes to the DBE program. The period of 2008–2011 can be classified as pre-Office of the Inspector General (OIG) results. During this period, cases of DBE fraud were occurring with enough frequency to warrant an OIG investigation. It is noteworthy to indicate that this period also includes the Great Recession. From 2012 to 2016, the DBE program saw some significant changes, primarily the OIG investigation and Final Rule regarding the clarification that the DBE program is not quota-based. The period of 2016 to 2018 will determine whether there were impacts on the DBE program because of the OIG results and the 2016 Final Rule.

A cost vector will be used to determine each variable's impact. The term *cost vector* combines two statistics to best represent the impact of each variable. Cost vectors are the combined value of each sample's average variable multiplied by its Ordinary Least Squares (OLS) regression coefficient. The creation of this statistic intends to provide each variable with the same weight of effect. For instance, the impact of a 10% DBE Participation Goal does not carry the same effect as a project with 10 bidders or a project duration of 10 calendar days. For this reason, the represented cost vectors and/or explainable net impact of each variable will be used to determine the results for hypothesis testing.

The terms *net explainable deficit* and *net explainable surplus* need to be clarified. Net explainable deficit/net explainable surplus will be used to describe a relationship that either causes

Bid Difference to increase or decrease in absolute terms. Net explainable deficit/net explainable surplus will be calculated by multiplying the cost vector by each state's total Bid Difference. As the literature review will show, there has been limited examination regarding this purpose, that is, studies have been limited to only two states. The purpose of this study is to examine the DBE program from a program level, meaning examining as many states as feasible. This will determine whether the cases examined are an anomaly for the program or whether the program is flawed.

1.4 Research Questions and Hypotheses

The research questions are as follows:

1. What relationship, if any, do DBE Participation Goals have with Bid Difference?
2. Does this relationship vary state by state? If so, how many states?
3. Do other factors have a more impactful relationship with Bid Difference on a program scale?
4. Do other factors have a more consistent relationship with Bid Difference on a state-by-state scale?

The hypotheses and method of resolution for each question are as follows:

H0: There is not a relationship between DBE Participation Goals and Bid Difference.

H1: There is a relationship between DBE Participation Goals and Bid Difference.

Criteria for failure to reject the null hypothesis will be determined by examining *p*-values of OLS regression values of DBE Participation Goal on an Aggregate National Sample (ANS) level. If DBE Participation Goal >0.05, failure to reject the null hypothesis will occur.

H0: Relationships between DBE Participation Goals and Bid Difference do not vary by state.

H1: Relationships between DBE Participation Goals and Bid Difference do vary by state.

Criteria for failure to reject the null hypothesis will involve each state's coefficient significant to the >0.05 level. If each state does meet the >0.05 level of significance, failure to reject the null hypothesis will occur.

H0: Other variables do not have a more impactful relationship with Bid Difference on a program scale.

H1: Other variables have a more impactful relationship with Bid Difference on a program scale.

The term *impactful relationship* will be determined by each variable's dollar impact. Criteria for failure to reject the null hypothesis will be determined by analyzing the total dollar impact of the DBE Participation Goal. Other variables will be compared for their absolute value in explainable difference. If other variables do not exceed the explainable value of DBE Participation Goal, failure to reject the null hypothesis will occur.

H0: Other variables do not have a more consistent relationship with Bid Difference on a state level.

H1: Other variables have a more consistent relationship with Bid Difference on a state level.

The term *consistent* will relate to the total amount of observations of each variable on a by-state basis. Criteria for failure to reject the null hypothesis will be determined by the total number of significant observations of DBE Participation Goal and all variables in the OLS regression. The DBE Participation Goal will be further observed for similar direction (i.e., negative or positive correlation). If other variables do not exceed the recorded observations of significance for the DBE Participation Goal, failure to reject the null hypothesis will occur.

1.5 Significance of the Study

Per Executive Order 12291, all publicly funded programs in excess of $100 million are required to have a cost-benefit analysis performed before implementing the programs. The status of the DBE program's creation of a cost-benefit analysis remains unconfirmed. To date, no cost-benefit analysis has been published for the DBE program. The intent of this work is to be the preliminary phase of determining a cost-benefit analysis for the DBE program. This work is significant because it will enable FHWA and DOT representatives to quantitatively decide whether there are associated additional costs of the program. This work is significant because it will enable FHWA and DOT representatives to quantitatively decide whether DBE Participation Goals increase project cost. There are a lack of documented benefits and costs for the program. Numerous studies by the FHWA have been able to illustrate issues with the DBE program. These studies state that the DBE program has administrative issues that open itself up to fraud and abuse. Despite these known issues, no analysis has been performed nor have any changes been adhered to. The objective of the paper is to analyze bid data using OLS regression coupled with summary statistics to provide a “bottom-line” analysis. This analysis will determine whether additional economic costs are correlated with the program. The analysis will include an examination of the DBE Participation Goal effect on Bid Difference. Additional variables will be included in the study to ensure that DBE correlation is presented in an unbiased manner. These variables will illustrate the microeconomic and macroeconomic influences that effect highway procurement. Using this research, policy makers will understand the quantifiable costs of the program. This understanding can set a basis for improving the program to ensure that the allocated funds are put to proper use, thus saving the public funds to be earmarked elsewhere.

As Chapter 2 indicates, there have been several documented government investigations and rulings surrounding the program. These issues provide negative representation of the DBE program. Despite this portrayal, recommended changes have yet to occur. This study aims to be the catalyst for the requirement set forth in Executive Order 12291, which requires a cost-benefit analysis to be performed for any large program. By providing the associated costs, policy makers need to examine the benefits that the program does or does not provide. This research intends to analyze the cost portion of the cost-benefit analysis.

This study is essential because it illustrates the issues with the DBE program. This magnification will require that policy makers look at the mechanics of the program to determine what changes, if any, are required. By assigning a hard dollar value to the program, the need to examine how and whether the program provides the opportunity to those who are deemed disadvantaged can be provided.

1.6 Assumptions

The assumptions of the study are as follows:

1) The Engineer’s Estimate is valid and accurate. There is no method obtained to validate or confirm whether the Engineer’s Estimate considered the means and methods, or interpreted the scope of work in the same manner as the contractor who was awarded the bid. The

researcher assumes that the Engineer Estimate and Winning Bid reflect a reasonable construction cost.

2) The data provided is accurate. Where possible, data points were randomly spot-checked to confirm accuracy. Where accuracy was of concern, assumption 3 prevailed.
3) There is one or more bidder on each project. Data points have been removed where obvious concerns of accuracy are indicated, these include samples where the Engineer's Estimate or Number of Bidders were 0.
4) No omitted or intentionally inaccurate data was provided by DOTs. It is assumed that through FOIA requests, all information provided is accurate, complete, and in accordance with state law. It is assumed that the Freedom of Information Act (FOIA) process did not intentionally withhold pertinent information unless specifically allowed and referenced by law.
5) Data from Winning Bids are complete and accurate. The Winning Bidder's contract was awarded due to compiling a complete and well-thought-out estimate and that the estimate was not low due to any errors in pricing.

1.7 Delimitations

The study is delimited by the following conditions:

1) Bid Difference is used as the dependent variable in the model. The estimating process is subject to alternate interpretations regarding means, methods, productions, and risk. It is understood that there is a variance on pricing from project to project or estimator to estimator (Alroomi, 2012). To create consistent analysis, Bid Difference is the dependent variable for the study. If attempts were made to recreate the estimate, many resources would be required to price all 60,000 estimates/observations. Even if this scenario were to occur, there would be no guarantee that pricing would result in the same outcome. Variables that impact this outcome would include, but are not limited to, subcontractor and/or supplier quotes and bias/preference for the project. It is acknowledged that Bid Difference does not capture all these human aspects that cannot be replicated.
2) This study does not examine projects that were either rejected or re-advertised for award. Due to this scenario, the model creates a ceiling in terms of Bid Difference. As the summary statistics show, DOTs were likely to award projects well below their estimated value.

3) There were no attempts to collect non-winning bids (i.e., 2nd, 3rd, etc. place bids). An attempt to collect non-winning bids would have created delimitation in the responses because some states did not keep adequate records of non-winning bidders.

1.8 Limitation of the Study

The research encountered unexpected issues that limited the study. These issues include the following:

1) Response rates by DOTs were 34%. Planned response rates were expected to be over 75%. Data from 52 DOTs. The 52 DOTs include 50 States, Washington DC (DC) & and Puerto Rico (PR) were requested via the FOIA. The FOIA process yielded data from a total of 18 states. The FOIA process became an extensive and gradual procedure that will be further elaborated in Chapter 3: Data Collection Strategies. Due to various state laws, most states did not have to release the Engineer's Estimate as a result of the information being deemed as pre-decisional. The exclusion of the Engineer's Estimate rendered all other bid data useless.
2) The Aggregate National Sample linear regression, and state specific regressions, yielded low adjusted r-squared values. The initial goal in the research was to examine states that yielded adjusted r-square values of 0.50 and higher. None of the states included in this sampled yielded these results. With the help of Purdue's Statistical Consulting Services (SCS), attempts were made to increase the significance of the variables by the use of sophisticated statistic methods. These methods increase the adjusted r-squared values by 2 percentage points. Due to the small increase in adjusted r-squared, but increased complexity, linear regression was performed.
3) The sample appears as a slightly heteroscedastic relationship. Attempts to resolve this issue were performed. The level of heteroscedasticity was minor when compared to the sample size in this research. The researched needed to weight the options of increased model complexity for minimal increased results. Additional tests were performed that took heteroscedasticity into account and yielded similar, but not identical, results. The regression can still be considered valid, but not a best linear unbiased estimate (BLUE).
4) There is the possibility of missing variable bias, as directed by points 2 and 3 listed previously. Additional variables were attempted but yielded fruitless results.

5) Some states did not provide complete datasets or included data with missing variables. Some states did not provide the requested 11-year time frame. These states include Utah and North Carolina. Massachusetts provided bid data for the requested years, but for several years did not track DBE Participation Goals and thus could not report each project DBE Participation Goal.

1.9 Organization of the Study

This chapter provided a brief history of the DBE program, along with a brief introduction to the problems that the DBE program faces. It also provided the purpose and significance of this study. Further, this chapter set the basis of the study by identifying the assumptions developed and communicated how the study is constrained

Chapter 2 will introduce literature that provides a more in-depth understanding of the issues that the DBE program is currently facing. These issues include economics, government intervention, and fraud.

In Chapter 3, the framework and methodology are presented. Detail regarding the design, data collection methods, confirmation or reliability, and validity of the study is also provided. In addition to these topics, Chapter 3 identifies the variables and statistical tests chosen for this study. Chapter 3 also provides the rationale for variable selection.

Chapter 4 provides in-depth results of each statistical test in two manners. The first manner examines the aggregate of each state to best reflect the program throughout the country. The second manner analyzes the program on an individual state level.

Chapter 5 provides a summary of each test that answers the research questions. Once these results have been summarized, conclusions, recommendations, and discussion regarding the results are given.

CHAPTER 2. REVIEW OF RELEVANT LITERATURE

Chapter 2 examines the history of the program, cost implications of the program, federal investigation findings, criminal studies, and insights into the program. Chapter 2 then transitions into relevant literature used for variable selection.

The DBE program has been involved with controversy since its creation. In the 35 years of its existence, the DBE program has been through multiple revisions to clarify the intent and mechanisms of the program. Despite the program's good intentions, there has been resistance from those involved with the program. Issues questioning additional economic costs, administration of the program, and the constitutionality of the program have been core issues of the program's critics.

Chapter 2 provides extensive analysis from all parties involved in the program. Extensive analysis will provide a consistent narrative that will highlight issues with the program from all parties. The significance of the study can be better understood by highlighting these issues. Chapter 2 provides documented evidence that exceeds anecdotal evidence observed in industry. The literature presented provides legitimate findings that bolster the claim of additional costs associated with the DBE program.

2.1 Economic Case Studies

A 1993 study discovered that a total of 72% of Engineering News Record (ENR) top 400 contractors perceive that DBE regulations have increased the cost of their projects (Koehn, 1993). These additional economic costs ranged from 3.62% to 3.94% for contractors in the heavy-highway sector. Koehn (1993) stated that the DBE program provides a lack of benefit to the public. The study found that of the firms involved in this survey, 80% do not believe DBE regulations benefit the general public, 93% felt that the DBE did not benefit the non-minority contractor, and 59% did not benefit the minority construction worker.

99% of states and transit authorities surveyed by the Government Accountability Office (GAO) had not conducted studies to determine whether the DBE program affected their contracting costs (Taylor, 2009). In this study, Taylor (2009) examined DBE Participation Goals in the state of Tennessee (TDOT) from 2005 to 2008. During these years, DBE Participation Goals ranged between 8.00% and 9.87%. Taylor (2009) discovered that, the higher the DBE Participation

Goal set, the higher the Bid Difference of the project. Taylor (2009) found that Tennessee DBE subcontractors are generally concentrated in areas of work such as guardrail installation, pavement marking, trucking, and landscaping. Taylor (2009) indicates that these areas of practice are often flooded with DBEs for two reasons. First, they seem to have the lowest barriers for entry in both capital and experience. Second, the TDOT encourages DBE entry into those areas. By limiting selections in these areas, Taylor (2009) stated, "Shadow costs occur because participation goal requirements create a binding constraint on the selection of subcontracting firms." Taylor (2009) indicates a variety of reasons for this increased cost among DBEs. These reasons include a small pool of certified DBEs, a limited number of "true" DBEs, and "front" companies that provide a higher markup due to limited subcontractor selection. These types of companies are referred to as *pass-through companies*.

In 1996, California created Proposition 209, which prohibited any consideration of race or gender for state-funded projects. The creation of Proposition 209 created a unique scenario to compare the impact of DBE participation. Proposition 209 created a rare situation where projects with similar work, but different contractual requirements could be compared in real time. To further investigate the associated costs of the DBE program, economics professor Justin Marion (2009) directly correlated federal-funded and state-funded highway contracts. The results stated that when DBE Participation Goals are included in a project, the cost difference increases approximately 5%. Marion (2009) goes into further detail regarding the surplus of this value. Marion's economic models presented a $64 million surplus when comparing costs of the federally funded projects. This surplus was created by reducing DBE Participation Goals to 9%. These goals were not eliminated, merely reduced. Marion (2009) explains why these considerable savings exist. These savings include having a contractor self-perform or do a buy/build analysis instead of being tied to "buy" a subcontract with a DBE and the option to choose a subcontractor from a level playing field. The concept of buy/build analysis is related to Porter's (2008) theory of competition.

DBEs and non-DBEs face similar types of financial issues, but at different rates. In the *Journal of Issues in Engineering*, Chang (1989) analyzes issues that contractors face regarding entry and existence in the heavy-highway market in Florida. Chang (1989) examines factors such as the ability to finance, bonding, labor issues, supervisory issues, and competition. Chang surveyed two separate groups: DBE contractors and non-DBE contractors. Chang (1989) found that both groups face difficulty with financing and boding due to institutional restrictions associated with risk assessment. Both groups have problems with bonding that include scrutinization of previous projects, credit rating, management ability, and financial stability (Chang, 1989). Chang's (1989) research provides benefit to the industry because he statistically analyzes how these two separate groups face the same issues at different frequencies. Chang (1989) finds that 55.8% of DBEs had a lack of finances as their primary issue, while 34.2% of non-DBEs shared a lack of financing as their central issue. 23.4% of DBEs have issues meeting loan requirements, while only 11.0% of non-DBEs have the same problem (Chang, 1989). This disparity of availability of financing presents the argument that DBEs are limited in their capacity and, as such, cannot grow their business. Further, Chang (1989) notes that there is a disparity regarding access to bank credit as non-DBEs face a rate of 7.4% less than DBEs. The study discovered that bonding could be a major issue when there is not adequate working capital. The lack of bonding further complicates company finances. This issue creates a paradox where contractors cannot gain experience without having bonding but cannot be bonded due to a lack of experience. Chang's (1989) findings are often incorporated into the GFE process. Due to Chang's (1989) findings, additional options in bonding and financing to perform a satisfactory GFE are to be provided by contractors in their GFE.

As of 2018, there has been a limited study of how a DBE program benefits or harms DBE firms. There has also been no published study that supports or rejects the notion that these programs assist in the development of a DBE firm. In 2011, Fairlie and Marion (2012) researched the effects that affirmative action has on the self-employment of those it stands to include/protect in the states of California and Washington. They discovered that self-employment by minorities and women increases when affirmative action is eliminated. Several explanations are provided as to why there may be an increase. These explanations include the types of businesses they start, labor market, age of company, and elasticity of the market. Fairlie and Marion (2012) provide little to no quantitative data to back the results of their study. They state that the primary explanation for this increase could simply be that, when there is a lack of affirmative action, minorities and women are not hired. They state that the lack of affirmative action results in minorities and women becoming self-employed.

The Federal Executive Branch has declared that careful examination of how those costs provide benefits to the public must occur. In 1981, President Reagan issued Executive Order 12291. This executive order was intended to reduce the burden of current and future regulations. It also required that, when agencies expect a program to impact the economy in excess of $100 million, they must meet specific requirements to ensure that social benefits outweigh additional costs. Executive Order 12291 provided three requirements for cost-benefit analysis. The first requirement ensures that adequate information concerning the need and consequences of the proposed action be provided. The second requirement ensures that the program not be undertaken unless the potential benefits offered to society outweigh additional potential costs. The third requirement ensures that the net benefits are maximized while delivering the least net cost. Since 1981, there have been four additional executive orders that have expanded this requirement: Executive Orders 12866 (Clinton), 13422 (Clinton), 13535 (Clinton), and 13563 (Obama). Executive Order 13563, titled "Improving Regulation and Regulatory Review," aimed to improve the accounting for benefits and costs, both quantitative and qualitative, ensuring that regulations are accessible, consistent, written in concise language, easy to understand and measure, and that they seek to improve the actual results of regulatory requirements. Executive Order 13563 aimed to improve regulation and review by taking the following actions:

1) Propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify).
2) Tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives while considering to the extent possible, among other things, the costs of cumulative regulations.
3) In choosing among alternative regulatory approaches, select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages, distributive impacts, and equity).
4) To the extent feasible, specify performance objectives rather than specifying the behavior or manner of compliance that regulated entities must adopt.
5) Identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

These economic findings raised some critical questions worth consideration. As Chang (1989) illustrates, there is inequality regarding how DBEs and non-DBEs receive financing. One requirement in the GFE is to provide DBEs access to financing (eCFR, 2018). The Code of Federal

Regulations (CFR) does not assert that DOTs are responsible for finding or providing DBEs with working capital, nor does the CFR assert that DOTs are required to pursue action against discriminatory loan practices. It can be determined that DOTs skirted loan oversight responsibility and transferred it to the contractor through the GFE clause. There are clear issues with these new responsibilities inherited to contractors, the most basic issue being that contractors do not function as banks. The role of the contractor is to build, and the role of the bank is to finance. Contractors have no responsibility to finance others any more than bankers have an obligation to repair the interstate system. This situation poses a conflicting role for contractors, which creates the role of builder-financier. This dual role places contractors in a leveraged position. Just as Chang (1989) mentions, financial institutions require a high level of risk assessment. If the risk is too high for a financial institution, then it will not issue financing. GFE requires contractors to finance subcontractors that financial institutions view as risky investments. This circumstance provides additional issues, which will be covered in Section 2.4.

2.2 Government Accountability Findings

In 2008, the Government Accountability Office (GAO) researched the level of oversight on the DBE program. The GAO (2008) found that the FHWA does not track whether each state is meeting its DBE Participation Goals. The GAO (2008) concluded that the FHWA faces two program administration problems: The DBE Program effectively tracks neither DOTs commitment to spending on DBEs nor the year each DBE performed the work.

In rebuttal to the 2008 GAO findings, the Office of the Inspector General (OIG) published a report in 2013 titled "Weakness in the Department's Disadvantaged Business Enterprise Program Limit Achievement of Its Objectives" (FHWA, 2013a). This report stated that the FHWA did not provide effective program management of the DBE program. The report reviewed 15 states at random over an 18-month period. During this review, 14 out of 15 states lacked clear DBE guidance and experienced a variety of issues regarding program oversight. The report discovered that DOTs placed more emphasis on DBEs' certification than DBE development. Additionally, the Inspector General found that the FHWA has not established any form of accountability to manage the DBE program in its 35+ years of existence. The report also stated that the FHWA did not adequately oversee or implement the DBE program because a lack of standardization and guidance was present. The study found that this lack of supervision was delegated to each state

DOT. Each DOT was required to determine to how to administer programs on their own. This individualism resulted in a myriad of issues. The study also found that less than 20% of the DBE firms received work on FHWA-funded projects. Most importantly, the OIG stated that this lack of oversight increased the risk of DBE fraud.

The qualifications to become a DBE are unclear. There are no real guidelines for what constitutes who is and who is not at a socioeconomic disadvantage. This lack of clarity has created additional issues with program administration. Traditionally, the term *disadvantaged* has been reserved for any minority or any woman who owns 51% or more of a company and has a personal net worth of $1 million. The traditional approach does not actively reflect a social disadvantage. By defining socioeconomic disadvantaged by net worth, a conflicting paradigm is created. For instance, a low-income white male could be faced with the same level of discrimination as a low-income female or a low-income minority business owner. To take the example to a further case, a non-DBE business facing foreclosure could carry the same level of disadvantage as a DBE company. Or to present the case from a practical point of view, two companies that have similar work experience and socioeconomic status may present discrimination based on the DBE status, which will provide preferential treatment due to race or gender, not on barriers facing two similar contractors.

Adarand v. Pena (1995) established the requirements for what constitutes a disadvantaged firm. This Supreme Court ruling challenged the constitutionality of the DBE program. In 1989, a Colorado-based non-DBE subcontractor, Adarand Constructors, Inc. (Adarand) was the low subcontract bidder for a prime contractor. However, Adarand was not awarded the subcontract because the contract would not count towards a DBE Participation Goal. If the prime contractor hired Adarand, then the contractor would not meet the established DBE Participation Goal. The contract was awarded to a DBE that cost more than Adarand. Adarand filed suit against the Colorado DOT, stating that the DBE clause violated the 14th Amendment of the Constitution. The court ruled in favor of Adarand. Adarand was never issued the contract because the case spent several years in litigation. The Supreme Court ruled that "racial classifications must be analyzed under a strict scrutiny standard and such classifications are constitutional only if they are narrowly tailored measures that advance compelling governmental interests" (Adarand v Pena, 1995). The interpretation of ruling states that there needs to be a clear and concise method used to determine who is disadvantaged. It is worthy to note that there were several iterations of Adarand challenging the constitutionality of the DBE program. These subsequent cases were dropped once Adarand became a certified DBE in Colorado, despite being under white-male majority ownership (U.S. Department of Justice [DOJ], 1999).

The concept of strict scrutiny relies heavily on the determination of whether the DBE program is goal based or quota based. The differentiation of the meanings of these two words are important. The term *quota* indicates that there is a strict requirement to adhere to the value of the DBE Participation Goal indicated. The term *goal* suggests that there is an attempt to meet the amount of DBE Participation Goal but no punitive action if the goal is not met. A goal is seen as a passive attempt to reach the DBE Participation Goal. A quota is seen as a by-any-means-necessary responsibility to meet the DBE Participation Goal value. Given this understanding, a quota does not meet the DBE Participation Goal because it indicates a strict requirement to obtain participation. Conversely, a DBE Participation Goal meets the requirements of strict scrutiny as it is an attempt, not a strict requirement.

Ten years after Adarand's final ruling, the U.S. Commission on Civil Rights noted "that federal agencies still largely fail to consider race-neutral alternatives as the Constitution requires" (U.S. Commission on Civil Rights, 2005). The DBE program has the potential for amendment. For instance, after Adarand, the FHWA clarified the intent of the program. These mechanisms for change or clarity are referred to as a *Final Rule*. The FHWA (2013b) stated, "The DOT DBE program is not a quota or set-aside program, and it is not intended to operate as one. To make this point unmistakably clear, the Department has added explicitly worded new or amended provisions to the rule."

One major result of the issuance of a Final Rule occurred in 1998. After the 1998 Final Rule, there was congressional discussion that debated whether the Final Rule was still, as some interpreted the program, a set-aside program. During this debate, Senator Mitch McConnell stated, "In other words, there are sanctions. The same threats appear in the Federal Transportation Regulations. When the Federal government is wielding that kind of weapon from on high, it does not have to punish them. A 10 percent quota is still a quota, even if the States always comply and no one is formally punished" (FHWA, 2014). In rebuttal, Senator Joe Lieberman indicated that, to date, state DOT funding had not been revoked to any state not meeting their goals. Lieberman further stated that, if states fail to meet their own goals, there is no federal sanction or enforcement mechanism. At the time of this debate, the FHWA had not clearly and concisely illustrated that there is no punitive damage or removal of funding if states do not meet their goals. It took several revisions of the DBE program's Final Rule(s) to communicate this point clearly and concisely. To date, there have been eight Final Rule(s) issues and 15 additional modifications to the program (FHWA, 2015a).

Several states have been involved in litigation over strict scrutiny. These states have included, but are not limited to, Colorado, Minnesota, California, and Illinois (Parvin, 1999). As indicated by Adarand v Pena (1995), Colorado ruled the DBE program unconstitutional. In the September 21, 1998, issue of *Engineering News Record*, Ichniowski (1998) reported the findings of Judge James M. Rosenbaum's ruling that the DBE program in Minnesota was "not narrowly tailored to serve a compelling government interest" based on "the terminology or palliative applied, whether the program be called an 'aspirational goal' or ameliorated by a 'flexible waiver,' the bottom line is that there is still a quota that is imposed by the government. This quota penalizes some and advantages others, each without constitutional justification." In California, the Associated General Contractors of America, San Diego Chapter, Inc. v. California DOT, argued the concept of strict scrutiny and lost in the Ninth Circuit of Appeals. In Illinois, several cases, including but not limited to Northern Contracting Inc v. Illinois, Midwest Fence Corporation v. United States DOT, and Dunnet Bay v. Illinois, argued the basis of strict scrutiny. Each Illinois case lost in federal court appeals.

2.3 Fraud

DBE fraud consumes a total of 35% of the DOT OIG's active grant and procurement fraud cases (McVicker, 2016). Principal Assistant IG for Investigations Michelle McVicker provided a clear and concise explanation of DBE-related fraud's impact. McVicker (2016) explains that a DBE utilized for a non-commercially useful function is committing fraud. The term *non-commercially useful function* means that the DBE provides no significance or impact to the project aside from DBE credit. Taylor (2009) previously referred to this term as a *shadow cost*. When a DBE is utilized in this manner, it is often referred to as a *pass-through company*. A pass-through company acts as an artificial company that all paperwork and DBE credit will pass through to the subcontractor or vendor, but the DBE will perform no services. McVicker (2016) states that DBE fraud is often associated and charged with other crimes such as bribery, extortion, money laundering, and tax fraud. Principal indicators of DBE fraud include the owner of the DBE company lacking the background, expertise, or equipment to perform the work. Another indication is when the prime contractor facilitates the purchase of the DBE-owned business or, in other words, facilitates the financing of a company. From 2011 to 2016, over $245 million in restitution related to DBE fraud was claimed. In this same period, those found guilty of DBE fraud were sentenced to a total of 425 months of incarceration.

The GAO published a 1989 report that assesses DBE fraud and abuse in DOT programs. The report stated that most DBE fraud included businesses owned by white males who have transferred legal ownership to their wives or minority employees. In this report, the GAO (1989) examines only two states: New York and Pennsylvania. The GAO (1989) discovered that the extent of the fraud and abuse nationwide was a result of the FHWA not having the data necessary to measure the extent of the problems. At the time, the FHWA relied primarily on irregularities that primarily involved ineligible businesses that engaged in questionable arrangements. As a result of the report, a total of 89 investigations were created, with a total of 32 being closed without any action. The 1989 report provides proof of the longstanding issues of the program. The knowledge of DBE fraud has been widespread and longstanding, but the action(s) taken to eliminate such fraud has been minimal. At the time of this report, the DBE program was five years old. These findings were similar to those of the 2008 GAO report.

The frequency and severity of DBE fraud is wide casted and yet to be quantified. McVicker (2016) has successfully prosecuted over $200 million in DBE Fraud. Two cases include a case between Marikina and Schuykill Products, and a case between Karen Construction and Weber Steel. In the Marikina and Schuykill Products case, it was determined that, for 15 years, Schuykill Products utilized Marikina as a pass-through DBE for a total of 339 projects. The Karen Construction and Weber Steel case featured a similar scenario with 224 cases of DBE fraud over 16 years. In 2011, a prime contractor in Chicago was involved in a DBE fraud case involving Elizabeth Perino, the owner of two DBE pass-through companies. Between 2004 and 2011, Perino's two companies, Perdel Contracting Corporation and Accurate Steel Installers, were fraudulently awarded over $50 million in contracts in the Chicagoland area (U.S. Attorney's Office, 2012). This was not the first DBE fraud case in Illinois. It was later discovered that Perino's cooperation was the direct result of a similar fraud case. Perino claims the only reason her operation was uncovered was because another DBE pass-through company reported her to gain favor in court. This additional pass-through, Diamond Coring, was doing business as the DBE firm

Stealth Group, Inc. Stealth Group had “set her up to win favor of prosecutors who were also investigating” Diamond Coring for DBE fraud at the same time (Slowey, 2017). Diamond Coring was also charged with fraud for obtaining more than $2.3 million in DBE pass-through contracts.

2.4 Other Research

A common theme in this chapter is a lack of administrative controls. Each of the previous findings failed to identify issues that program administrators face. If issues are not identified, they cannot be fixed. Orndoff, Papkov, Behney, and Lubart (2011) interviewed several program administrators and found that program administrators faced challenges with DBE enforcement. The research provides insight into the issues program administrators face while overseeing the DBE program. Program administrators face issues that include negative interaction with prime contractors, the number of DBEs available for work, and lack of enforcement of DBE Participation Goals by the FHWA and DOTs (Orndoff et al., 2011). Orndoff et al. (2011) suggest that the program can improve by providing additional supportive resources to reduce the administrative burden and offer more funding to provide such resources. Furthermore, the research discovered that the number of issues related to the DBE problems is linked to prime contractors underutilizing DBEs.

In the ASCE’s journal *Constructability Concepts and Practice*, Sarah Picker (2007) published “Using Transportation Construction Contracts to Create Social Equity.” In this article, Picker (2007), a senior transportation engineer at Caltrans, presents the inequities that DBEs face in the construction industry. Picker (2007) advocates for the use of federal dollars in the DBE program as an outreach program to teach DBEs fundamental managerial skills in construction. Picker (2007) identifies estimating, job costing, and accounting as fundamental managerial skills. She recommends contractors to track the availability of DBEs to provide all tangible opportunities for DBEs in their market. Picker (2007) then states that contractors should provide better short-term lending programs sponsored by the FHWA. She provides several recommendations to build social equity. The responsibility of the recommendations falls exclusively on the contractor. They include contractor-financed lending programs, DBE availability tracking, and skills training.

Despite the size of the program, few have graduated from it. A recent estimate show that less than 2% of DBE firms graduate the program. In the 2019 *Compendium of Successful Practices, Strategies, and Resources in the US DOT Disadvantaged Business Enterprise Program*, the

National Academy of Sciences (NAS) examined 11,000 DBE firms and discovered that only 749 graduated the program. The study, performed by Keen Consulting (published by NAS), examined DBE firms in all 50 states. The study found that DBEs face barriers that prevent them from graduating. These barriers include limited access to capital, state DOT prequalification, no formal mentoring process, and a lack of individualized assistance by state DOTs (NAS, 2019). There are disincentives for DBEs to graduate the program (NAS, 2019). These findings are not in accordance with the FHWA's DBE Supportive Services. The DBE Supportive Service supplies up to $10 million annually to provide training, assistance, and services to firms that are certified in the DBE program. The intent of this program is to facilitate the DBE firms' development into viable, self-sufficient businesses capable of competing for, and performing on, federally assisted highway projects (FHWA, n.d.b).

Additional studies have found that there is a disparity in the types of DBEs. This disparity is universal, both in DBE firms that are not registered but also graduated from the DBE program. The research of both the NAS and Marion have each found that white women are at nearly 2:1 of the DBE pool. This finding supports the findings of the numerous GAO reports and the findings of Fairlie and Marion (2012). White women have often started a DBE company due to a spouse's or parent's previous involvement in the industry (NAS, 2019). This logic is in direct conflict with what regulates entry into the DBE program. In other words, even certified DBEs can act as a legal pass-through.

2.5 Competitive Forces Affecting Bid Difference

In DOT project procurement, bids are submitted in a non-negotiated matter. This lack of negotiation pits companies against each other in a way that best value is ignored. Contracts are awarded merely on price. The basis of award creates a clear example of competition among contractors. In the case of DOT contracting, competition can take many forms. The primary intent of this section is to identify what the types of competition are, how they can be measured, and why they are important to this study.

During a portion of this period examined, documented cases of extreme competition were observed (Danforth et al, 2017). Such examples included new competition entering the market due to a near halt of all commercial projects during the Great Recession. This halt of commercial construction created an influx of bidders entering the heavy-civil marketplace. This influx forced contractors to reduce cost. These cost reduction methods included improving efficiency, reducing overhead, or removing profit to remain in the market as indicated by Tansey et al. (2014) and Lim et al. (2010). During the Great Recession, the FHWA noted in Report MH-2013-012 that DOTs averaged 18% in their budgets due to previous factors listed. The acknowledgment that competition will lower bid cost is well documented, with other works by Wilmot and Cheng (2003), Alroomi (2012), and Hegazy and Ayed (1998) all supporting the claim. As such, the number of bidders was chosen to represent direct competition amongst bidders. This is referred to as *direct competition*.

Additional types of competition exist aside from direct competition. As Hegazy and Ayed (1998) indicate, contract size has a significant impact on project costs. They define size by dollar value and by duration. Wilmot and Cheng (2003) further build on the works of Hegazy and Ayed (1998) by expanding competition to include year and season. Further support of these variables' significance arises from the works of Shane et al. (2009). They state that Engineer's Estimates are often overshadowed by economic, societal, and political challenges that influence the cost. Due to these challenges, the Engineer's Estimate cannot accurately predict cost in the distant future. Shane et al.'s (2009) work provides two important findings. The first is that Engineer's Estimates often exclude future market conditions because they are unable to prognosticate future conditions. Secondly, factors such as macroeconomic indicators and societal/political indicators should be included in the study to best examine market conditions present in the procurement process.

Shane et al. (2009) discuss the omission of economic indicators. The variables Unemployment Rate, Standard & Poor's 500 Index (S&P 500), and Volatility Index (VIX) were included as variables. To reflect the impact of the Great Recession, unemployment rate was selected for inclusion. The S&P 500 is composed of 500 large companies across differing industries. This large representation of all markets prevents misrepresentation if a specific sector is in an unhealthy cycle. The S&P 500 is considered one of the most common indicators of the status of the overall economy because of its large scope. In addition to the S&P 500, the Chicago Board of Options Exchange (CBOE) created the VIX, which is a calculation designed to produce a measure of 30-day expected volatility of the S&P 500. CBOE's VIX is considered one of the most recognized measures of volatility. VIX is often referred to as the "fear index" because it represents uncertainty in the market.

Crude oil was included as a variable due to its close relationship to economic activity. Crude oil consumption reflects current and expected levels of economic growth. Growth drives demand, and demand drives oil prices. Oil prices traditionally rise when economic activity is growing (EIA, 2020).

Through the works of Hegazy and Ayed (1998), Wilmot and Cheng (2003), and Shane et al. (2009), we can identify that competitive variables can include the number of bidders, duration of the project, the value of project, season/quarter, year, state, unemployment rate, S&P 500 index, VIX, and crude oil price per barrel. It is worth noting that in this research, the terms *duration* and *days* are used interchangeably.

2.6 Summary

There are positive and negative aspects of the DBE program. The program provides minority groups the opportunity to own and develop a business where diversity is needed. However, the program has administrative issues that have resulted in economic, legislative, and legal issues. The program is a multibillion-dollar annual program and has been in existence for over 30 years. Advocates of the program state that the DBE program is meant to better assist those who are economically and socially disadvantaged. Advocates of the program have illustrated the barriers that DBEs have faced in a white-male–dominated industry. They also provide recommendations on how to better improve the program, including providing better financing opportunities and a mentorship/training program. Those against the program are quick to point out the additional costs associated with the program, judicial issues, and rising cases of fraud. Some go even further, suggesting that the program does not help those disadvantaged but merely benefits white women whose spouses have had significant experience in the industry (Keen et al., 2019).

Regardless of the stance one may take on the program, there appears to be a program-wide issue. Despite the age and size of the program, confusion over the understanding of simple basics for the program remains. Issues to determine the criteria of eligibility into the DBE program, how much the DBE has earned each year, or who is tracking the DBE remain fundamental issues of the program. Without an understanding of these issues, the benefits that the program provides cannot be quantified. This lack of quantification prevents a cost-benefit analysis.

The issues described in the previous portions of this research have yet to be resolved. For instance, Adarand was not considered a DBE and proved a lack of strict scrutiny during his eight court cases. He later was ruled as a DBE by the very same program he claimed discriminated against him because he was not disadvantaged. Adarand argued that the very program that aims to eliminate discrimination discriminated against him.

The method of how to better assist those who are socially and economically disadvantaged is unclear. For instance, the DBE fraud that occurred with Perino is that of a similar method that Picker (2007) expresses as a method to better assist DBEs. McVicker (2016) names indicators of fraud, such as a DBE owner lacking the expertise or equipment to perform the work and the prime contractor facilitating the financing of a DBE-owned business. Picker (2007) suggests that contractors provide expertise and financial assistance to DBEs to best enable them. There is a contradiction by those who administer the program and those who legally enforce the program. The recommendations by a senior DOT representative (Picker, 2007) to increase DBE participation are considered fraudulent by an FBI investigator (McVicker, 2016). There is a lack of clarity regarding contractors mentoring DBEs and whether they are mentoring or committing fraud. It is noteworthy to mention that it was McVicker (2016) who prosecuted both Perino and Cappello in Chicago for these same fraudulent activities.

The basics of the program have not been understood. Until 2016, the FHWA had to clarify that the program promotes a goal, not a mandated quota. It took the FHWA almost 30 years after the creation of this program to clarify that there is no punitive action to DOTs if the goals are not met (FHWA, 2013c). This position is further reinforced by the frequency and magnitude of DBE fraud cases that are discovered. Also, logic would dictate that, if there were no pressure to meet the DBE Participation Goal, then the need to fraudulently create a DBE company would not exist. Simply put, one would not risk jail time and forfeiture of profits for a requirement that does not exist.

3. CHAPTER FRAMEWORK AND METHODOLOGY

Chapter 3 provides an in-depth understanding of the methods for designing the linear regression model used in this study. Specific details about the model provide the audience an understanding of why the data was chosen, where it came from, how it was collected, how it was measured, and how it was statistically analyzed.

3.1 Research Design

Chapter 2 established the framework of the research questions with a quantitative correlational research design method. The research was conducted using FOIA requests to collect bid data to identify the correlation between DBE Participation Goals and Bid Difference. For the quantitative nature of the study, linear regression was utilized. By using this design framework, this research produces quantifiable data that is easy to interpret and that can be easily replicated and repeated as required. In addition, quantitative research methods are generally better suited for larger sample groups, as was the case in this study where the sample size is over 60,000 projects awarded.

Other regression methods were examined. Those methods yielded similar results but over-complicated the regression. Linear regression was used because it provided consistent results in a format that was user-friendly. Linear regression was chosen for its simplicity and consistency.

3.2 Participants

Participation selection was limited. Due to the limitations described in Section 1.8, participant selection became a multi-step process. The data collection process proved difficult because many states did not transmit complete data. Many states would release only partial data, deny the request, not respond to the request, or not list an FOIA Officer contact. Due to these issues, all 52 DOTs were issued FOIA requests, with only 18 replying with useable bid data. State responses were grouped into five categories: denied, incomplete/missing Engineer's Estimate, approved with missing partial data, approved, and no response. All FOIA requests were filed from January 2019 to February of 2019. The complete list of states participating in the study can be found in Table 1 and Figure 1.

The process for participant selection was as follows:

1) The initial participants were 15 states investigated in the 2013 OIG report (FHWA, 2013a). The initial framework involved an examination of the relationship between DBE Participation Goals and Bid Difference for these states. These 15 states were intentionally selected to compliment the OIG report. However, during the FOIA process, some DOTs would not release a complete bid due to public information laws applicable to their states.
2) Participants were randomly selected by assigning each state/sample a corresponding value in alphabetical order. The numbers were randomly selected from a random number generator. All states were simultaneously selected using a simple random sampling technique. The simultaneous method was utilized to eliminate any sampling bias.
3) The first 15 participants were generated. FOIA responses for bid data were filed. Just as with step 1, some states would not release complete bid data due to public information laws applicable to their states.
4) The study continued with participant selection with every 10 states in drawing order. Subsequent FOIA filings yielded similar results because some states would not release complete bid data due to public information laws applicable to their states.
5) Participant selection continued until all 52 DOTs were FOIA'd. Washington, D.C., and Puerto Rico were included in participant selection.

Table 1 Participants in the Study

California	Minnesota	Oregon
Colorado	Mississippi	Rhode Island
Indiana	Missouri	Texas
Louisiana	New Hampshire	UID*
Massachusetts	North Carolina	Utah
Michigan	Ohio	Washington

**UID = Confidential State to remained unidentified per Confidentiality Agreement*

3.3 Data Collection and Data Collection Strategy

Data was collected via FOIA requests. The methods for transmitting these requests varied. Where practical, these FOIA requests were sent through email, often to a public information officer. In some cases, official forms needed to be mailed in. In other select cases, the creation of an account to access a specific state's procedural website was required. All bid data was received through Purdue email. A few states charged a fee to generate or recreate this data. Where payment exceeded $100 per state, the request was canceled. In some cases, attempts at the waiver of payment were filed due to the academic intent and public interest.

Other variables associated with economic indicators were collected using published data from governmental agencies. These included the Federal Reserve Economic Data (FRED) from the Federal Reserve Bank of St. Louis, Chicago Board of Options Exchange (CBOE), U.S. Energy Information Administration (EIA), and the Bureau of Labor Statistics (BLS).

As described earlier, the FOIA process resulted in a gradual increase in requests. The FOIA process began in January of 2019 and closed in July 2019. Throughout this seven-month process, the average response time for complete data sets was three months.

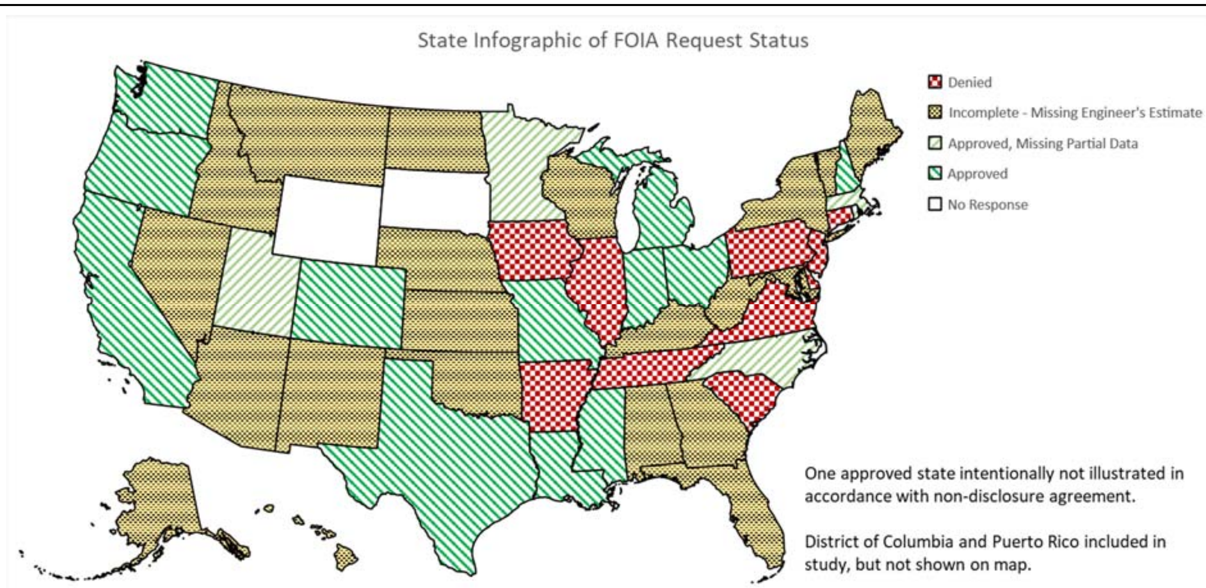


Figure 1 Infographic of DOTs Providing Bid Data

For states that did not provide complete data, several attempts were made. Some attempts include the following:

- Following several attempts to rebut Illinois' FOIA Officer's interpretation of Illinois Legislation, a lawsuit was filed through the Illinois Attorney General. This process involved three formal appeals. Each appeal involved the method of storage of IDOTs bid results and interpretation of the confidentiality concerning the Engineer's Estimate. Ultimately, IDOT did not release their data.
- After the appeal of an initial denial of FOIA request, a similar progression of the events like the Illinois condition was filed with an unidentified state. A compromise was made, and a settlement out of court occurred. Access to bid data was granted, but a confidentiality agreement was created that requires that the researcher not reveal the state from which the data came. Per the conditions of the settlement, the state wishes to remain confidential. For this study, this state has been identified as the state "UID." For this reason, certain data will be omitted for this specific state.
- For states that did not initially respond, alternate methods and/or follow-up requests were sent in. These methods included direct contact through FOIA offices, calls to agencies, and outreach to legislators. Where the states did not respond (Wyoming and South Dakota), state law does not require a response. No follow-up was attempted for these two states.

3.4 Instrumentation

The study required the use of three main instruments. Each instrument used was well-established. The use of well-established technology eliminated the concerns of validity and reliability of the study. Below are the instruments used, along with their application in the study.

- Microsoft Outlook: Used for sending, filing, and receiving correspondence of FOIA requests.
- Microsoft Excel: Used for standardizing complete bid data sets to provide a uniform input file for statistical software. Standardization included utilizing Excel to create the variables Bid Difference, Quarter, and Year. Additional uses

included the creation of various logs for data collection, creation of summary statistics where required, and creation of charts and tables.

- Stata: Used for statistical tests, charts, and tables listed in Section 3.7.

This list is neither exhaustive nor comprehensive. This portion of the research intends to provide information regarding the main instruments used, not create an exhaustive list that creates minutiae. For instance, this list does not include such items as Microsoft Word, which was used to create this document, nor does it include the use of Adobe PDF software to view or create documents.

3.5 Reliability and Validity

Establishing a study that is both reliable and valid is essential to becoming a sound study. In this study, reliability is the consistency of statistical analysis results or the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects (Pindyck & Rubinfeld, 2018)). Validity is related to the accuracy of a measurement. In this section, the researcher describes the conditions present that have the potential to harm the study, and the methods utilized to reduce the harm.

3.5.1 Reliability

This study measures reliability in two ways: Test-Retest Method, and Internal Consistency. The study was checked for reliability on two levels. The first level included checking the validity of the data. The method of triangulation was utilized in this study. Triangulation compared the results of the bid data received through FOIA requests and bid data that was openly published. This method of triangulation was utilized to ensure that there were no errors in either sample, thus confirming that the 60,000+ samples were accurate. Bid data variables were spot-checked where possible. The procedure for spot checks included downloading the FOIA result spreadsheets and copying the data into an existing tab. Published projects were randomly selected, and their variables were hard entered so that the FOIA results and published results were compared. Comparison formulas such as the "IF" and conditional formatting functions were utilized to compare the samples. The "IF" function generates a prompt if comparison conditions are violated.

The Test-Retest method was utilized for the OLS model. The ANS would act as the baseline for the test portion. The results of the ANS act as the sum of the parts for individual samples/states. Checks were performed on sum of squares (SST) and mean sum of squares (MST) values with the sum of the ANS.

The model was first tested on the Aggregate National Sample. The use of the Aggregate National Sample allowed the researcher to examine all 18 states that were included in the model. Eighteen additional models were regressed, one for each state included in this research. Coefficients and other statistics were calculated and compared to ensure that the sum of squares for the ANS were consistent. As stated previously, several statistical models were initially regressed. Although findings from these complex models will not be included, they were consistent with the results of the regression included in this study. This consistency acts as an additional test-retest method. Such statistical models included robust and cubic regression.

To ensure repeated outcomes, a "do" file in Stata was created and saved. Do files allow commands to be saved and automatically executed at the start of opening the Do file. Do files create a trackable log of commands created in Stata analysis sessions. These Do files were created to establish a manner of consistency and convenience. The use of these Do files created an additional level of consistency. Do files create the means to audit and replicate testing. This means is especially usefully for multi-stepped regressions like the process performed in this study.

3.5.2 Validity

Validity is the strength of a study's conclusions, inferences, or propositions (Alemu, 2016). The research framework focused on external validation, specifically Population Validity. Population Validity describes how well the sample used can be extrapolated to a population. Population Validity applies because the sample data translates to how well the ANS represents each state/sample.

The initial focus of the study was to replicate the 15 states listed in the OIG study (FHWA, 2013a). However, certain state legislation banned the release of the Engineer's Estimate. Because of this ban, the focus of the study transitioned from replication of the 15 states to examination of the program on a national level. Because this study aims to examine the program on a national and state level, the model needs to reflect the population, so the need for population validity is required.

There is a conflict in determining how the population should be represented in this study. The conflict requires the balance of representation between the large and small states. Just as the Constitution's framers agreed that states would be represented equally in the Senate and in proportion to their populations in the House, the same issue applies to state funding. Regardless of this scenario, the following methods were involved in checking the validity of the study.

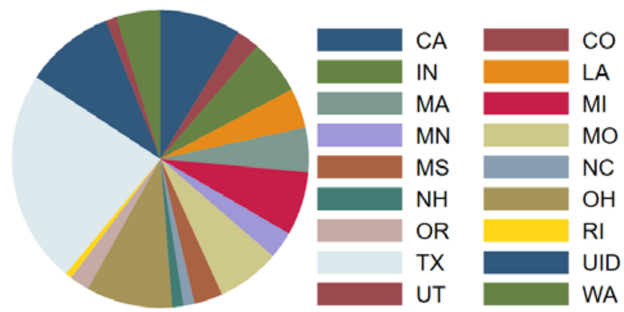


Figure 2 Values of States Total Dollar of Award, by percent

When the study is examined by the total number of states, the project is limited due to the relatively small population size. Given that the population covers all state DOTs (including Puerto Rico and Washington, D.C.), the population for the study is 52. With a low sample of 18, checks for margin of error and confidence level were less than ideal. The margin of error resulted in 19%. The margin of error is calculated as $\frac{Z * \sigma}{\sqrt{n}}$, where n = sample size, σ = population standard deviation, z = z-score.

However, when the data is examined by proportion of bid results, the margin of error and confidence levels greatly improve. For example, Rhode Island's total project values awarded were $1.3 billion, and yet Texas' value totaled over $43.3 billion of contract awards in the same period. The study represents over 26% of the national funding in just five states. These states cover 50% of the top 10 states receiving funding. The sample in this study represents nearly $200 billion of construction funding. This method is summarized by Figures 2 & 3 and Table 2. The 11-year average of funding is $18.3 billion. The FHWA averaged $40.59 billion in funding for 2013 and 2014 (FHWA, 2017). This sample represents 45.11% of the funds allocated by the FHWA. When

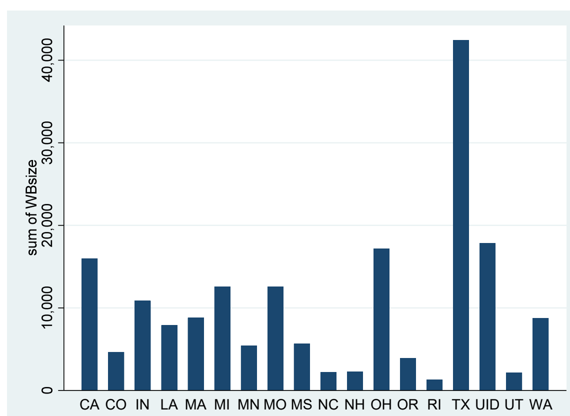


Figure 3 Values of States Total Dollar of Award, by dollar

analyzed in terms of millions of dollars represented by the annual budget, the margin of error is calculated as <1%.

Variables in this study were chosen in alignment with Section 2.1. This section provides further explanation for variable creation and selection. Variables chosen in this study provide a mixture of economic indicators, time variables, and regional indicators. The research is better supported by providing the context for the selection of these variables. In return, a better understanding of interpretation and conclusions of the statistical results can be provided. In each subsequent subsection of this chapter, the detail will be provided where variables were created through formulas from the raw data received through FOIA requests.

Table 2 Top 10 States Receiving FHWA Funding in 2015

State	Total (Millions)	Percent of Total	Cumulative	In Study	Cumulative in Study
CALIFORNIA	$3,542.47	9.37%	9.37%	9.37%	9.37%
TEXAS	$3,331.60	8.81%	18.19%	8.81%	18.19%
FLORIDA	$1,828.69	4.84%	23.02%	-	18.19%
NEW YORK	$1,620.09	4.29%	27.31%	-	18.19%
PENNSYLVANIA	$1,583.60	4.19%	31.50%	-	18.19%
ILLINOIS	$1,372.23	3.63%	35.13%	-	18.19%
OHIO	$1,293.74	3.42%	38.55%	3.42%	21.61%
GEORGIA	$1,246.24	3.30%	41.85%	-	21.61%
MICHIGAN	$1,016.21	2.69%	44.54%	2.69%	24.30%
NORTH CAROLINA	$1,006.63	2.66%	47.20%	2.66%	26.96%

3.6.1. Dependent Variable

As described in Chapter 1, the dependent variable is Bid Difference. Bid Difference is often used as a comparison of how competitive one's bid is. Bid Difference is often utilized to determine how close someone was to the lowest bidder. This paper treats the Engineer's Estimate as the low bidder. The rationale for this treatment is to capture the market effects that were unknown at the time of the creation of the Engineer's Estimate. As clarified in the delimitations, it is assumed that both the Engineer's Estimate and the Winning Bid have included reasonable profit, overhead, site supervision, and accurate cost data reflective of the scope of work required in the contract.

By utilizing Bid Difference, the researcher can establish a baseline for analysis. Although this study is quantitative, the literature review shows that an accurate estimate must rely on the experience of the estimator. There are qualitative components in the creation of a responsible and responsive estimate (Carr, 1989; Choi, 2014). To claim that the estimating process is purely quantitative is inaccurate. There must be some qualitative insight when formulating an accurate estimate. These insights could include some of the variables listed in Taylor's (2009) or Marion's (2007) work. These variables include project distance from the office or competitors' level of want/backlog. For instance, a distance of 25 miles from a project may seem far for one contractor but may seem close to another. This baseline provides the ability to disregard the qualitative aspects of that make each project so that the focus can remain on how these objective independent variables relate to this objective dependent variable.

3.6.2 Main Independent Variable: DBE Participation Goal

This research intends to examine how DBE Participation Goals affect Bid Difference. DBE Participation is unique amongst the other independent variables because it is the sole value that is dictated by DOTs. In addition to the ability to control/set the project specific limits, DBE Participation Goals is the only variable included in this study that is associated with fraud and competitiveness, as indicated in Chapter 2.

Because DBE Participation Goals are a function of the percentage of the Winning Bid, the existence of non-integer numerals was present. In this study, decimals were rounded to the nearest hundredth. In Stata, the variable was treated as continuous and is called *DBE* in the linear regression model.

3.6.3 Economic Measurement Variables

To best represent the conditions of the market at bid time, indicators of the economy were included in the regression model. Due to the period studied, an emphasis on the economy was deemed appropriate because the nation faced the Great Recession. As Porter's (2008) Five Forces indicate, competition will reduce costs. The intent of the use of the variables listed in this section is to complement works established in Section 2.1 and Porter (2008). The literature focuses on the threat of competitors entering the market, which limits the profit potential of an industry. Porter (2008) further details that when the threat of new competitors is high, profits must be limited. Porter (2008) states that this reason is to lower or maintain prices and therefore deter new competitors from entering the market.

Unemployment Rate – This variable was selected to provide an economic indicator of each state in the study. Data was collected from the Bureau of Labor Statistics (BLS, 2018). The data was published monthly and then formatted into quarterly averages. The data was averaged by quarter to create consistency with gross domestic product (GDP). In Stata, the variable was treated as continuous and was called *NatlEmpl* in the linear regression model.

Number of Bidders – This variable acts as the project level indicator of competition. As described by Porter (2008), Cheng (2003), Alroomi (2012), and Hegazy and Ayed (1998), the Number of Bidders determines the highest level of competition. The Number of Bidders was collected from FOIA requests for bid results. In Stata, the variable was treated as continuous and was called *Bidders* in the linear regression model.

The use of macroeconomic indicators relies greatly on widely accepted indicators, such as the S&P 500 index. The S&P 500 is the average value of 500 large companies across differing industries. This large representation of all markets helps smooth representation of the market if specific stocks are too volatile. The S&P 500 is one of the most commonly used indicators of the economy. In Stata, the variable was treated as continuous and was called *SP* in the linear regression model.

In addition to the S&P 500, the CBOE created VIX to represent the market. VIX is an index that measures and trades the 30-day expected volatility of the S&P 500. Although VIX is relatively young, it is considered the options/futures market standard. VIX is often used to measure the level of risk in the market. In Stata, the variable was treated as continuous and was called *VIX* in the linear regression model.

3.6.4 Cross-Sectional Variables

In this subsection, time is represented as a historical value/time series. These variables offer the ability to provide cross-sectional data on each state. Each variable has been modeled with a binary function.

Year – In a similar fashion to S&P 500 and Unemployment, the variable *year* was created to illustrate the level of competitiveness required throughout the period researched. Data was collected through FOIA requests for the date of the bid and assigned a numerical value for its representative year. For example, a project bid on December 31, 2010, would have a value of 10 in the model. In Stata, the variable(s) was treated as binary. The variables are called *Y08dummy, Y09dummy, Y10dummy, Y11dummy, Y12dummy, Y13dummy, Y14dummy, Y15dummy, Y16dummy, Y17dummy,* and *Y18dummy* in the linear regression model for each respective year. Due to the binary relationship, the variable *Y14dummy* is omitted from the regression model. This omission is required to remove collinearity because the remaining binary variables need a variable to be compared against. Y14 was chosen for omission as the data shows 2014 as an inflection point for trends. Yearly impacts are clearer to understand when this inflection point is present.

Quarter of Year – The creation of this variable was to examine the effects of seasonal shocks that the construction market often faces. Due to non-construction periods related to winter weather, contractors are often forced to cease construction in the winter. This results in a series of construction projects ending in the fall, further resulting in backlog erosion in the winter. Data was collected through FOIA requests for the date of the bid and assigned a numerical value for its representative quarter. The study utilized typical quarters, with Q1 representing January through March, Q2 April through June, etc. For example, a project bid on December 31, 2010, would have a value of 4 in the model. In Stata, the variable(s) was treated as binary and are called *Q1dummy, Q2dummy, Q3dummy,* and *Q4dummy* in the linear regression model for each respective quarter. As with *Y08dummy,* due to the binary relationship, the variable *Q1dummy* is omitted from the regression model. This omission is required to remove collinearity because the remaining binary variables need a variable to be compared against.

3.6.5 Regional Variable

Acknowledging that the market conditions for each state vary, states were categorized individually. States were issued numbers in alphabetical order. In Stata, the variables were treated as binary and named after each state's representative abbreviation. The variables are called *CA, CO, IN, LA, MA, MI, MN, MO MS, NC, NH, OH, OR, RI, TX, UID, UT,* and *WA*. To eliminate collinearity, the regional variables are included in the Aggregate National Sample only. As with *Y14dummy,* due to the binary relationship, the variable *CA* is omitted from the regression model. This omission is required to remove collinearity because the remaining binary variables need a variable for comparison.

3.6.6 Size Variables

This section intends to determine whether project descriptors related to size impact Bid Difference. These project descriptors are related to the size of the project. These descriptors include the dollar value and anticipated duration. These variables can determine whether there is more or less competition based on project size.

Duration of Project – This variable was collected using FOIA requests. The contractual end date was requested. The contractual end date was chosen because states vary in methods of measuring duration. Some states prefer duration to be measured by the calendar day, while others prefer the workday (Monday through Friday) method. To create uniformity, the duration of the project was the calendar days' value from the bid date and contract completion date. In Stata, the variable was treated as continuous and was called *Duration* in the linear regression model.

Size of Project – With the same logic established with duration, the size of the project was considered, as well. The size of the project was measured by the Winning Bid. Data was collected through FOIA requests. Variables were reported by the millions and rounded to the nearest hundredth of a million dollars. In Stata, the variable was treated as continuous and was called *WBsize* in the linear regression model.

3.7 Data Analysis Techniques

This section provides detail on the types and procedures of statistical tests utilized in this research. The following section identifies the basic assumptions of the statistical model, what tests are utilized to test the model, and why they are used. Once the assumptions have been identified, the test methods utilized for OLS regression are described in the same manner used to determine the reliability of the study as described in Section 3.5.

3.7.1 Summary Statistics

Summary statistics are included in this research. Given the large sample size and multiple state agencies, the summary statistics will provide insight into the market during the period studied. Each summary statistic will be the multiplicand for the cost vector. Results are published in a table format that summarizes each state and provides a research summary. Results will be published with means, maximum, and minimum values.

Summary statistics are dually beneficial for this study. Cost vectors are derived from two statistics in this study: summary statistics and regression coefficients. No analysis can be performed without summary statistics. Secondly, summary statistics provide insight of the general trends during this period. The summary statistics provide enough insight to advance the study as a standalone subject.

3.7.2 Normality

Checks for normality are performed before any data is analyzed. It is expected that there may be a skew in the data because data was skewed in the researcher's previous work. Previous research identified explanation for skew existed because of DOTs' likelihood to award contracts well below the Engineer's Estimate but not award projects well above the Engineer's Estimate. Checks for normality are performed using histograms. Histograms are created on a program and state level for the dependent variable of Bid Difference. Additional histograms are created for residuals and fitted values.

3.7.3 OLS Assumptions

The use of a regression model was deemed the best fit for determining the relationship between DBE Participation Goals and Bid Difference. The OLS model is a multiple regression model. The multiple regression model is the most widely used technique for empirical analysis in economics and other social sciences (Woolridge, 2018). It allows the researcher to intentionally control for many factors that may simultaneously affect the dependent variable. OLS can treat data as binary or continuous. Other regressions are unable to treat variables in the same manner. Due to this versatility and simplicity, OLS regression was chosen. By using OLS, the researcher can infer causality in cases where other methods fall short. The OLS is often described as an unbiased estimator. For the OLS to be unbiased, basic assumptions must be met. These assumptions are referred to as the *Gauss-Markov theorem*. The Gauss Markov theorem tells us that, if a specific set of assumptions are met, then the ordinary least squares estimate for regression coefficients gives the best linear unbiased estimate (BLUE) possible (Woolridge, 2018).

Woolridge (2018) provides the list of assumptions in the Gauss-Markov theorem. Stata's user guide provides insight on the recommended test methods for each assumption. The theorems and test methods include the following:

3.7.3.1 Linear in Parameters

The model does not have logarithmic, exponential, etc. relationships.

There is no test for this assumption, merely a clarification/basis of understanding that the other models may be regressed in other fashions. A scatter plot of Bid Difference and DBE Participation Goals with the fitted/expected values will be included for interpretation/confirmation of a linear relationship.

3.7.3.2 The Sample Is Random

There is no inherited bias in selecting the sample.

There is no test for this assumption, merely identifying ways that the OLS may create bias if selection bias is present. Previous sections of the research have provided detail regarding the selection process for the sample. A histogram of Bid Difference is provided for interpretation/confirmation of randomness. In addition, Kernel density of the residuals is provided. Kernel density estimation is a fundamental data smoothing problem where inferences about the population are made based on a finite data sample.

3.7.3.3 No Perfect Collinearity

In the sample, none of the independent variables are constant, and there are no exact linear relationships among the independent variables.

It is worth clarifying that the independent variables may contain collinearity, just not perfect collinearity. No tests are provided for this assumption because Stata provides notice in regression results when perfect collinearity exists. Stata automatically omits colinear values in regression. This is an occurrence once the linear regression is performed in the same manner as the Aggregate National Sample. Each state dummy variable is included in a by-state model. To avoid collinearity, the state level regressions will not include the binary state sample variables.

3.7.3.4 Zero Conditional Mean

The distribution of error terms has zero mean and does not depend on the independent variables.

Satisfying this assumption can be difficult. Violation of the zero conditional mean is often the cause of omitted variable bias (Buck, 2015). There is no formal method for testing omitted variable bias. To best overcome this understanding, a plot of residuals vs. fitted values (RVF Plot) is provided. In this plot, an additional line is plotted called a *Locally Weighted Scatterplot Smoothing* (LOWESS). LOWESS is a popular tool used in regression analysis that creates a smooth line through a scatter plot to help see the relationship between variables and foresee trends. A scatter plot is particularly useful because it can fit a line to a scatter plot where there are noisy data values. In this case, the sample of 60,000 data points interfere with the ability to see a line of best fit (Institute for Digital Research & Education, n.d.). The model is considered meeting this assumption if the LOWESS smoothing line is at or near zero.

3.7.3.5 Homoskedasticity

The model error term is the same across all values of the independent variables.

Due to the large sample size, the use of statistical testing for homoskedasticity is not utilized. Instead, homoskedasticity is interpreted with a scatter plot of residuals vs. predicted values of the model.

3.7.4 Pearson's Correlation

Pearson's Correlation is a measure of the strength and direction of association that exists between two continuous variables (Woolridge, 2018). Pearson's Correlation generates a coefficient called *Pearson's Correlation coefficient*, denoted as r. Pearson's Correlation attempts to draw a line of best fit through the data of two variables. The Pearson's Correlation coefficient, r, indicates how far away all these data points are to this line of best fit. Its value can range from -1 for a perfect negative linear relationship to +1 for a perfect positive linear relationship. A value of 0 (zero) indicates no relationship between the two variables. Below is a list of the assumptions and test methods to determine whether the assumptions have been met.

For Pearson's to be valid, four assumptions must be made:

<u>Variables should be measured at the continuous level.</u>

Stata provides the ability to describe the variables. These variables include continuous and categorical. Categorical variables, such as year, quarter, and state, are not included in Pearson's Correlation.

<u>Variables should be linear in relationship.</u>

Best-fit lines will be included in scatter plots for confirmation on linearity. This method is tested in the OLS assumptions.

<u>There should be no significant outliers.</u>

Outliers for each variable are checked using scatterplots that use a leverage-versus-residual-squared plot. This plot is a graph of leverage against the residuals squared. If further evaluation is needed, the command "extremes" in Stata is utilized. This command allows for checking the extreme values of each variable (Institute for Digital Research & Education, n.d.).

<u>Variables should be approximately normally distributed.</u>

Kernel density plots are performed. This test is performed in the previously mentioned OLS assumption tests.

3.7.5 Ordinary Least Squares Regression

The linear regression model uses the OLS estimator to find the correlation between Bid Difference and DBE Participation Goal. OLS regression is a method for estimating the unknown parameters in a linear regression model. OLS chooses the parameters of a linear function of a set of explanatory variables by the principle of least squares. OLS minimizes the sum of the squares of the differences between the observed dependent variable in the given dataset and those predicted by the linear function (Woolridge, 2018).

Each model is analyzed for the following conditions: the adjusted r-squared value for the total fit of the model, the total sum of squares (SST), and the model coefficients. The adjusted r-squared value measures the strength of the association of the independent variables on the dependent variables. In other words, it is the value that represents how much the model can explain. The total sum of squares predicts how much of the variation between the observed data and predicted data is explained by the model proposed. As a generalization, a high SST value indicates a considerable amount of variation being explained by the model. The model coefficients are examined to determine their impact on Bid Difference. As described in previous sections, these variables were selected for their influence on economic principles expressed in Chapter 2. With the explanation for variable selection identified, the methods, criteria, and assumptions have been illustrated in previous portions of this chapter.

The model for the Aggregate National Sample is as follows:

$$Bid\ Difference = \beta_1 DBE + \beta_2 Bidders + \beta_3 Wbsize + \beta_4 Duration + \beta_5 NatEmpl + \beta_6 Crude + \beta_7 SP + \beta_8 VIX + \beta_9 Q2dummy + \beta_{10} Q3dummy + \beta_{11} Q4dummy + \beta_{12} Y08dummy + \beta_{13} Y09dummy + \beta_{14} Y10dummy + \beta_{15} Y11dummy + \beta_{16} Y12dummy + \beta_{17} Y13dummy + \beta_{18} Y15dummy + \beta_{19} Y16dummy + \beta_{20} Y17dummy + \beta_{21} Y18dummy + \beta_{22} CO + \beta_{23} IN + \beta_{24} LA + \beta_{25} MA + \beta_{26} MI + \beta_{27} MN + \beta_{28} MO + \beta_{29} MS + \beta_{30} NC + \beta_{31} NH + \beta_{32} OH + \beta_{33} OR + \beta_{34} RI + \beta_{35} TX + \beta_{36} UID + \beta_{37} UT + \beta_{38} WA + \mu,$$

where μ = Constant.

The model of each state specific OLS is as follows:

$$Bid\ Difference = \beta_1 DBE + \beta_2 Bidders + \beta_3 Wbsize + \beta_4 Duration + \beta_5 NatEmpl + \beta_6 Crude + \beta_7 SP + \beta_8 VIX + \beta_9 Q2dummy + \beta_{10} Q3dummy + \beta_{11} Q4dummy + \beta_{12} Y09dummy + \beta_{13} Y10dummy + \beta_{14} Y11dummy + \beta_{15} Y12dummy + \beta_{16} Y13dummy + \beta_{17} Y14dummy + \beta_{18} Y15dummy + \beta_{19} Y16dummy + \beta_{20} Y17dummy + \beta_{21} Y18dummy + \mu,$$

where μ = Constant.

Each model excludes the variable *Q1dummy* and *Y14dummy*. The intent of this exclusion is to have those variables act as the baseline in the model as the binary variables will create collinearity if they are included. For the Aggregate National Sample, the state of California has been omitted for the same reason.

3.8 Summary

Chapter 3 presented the framework of the study by identifying the participants, what data was collected, how the data was collected, how the data was measured, and how the data was analyzed. The chapter further provided the testing procedures and assumptions for each statistical test performed. These methods were called out explicitly to illustrate the in-depth analysis required to produce an accurate and unbiased OLS model. OLS assumptions are fundamental to a sound statistical method. The confirmation of the assumptions will bolster the trustworthiness of the results by eliminating any known or unknown biases. Because of this legitimacy, additional data and conclusions can be inferred by examining the strength of the coefficient of each variable. Through this inference, the researcher can determine whether a DBE Participation Goal has a similar effect as other variables.

Most importantly, this chapter established the criteria for determining the acceptable results of the study.

CHAPTER 4. RESULTS

The results of the statistical analysis and associated assumptions are presented in this chapter. Results are presented in the same order as presented in Chapter 3. The results of the assumptions for each test are introduced and reported. The results of each test are presented in two manners: by Aggregate National Sample and by state. To ease the burden of data confirmation on the reader, the results of each statistical assumption covered in Sections 4.2 through 4.5 are reported by Aggregate National Sample. The applicable figures are listed in Appendices C through F. State UID has identifiable variables and identifiers redacted where required.

4.1 Summary Statistics

The summary statistics listed in Table 3 provide the base of understanding the impacts of the OLS regression. Figure 4 provides a general trend of notable statistics observed in the study. These summary statistics do not reveal all the details presented in the findings. Some findings have been omitted, either unintentionally or intentionally. Such examples include missing or partial data that had to be excluded. Such an example is in the cases of North Carolina and Utah, where only a sample of bid results were complete. In addition to the limitation of summarized bid data, other summaries were intentionally omitted. State UID was intentionally excluded from this summary table. This intentional exclusion was to ensure that any identifiers, such as contract size or the number of bids, cannot provide triangulation to the state' or the number of bids, cannot provide triangulation to the state's identity.

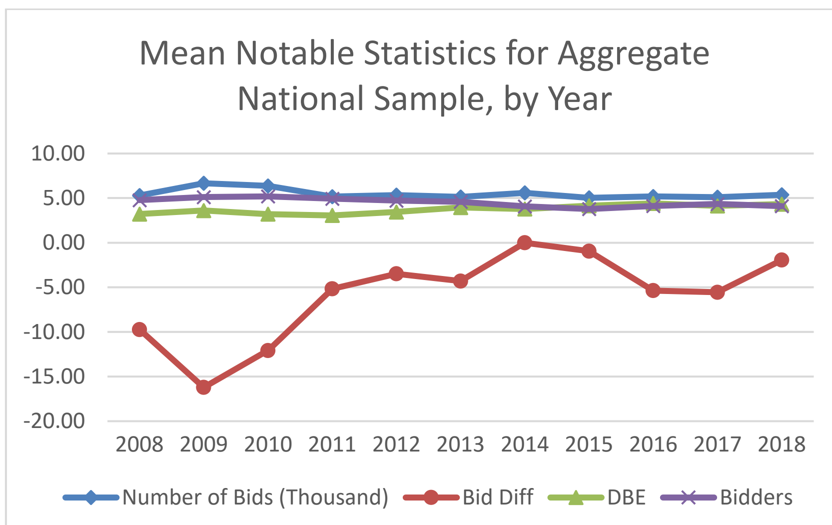


Figure 4 Notable Mean Statistics for Aggregate National Sample by Year

Table 3 Bid Summary Statistics

Variable Summary Statistics									
State	DBE	Bidders	Wbsize	Duration	NatEmpl	Crude	SP	VIX	Total Bid Difference
CA	7.76	5.87	6.88	202	6.05	69.91	1915.8	17.48	-$1,560,209,034
CO	4.82	4.78	3.17	129	6.84	77.58	1662.92	20.23	$16,606,927
IN	5.14	4.21	2.29	308	6.88	74.03	1677.84	20.73	-$1,664,839,721
LA	3.29	3.78	2.06	112	6.97	77.68	1635.42	20.77	-$667,158,313
MA	1.49	5.28	3.77	584	6.83	77.08	1663.52	20.65	-$505,004,259
MI	4.1	4.66	1.45	150	6.95	77.01	1658.11	19.89	-$395,825,857
MN	3.11	3.8	3.69	99	6.49	78.55	1741.42	20.75	-$95,239,920
MO	6.08	4.1	2.74	312	6.86	75.42	1686.82	21.23	$4,725,187,200
MS	2.25	3.43	4.15	220	6.7	73.48	1713.2	20.34	-$217,398,992
NC	4.05	4.13	4.31	198	4.7	80.66	2053.38	20.24	-$188,314,246
NH	0	3.79	3.48	294	6.96	77.28	1644.24	21.13	-$247,889,897
OH	4.4	4.07	2.11	253	6.63	75.51	1744.37	19.22	-$732,388,360
OR	1.03	5.58	3.3	366	7.12	76.39	1620.91	20.99	-$485,390,390
RI	7.82	4.06	2.85	366	6.65	74.52	1822.85	17.98	-$161,275,022
TX	2.07	5.04	4.95	157	6.79	74.98	1717.54	19.88	-$1,911,264,794
UID	*	*	*	*	*	*	*	*	*
UT	2.57	4.53	5.31	85	8.52	77.86	1077	30.34	-$272,791,062
WA	5.01	4.31	5.72	100	6.83	75.56	1677.02	20.64	-$1,419,749,674
ANS	3.73	4.54	3.03	239	6.82	75.83	1687.64	20.28	-$6,627,529,394
Max	7.82	5.87	6.88	584	8.52	80.66	2053.38	30.34	$4,725,187,200
Min	0	3.43	1.45	85	4.7	69.91	1077	17.48	-$1,911,264,794
Avg	3.74	4.46	3.58	238	6.77	76.12	1684.41	20.76	-$368,196,125

**MA had missing DBE Participation Goal data for several years*

The study examined 60,000 contracts from 2008 to 2018. During this period, states averaged a total of 5,400 contracts awarded per year. This sample represents over $165 billion in contracts awarded, nearly $15 billion in new projects per year. During this period, the state of Texas had the most substantial amount of funding, with an average of $42.42 billion ($3.8 billion/year). Rhode Island averaged the least amount of funding at $1.29 billion ($117.5 million/year). As indicated by Figures 5 & 6, states that averaged the most and had the least issued contracts during this period included Michigan at the largest average of 790 contracts per year and Rhode Island with the least at 41 contracts per year. The average cost per contract averaged $3.03 million. California had the highest average contract value of $6.88 million, and Michigan had the lowest average contract value at $1.44 million. The largest project awarded in this sample came from Utah, for a value of $1,098,426,240. The smallest contract value awarded came from Louisiana in the amount of $1,500. During this period, states saw bids average of 6.23% below the Engineer's Estimate.

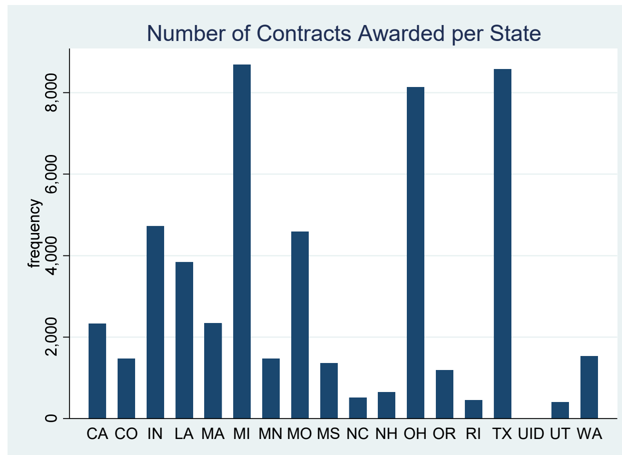


Figure 5 Number of Contracts per State

Data was interpreted in two manners to determine which states had the best and worst Bid Difference percentages. The two manners were in terms of absolute distance from zero and lowest cost vs. highest cost. In terms of absolute, Utah had the worst Bid Difference at 25.93% below, and Minnesota had the closest at 4.47% below. In terms of the highest cost, Missouri averaged a Bid Difference 24.25% greater than the Engineer's Estimate, while Utah remained at 25.93% below. It is noteworthy that only Missouri

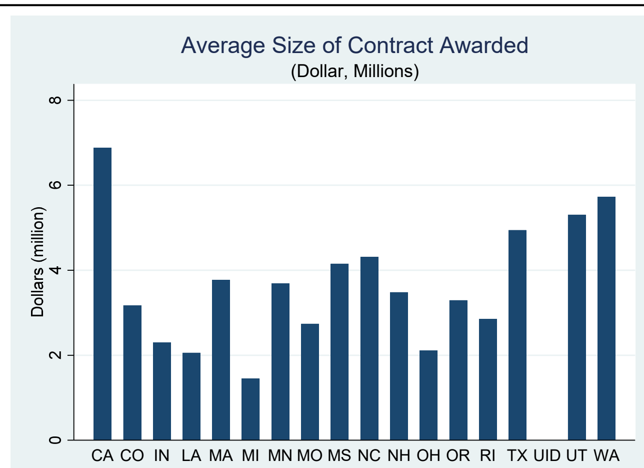


Figure 6 Average Dollar Value for Winning Bids – By Sample

averaged a Bid Difference above any value of zero, meaning that each project awarded, on average, was above the Engineer's Estimate. Washington had the largest average dollars below the Engineer's Estimate at $675,000, while Missouri averaged awards $970,000 over the Engineer's Estimate. Colorado had the closest average at $7,601 above per award. Missouri remained the furthest dollar value of Bid Difference. Michigan was the closest surplus in terms of bids awarded below the Engineer's Estimate at an average of $34,000 below the Engineer's Estimate per contract award.

Table 4 DBE Participation Goal Statistics

Sample	CA	CO	IN	LA	MA	MI	MN	MO	MS	NC	OH	OR	RI	TX	UT	UID	WA
Max	29	24	38	20	14	30	27	20	10	14	20	17	25	13	18	8	26
Mean	7.8	4.8	5.1	3.3	1.5	4.1	3.1	6.1	2.3	4.1	4.4	1	7.8	2.1	2.4	2.6	5

**NH excluded as sample does not track DBE Participation Goal s.*

As Table 4 indicates, DBE Participation Goals fluctuated by state. The State of Oregon had the lowest goal (1.03%), while Rhode Island had the highest (7.82%), nearly beating the State of California (7.76%). The state of New Hampshire was excluded in this minimum range because DBE Participation Goals are not required and are therefore set to 0% by the state. Rhode Island's and California's high DBE Participation Goals were double the median (3.67%) and the average of the sample (3.74%) DBE Participation Goal of the research group. As far as projects that that saw the highest and lowest amounts of DBE Participation Goals, Indiana saw projects at both extremes, with projects at 38% on the high end and only 0.10%

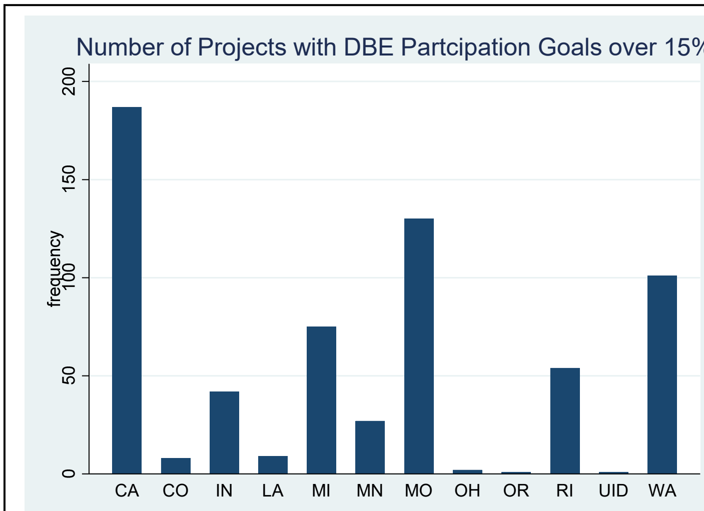


Figure 7 Number of Projects with DBE Participation Goals over 15%, by State

on the low end. As indicated by Figure 7, California had the largest amount of DBE Participation Goal percentages with projects over 15%. California awarded 7.9% (187) of contracts with DBE Participation Goals over 15%. In terms of total dollar values of projects awarded with DBE Participation Goals over 15%, Figure 8 indicates Minnesota had the highest at $773.5 million (14.27% of total budget) in contract value. Several states had 0 projects above 15% DBE Participation Goals.

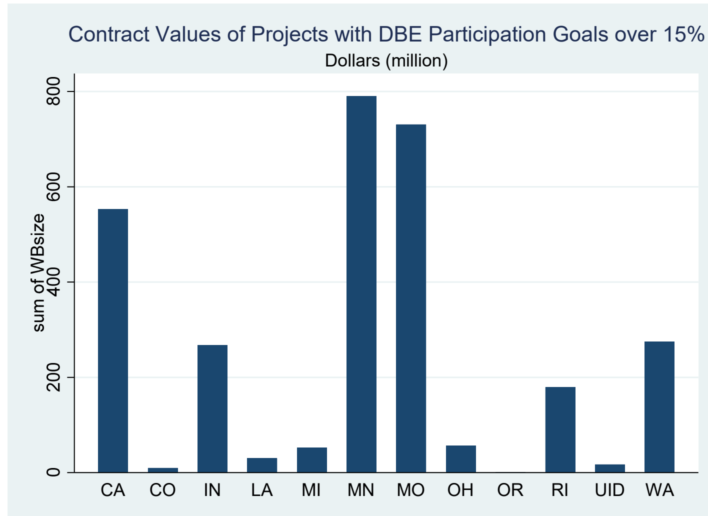


Figure 8 Contract Values of Projects with DBE Participation Goals over 15%, by State

Each state averaged between three and six bidders per project. Table 2 and Figures 9 and 10 provide further detail as an examination into the variable Number of Bidders. There are several insights provided. The number of bidders provide unique insight in terms of direct competition. The period saw an increase in bidders from 2008 to 2013. To measure this phenomenon, the term *high concentration of bidders* is introduced. Figure 9 provides insight into the economic principle of competitiveness through an examination of the high concentration of bidders. A high concentration was considered any project that had nine or more bidders. The use of nine bidders is double the average number of bidders for the Aggregate National Sample (4.54 bidders). A total of 4,695 bids had bid concentrations over 2, meaning a total of nine or more bidders. As indicated

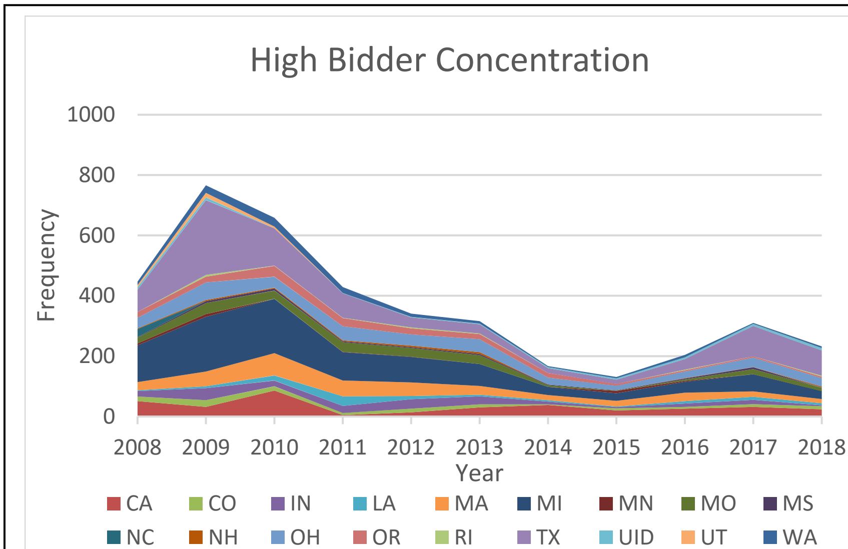


Figure 9 High Concentration of Bidders

by Figure 9, there was a peak during the same periods of the Great Recession. The pattern of the chart mimics that of unemployment rates, as indicated by Figures 9 and 10 High bidder concentration represents a total of 7.8% of the research sample. States that saw the highest concentration included Michigan at 905 observations and Texas at 839 observations. States that saw the least amount of high concentration were Rhode Island at 18 observations and Minnesota at 28 observations. North Carolina and Utah also had 28 bids but were missing several years, thus misrepresenting the number of bidders.

Similar analysis to high bidder concentration was performed using bids where only one bidder was present. This term is referred to as *low bidder concentration*. Figure 10 provides insight on the trends observed in 2008-2018. The intent of this analysis was to determine whether competition reduced after the period where high bidder concentration reduced. During this period, a total of 2,991 projects were observed having low bidder concentration. This sample represents a total of 4.97% of the research sample size. States that saw the greatest amount of low concentration included Ohio at 841 bids and State UID at 309 bids. States that saw the least amount of low concentration were Utah at 16 bids and California at 21 bids.

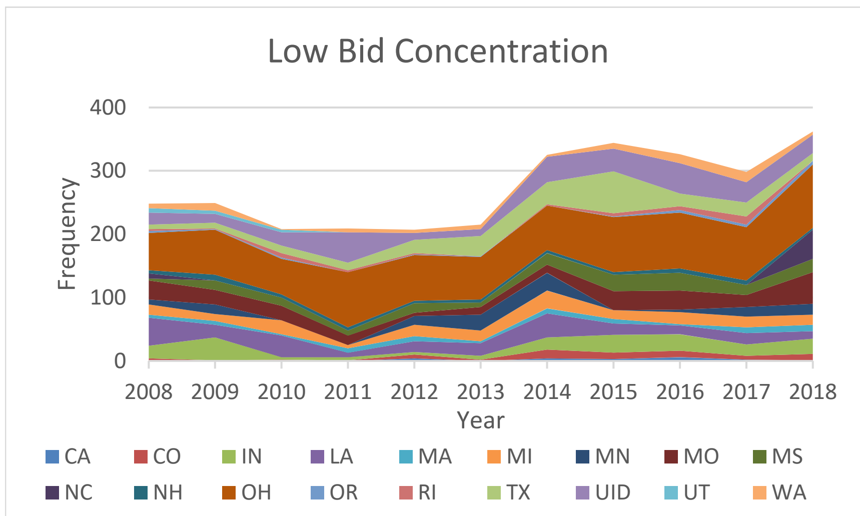


Figure 10 Low Concentration of Bidders

Figures 11 and 12 were created to illustrate the relationship between high concentration and low concentration. This figure combines two separate graphs that summarized the amount of each. Figure 11 shows a side-by-side histogram. Figure 12 shows the percentage of frequency. The transition from a majority of high bid concentration to low bid concentration occurred between the years of 2013 and 2014. During this period, the economy entered and slowly climbed out of the Great Recession. This chart indicates that competition decreased from 2013 to 2014 as a high-bidder concentration transitioned to a low-competition market. This trend is further observed in Figure 13, where the Number of Bidders gradually decreased.

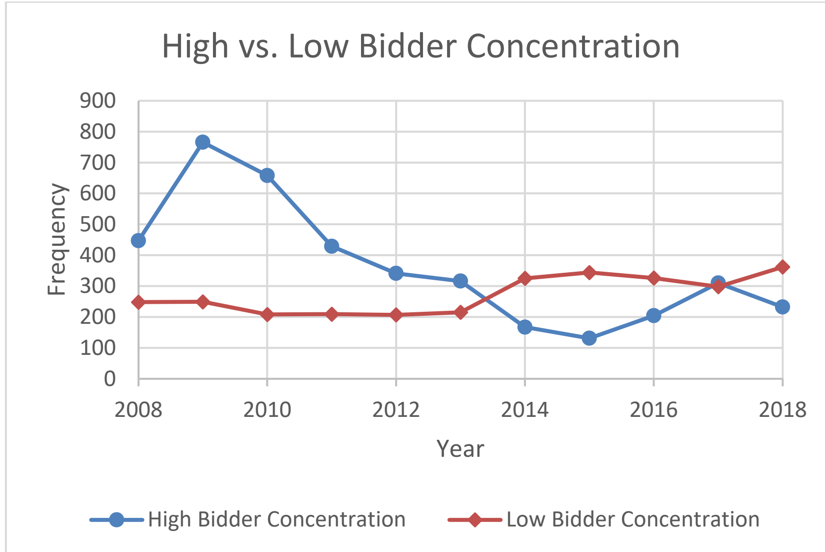
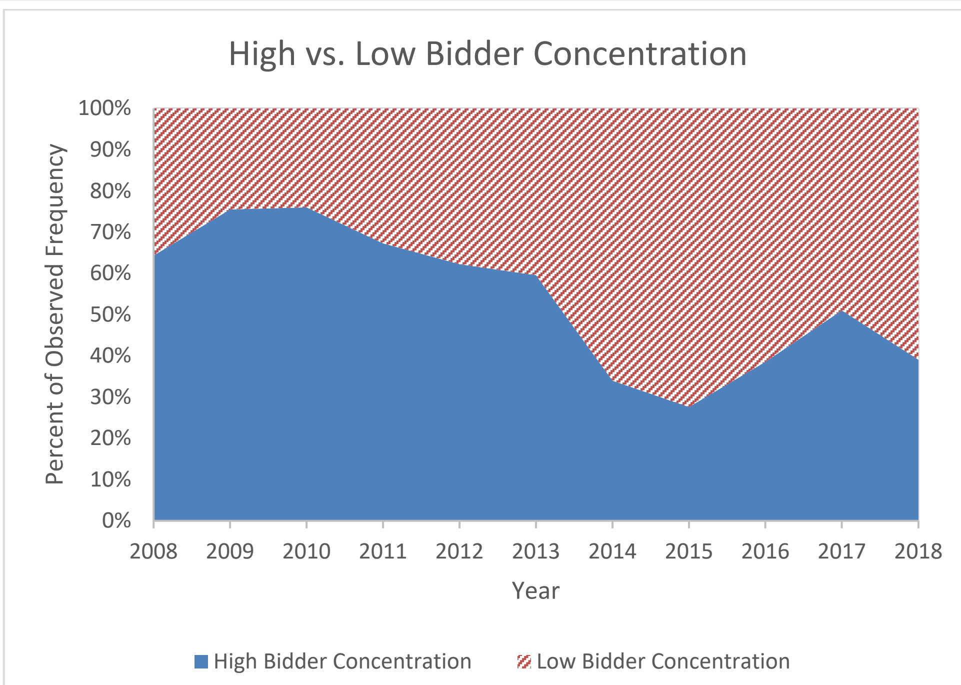


Figure 11 High vs. Low Bidder Concentrations – Frequency



.

Figure 12 High vs. Low Bidder Concentrations by Percentage

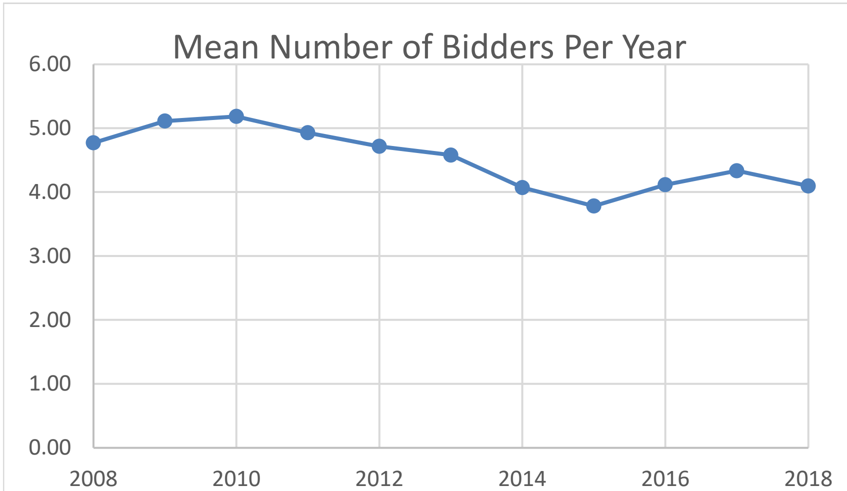


Figure 13 Mean Number of Bidders by Year

Unemployment rate is considered healthy at 5.2% to 6.0% (Farrell, 2013). The unemployment rate did not reach the high end of acceptable until the third quarter of 2014. As indicated by Figure 14, the economy for many states in the group was inadequate. Many states did not enter the acceptable levels of unemployment until 2015, with a total of 10 states having less-than-ideal unemployment rates in the third quarter of 2014. This "break" in the economy appears consistent through the Unemployment Rate and the Concentration of Bidders. It establishes that different market conditions existed throughout the time series of this data.

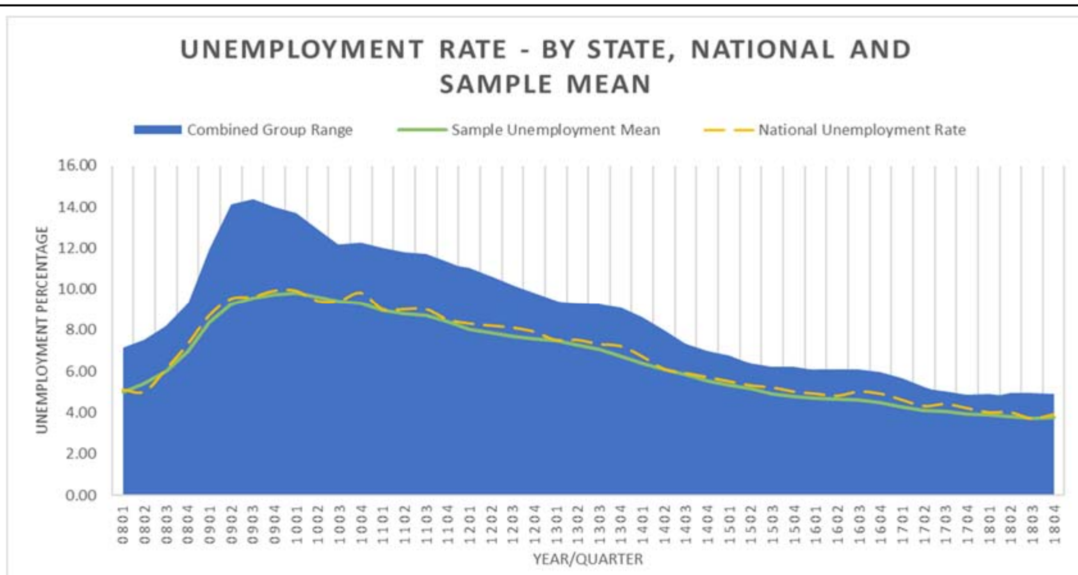


Figure 14 Unemployment Measured by State, National, and Sample Mean

4.2 Normality

Tests for normality were performed using histograms. Histograms were plotted for their importance in the model, which included Bid Difference, DBE Participation Goals, and OLS Residuals. The interpretation was on a state-by-state basis, along with the ANS. The distribution for each state appeared normally distributed, with some states illustrating a slight skew. This skew can be confirmed by the likelihood of states not wanting to award projects that were substantially great in Bid Difference. Further examination of each state's distribution can be found in Appendix C. Figure 15 show the distribution of Bid Difference for the ANS. The ANS appears normal in two cases: Bid Difference and residuals. DBE Participation presents an expected skew given the number of projects with 0% DBE Participation Goal. Given these results, we can assume that the model is normally distributed.

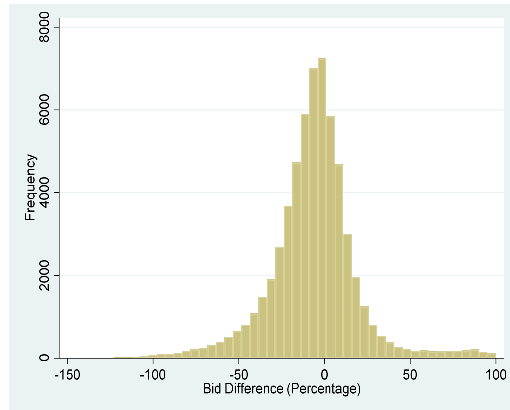


Figure 15 Bid Difference Distribution

4.3 OLS Assumption

Checks for Gauss-Markov were performed in accordance with Section 3.7.3. In instances where Gauss-Markov are not met, the rationale for inclusion will be provided in applicable sections. The results are as follows:

4.3.1 Linear in Parameters

All samples were tested for linear in parameters using two-way plots with fitted lines of Bid Difference and the respective continuous variables. These variables included DBE Participation Goal, Number of Bidders, WB Size, Duration, Unemployment Rate, Crude Oil Barrel Cost, S&P 500 Index, and VIX. Figure 16 demonstrates that the data has a linear relationship. The direction and magnitude of the relationship is discussed in Section 4.5.

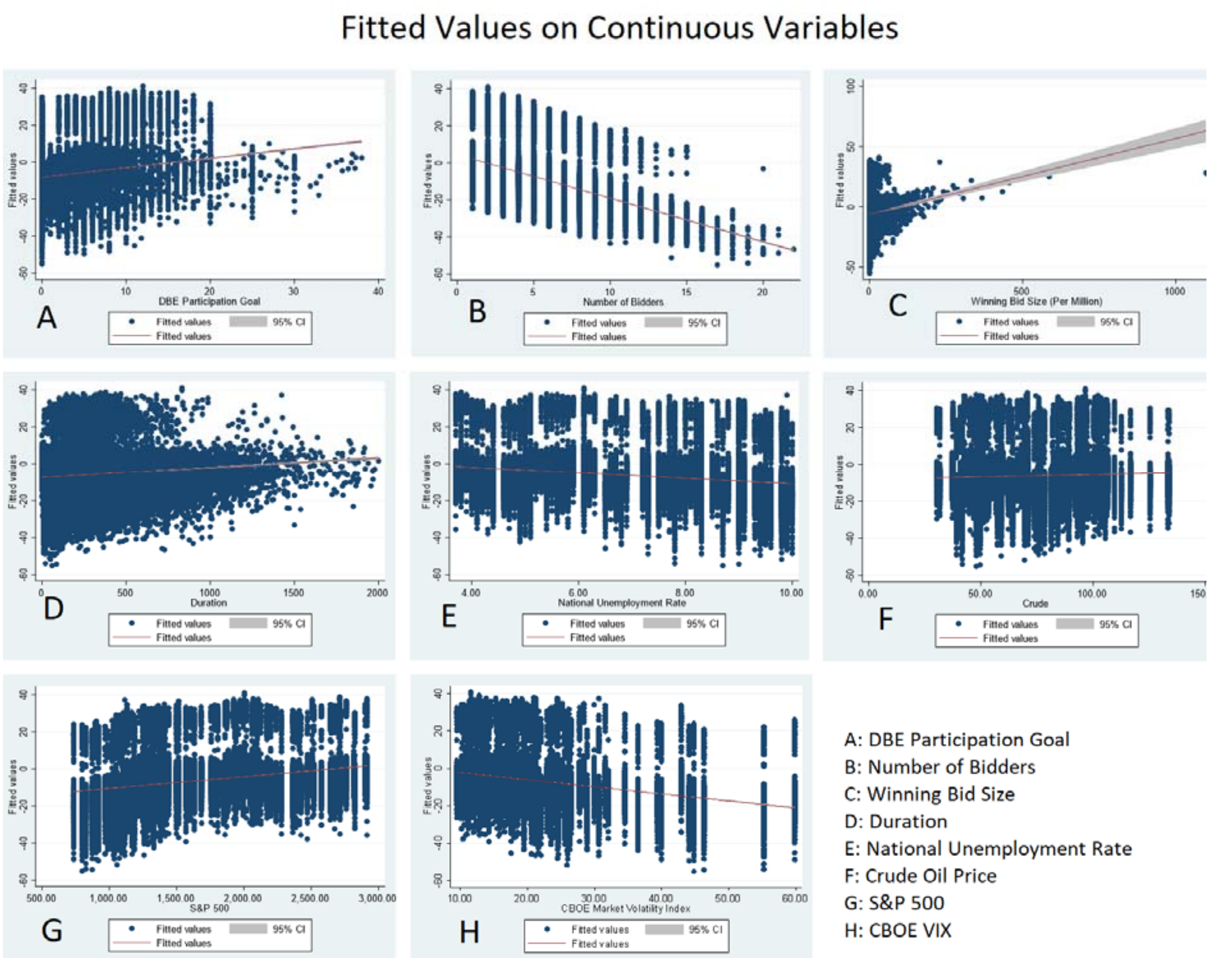


Figure 16 Linear Relationship of Bid Difference and Continuous Variables

4.3.2 The Sample Is Random

There is no official test for random sampling as indicated in Section 3.7.3. However, confirmation of randomness results in the display of a normal distribution of the variables. As Section 4.3 has indicated, the sample is normally distributed and therefore meets the assumption of randomness. In addition, Figure 17 shows a very narrow plot of the residuals of the OLS model, thus further confirming the assumption of randomness.

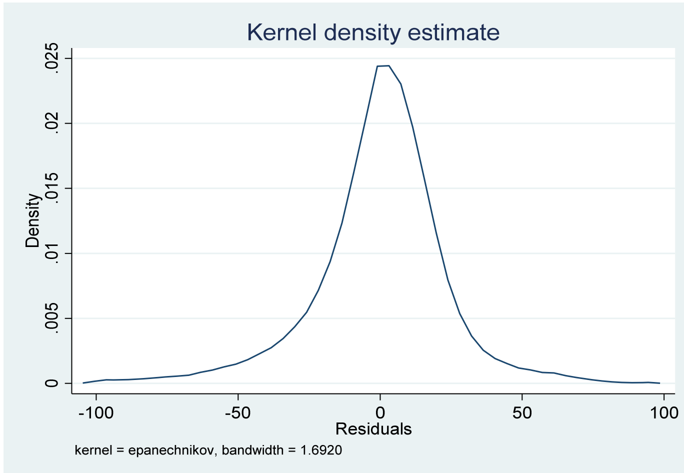


Figure 17 Kernel Density of Residuals for Aggregate National Sample

4.3.3 No Perfect Collinearity

As discussed in Section 3.7.3, STATA has the capability of removing any perfect collinearity in the regression model. For this reason, along with no objective test to prove a lack of perfect collinearity, no results have been published in this section.

4.3.4 Zero Conditional Mean and Homoskedasticity

To test this assumption, a Residuals Versus Fitted (RVF) Plot for the Aggregate National Sample was provided. As indicated by Figure 18, with the LOWESS line hovering at or near zero, we can confirm that the distribution of error has zero mean and does not depend on the independent variables. Therefore, the assumption of the zero conditional mean has been met. Homoskedasticity cannot be confirmed based on the interpretation. The plot has indications of heteroscedasticity. This indication is due to the typical funnel shape associated with heteroscedasticity. This funnel can be seen at the portion of the chart where the fitted values range from -40 to -20 and 0 to +20. Although the plot seems to narrow on the low end of the fitted value range, the level of heteroscedasticity can be dismissed. Due to this level of heteroskedasticity, significance tests are virtually unaffected on a sample size as large as this one. OLS estimation can be used without concern of severe distortion (Barreto & Howland, 2013).

The OLS estimator cannot be considered the best linear unbiased estimate but can remain as reliable. Heteroscedastic patterns are common in large datasets where the data are cross-sectional or categorical (Berry & Feldman, 2006). This research fits the commonality qualities that Berry and Feldman (2006) state. Additionally, the data can be considered reliable if the data are not considered extreme, and OLS estimation can therefore still be used without concern of bias. This impact may result in significance tests being too high or too low because it gives equal weight to all observations. Fortunately, unless heteroskedasticity is severe, significance tests are virtually unaffected, and thus OLS estimation can be used without concern of severe distortion (Barreto & Howland, 2013).

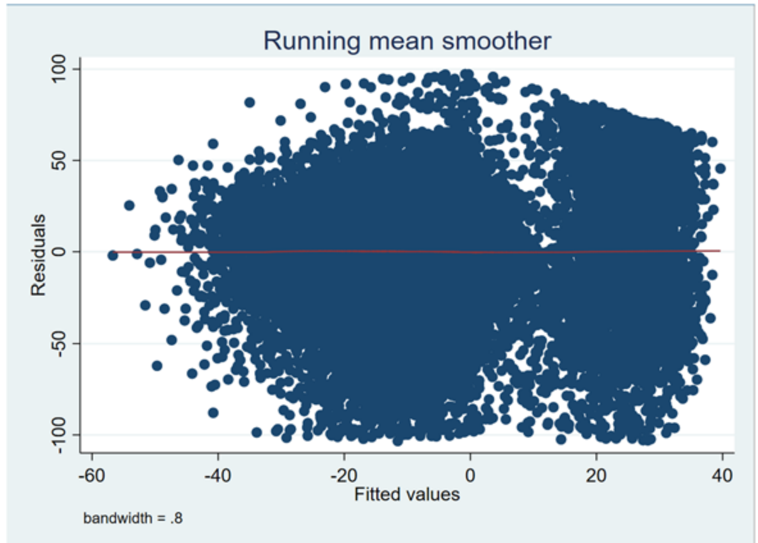


Figure 18 RVF Plot for Zero Conditional Mean

4.4 Pearson's Correlation

The model was checked for Pearson's r. All 19 populations were analyzed using most variables included in the OLS regression. Testing methods needed to be modified due to the nature of the data and the test method. Pearson's r creates issues with categorical variables, which result in hundreds of pages due to the large combinations of cross-checked variables. The inclusion of categorical variables would have created excessive data with little to no importance. Attempts to perform Pearson's Correlation on the dummy variables yielded only partial data. This partial data is due to Stata's cache limit, which had been reached and which omitted several states. Even when creating the abridged version, Stata was unable to efficiently produce the tables in a cross-reference fashion. This lack of efficiency would have led to each table taking nearly double the page space. For this reason, results do not include the interactions between SP and VIX. This section aims to provide the audience with specific details in terms of variables' directions and significance with

Bid Difference. Results will be reported if they meet or exceed 95% significance. Data output can be found in Appendix D.

4.4.1 Aggregate National Sample

The Aggregate National Sample (ANS)—the aggregate representation of the 18 states in this study—had all variables significant to the 95% confidence interval. Variables with positive significant correlation included DBE Participation Goal, Project Size, Project Duration, Crude Oil, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX. Table 4 provides further detail.

Pearson's Correlation for ANS determined that all eight variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

Table 5 Pearson's Correlation for Aggregate National Sample

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0819*	1.0000					
Bidders	-0.2364*	0.0472*	1.0000				
WBsize	0.0273*	0.0955*	0.0196*	1.0000			
Duration	0.0476*	0.0994*	0.0958*	0.3489*	1.0000		
NatEmpl	-0.1165*	-0.0819*	0.1518*	-0.0248*	-0.0033	1.0000	
Crude	0.0231*	-0.0696*	0.0411*	-0.0033	0.0043	0.3502*	1.0000
SP	0.1370*	0.0900*	-0.1506*	0.0225*	0.0024	-0.8729*	-0.3677*
VIX	-0.1321*	-0.0570*	0.1174*	-0.0111*	-0.0047	0.4967*	-0.0778*

4.4.2 California

California's Pearson's Correlation had seven variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, and VIX. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, Crude Oil, and S&P 500.

Pearson's Correlation for California determined that seven variables were significant with DBE Participation. Variables with positive correlation included Bid Difference and S&P 500. Variables with negative correlation included Number of Bidders, Project Size, Unemployment Rate, Crude Oil, and VIX.

4.4.3 Colorado

Colorado's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Colorado determined that four variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, and Project Duration. There were no variables with negative correlation.

4.4.4 Indiana

Indiana's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Duration, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Indiana determined that six variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Project Duration, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

4.4.5 Louisiana

Louisiana's Pearson's Correlation had five variables significant with Bid Difference. Variables with positive significant correlation included Crude Oil and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Louisiana determined that six variables were significant with DBE Participation. Variables with positive correlation included Number of Bidders, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Crude Oil, and VIX.

4.4.6 Massachusetts

Massachusetts's Pearson's Correlation had seven variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, and S&P 500. Variables with negative significant correlation included Number of Bidders, Project Duration, Unemployment Rate, and VIX.

Pearson's Correlation for Massachusetts determined that seven variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

4.4.7 Michigan

Michigan's Pearson's Correlation had eight variables significant with Bid Difference. Variables with positive significant correlation included Project Size, Project Duration, Crude Oil, and S&P 500. Variables with negative significant correlation included DBE Participation Goal, Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Michigan determined that seven variables were significant with DBE Participation. Variables with positive correlation included Number of Bidders, Project Size, Unemployment Rate, Crude Oil, and VIX. Variables with negative correlation included Bid Difference and S&P 500.

4.4.8 Minnesota

Minnesota's Pearson's Correlation had four variables significant with Bid Difference. Variables with positive significant correlation included Crude Oil and S&P 500. Variables with negative significant correlation included Number of Bidders and VIX.

Pearson's Correlation for Minnesota determined that seven variables were significant with DBE Participation. Variables with positive correlation included Number of Bidders, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

4.4.9 Missouri

Missouri's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included Project Size, Project Duration, and Crude Oil. Variables with negative significant correlation included DBE Participation Goal, Number of Bidders, and VIX.

Pearson's Correlation for Missouri determined that eight variables were significant with DBE Participation. Variables with positive correlation included Number of Bidders, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Bid Difference, Unemployment Rate, Crude Oil, and VIX.

4.4.10 Mississippi

Mississippi's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included Project Size, Crude Oil, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Mississippi determined that five variables were significant with DBE Participation. Variables with positive correlation included Number of Bidders, Project Size, Project Duration, and Unemployment Rate. S&P 500 was the single variable with negative correlation.

4.4.11 North Carolina

North Carolina's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal and S&P 500. Variables with negative significant correlation included Number of Bidders, Project Duration, Unemployment Rate, and VIX.

Pearson's Correlation for North Carolina determined that eight variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, Project Duration, Unemployment Rate, Crude Oil, and VIX. S&P 500 was the singular variable with negative correlation.

4.4.12 New Hampshire

New Hampshire's Pearson's Correlation had two variables significant with Bid Difference. Crude Oil was the single variable with positive significant correlation. Number of Bidders was the singular variable with negative significant correlation.

No variables were correlated with DBE Participation Goal because New Hampshire has a race-neutral program.

4.4.13 Ohio

Ohio's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Ohio determined that eight variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

4.4.14 Oregon

Oregon's Pearson's Correlation had six variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, Crude Oil, and VIX.

Pearson's Correlation for Oregon determined that seven variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Project Size, Project Duration, and S&P 500. Variables with negative correlation included Unemployment Rate, Crude Oil, and VIX.

4.4.15 Rhode Island

Rhode Island's Pearson's Correlation had five variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal and S&P 500.

Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Rhode Island determined that six variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, and S&P 500. Variables with negative correlation included Unemployment Rate and Crude Oil.

4.4.16 Texas

Texas's Pearson's Correlation had eight variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, Project Duration, Crude Oil, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, and VIX.

Pearson's Correlation for Texas determined that five variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, Project Duration. Unemployment Rate was the lone variable negatively significant with DBE Participation.

4.4.17 Unidentified State

UID's Pearson's Correlation had eight variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal, Project Size, Project Duration, and S&P 500. Variables with negative significant correlation included Number of Bidders, Unemployment Rate, Crude Oil, and VIX.

Pearson's Correlation for UID determined that eight variables were significant with DBE Participation. Variables with positive correlation included Bid Difference, Number of Bidders, Project Size, Project Duration, Unemployment Rate, Crude Oil, and VIX. S&P 500 was the lone variable negatively significant with DBE Participation.

4.4.18 Utah

Utah's Pearson's Correlation had four variables significant with Bid Difference. Variables with positive significant correlation included Crude Oil and S&P 500. Variables with negative significant correlation included Number of Bidders and VIX.

Pearson's Correlation for Utah determined that five variables were significant with DBE Participation. Variables with positive correlation included Project Duration, Crude Oil, and S&P 500. Variables with negative correlation included Unemployment Rate and VIX.

4.4.19 Washington State

Washington's Pearson's Correlation had seven variables significant with Bid Difference. Variables with positive significant correlation included DBE Participation Goal and S&P 500. Variables with negative significant correlation included Number of Bidders, Project Duration, Unemployment Rate, Crude Oil, and VIX.

Pearson's Correlation for Washington determined that seven variables were significant with DBE Participation. Variables with positive correlation included Bid Difference and S&P 500. Variables with negative correlation included Number of Bidders, Project Duration, Unemployment Rate, Crude Oil, and VIX.

4.4.20 Summary of Pearson's Correlation Findings

As summarized by Table 6, Bid Difference averaged 6.15 significant variables per sample. Table 5 presents the breakdown of significant variables. Results were reported based on p >0.05. It is apparent that general trends can be supported. 77% of the qualifying sample groups determined that DBE Participation Goals are correlated with Bid Difference. Additionally, 67% of the sample presents positively correlation with Bid Difference and DBE Participation Goals. The most surprising aspect of the data is that Number of Bidders was constantly negatively correlated with each state. No other variable in the study showed a 100% rate of correlation among the states. However, the variable VIX was nearly constant. VIX had negative significant correlation with 89% of the data sets in the study. Lastly, Unemployment Rate was negatively significant for 73% of the sample groups.

Overall, these results indicate that the Number of Bidders, VIX, and S&P 500 are constant and uniformly correlated with Bid Difference. In addition, variables such as Unemployment and DBE Participation Goals showed consistent, but not constant, correlation.

Table 6 Variables Significant with Bid Difference by State

Variables Significant with Bid Difference, by State								
State	DBE	Bidders	Wbsize	Duration	NatEmp	Crude	SP	VIX
CA	+	-	+	-	-	-	+	-
CO	+	-	+	+	-	+	+	-
IN	+	-	-	+	-	-	+	-
LA	+	-	+	+	-	+	+	-
MA	+	-	+	-	-	-	+	-
MI	-	-	+	+	-	+	+	-
MN	+	-	+	-	-	+	+	-
MO	-	-	+	+	+	+	+	-
MS	+	-	+	-	-	+	+	-
NC	+	-	-	-	-	+	+	-
NH	N/A	-	+	+	-	+	+	-
OH	+	-	+	-	-	+	+	-
OR	+	-	+	-	-	-	+	-
RI	+	-	-	+	-	-	+	-
TX	+	-	+	+	-	+	+	-
UID	+	-	+	+	-	-	+	-
UT	-	-	+	+	-	+	+	-
WA	+	-	-	-	-	-	+	-
ANS	+	-	+	+	-	+	+	-
# Sig. +	12	0	10	6	0	9	17	0
# Sig. -	2	19	0	3	14	5	0	18

Gray area indicates significance p *>0.05*

Constant and consistent trends show that, as positive correlations such as DBE Participation Goals and S&P 500 increase, Bid Difference also increases. Possible causation may exist for each variable. For instance, DBE Participation may cause increased prices for reasons illustrated in the literature review. The S&P 500 is an index of the stock market. As the S&P 500 value increases, earnings in the stock market increase. Possible causation for S&P 500 may be an indicator of a healthier market, which consequently reduces competition and increases Bid Difference. A similar conclusion can be provided for variables with negative correlations. The variables Number of Bidders and VIX indicate that, as their values decrease, Bid Difference also decreases. As indicated in Chapter 2, Number of Bidders is viewed as direct competition. As the number of bidders increase on a project, project costs are reduced. The reduction in project costs translates to a decrease in Bid Difference. It is reasonable to assume that direct competition is the cause for a constant negative significant correlation. Just as S&P 500 is an indicator of a healthy market, VIX is an indicator of an uncertain market. As VIX increases, so does market volatility. This volatility translates to increased competition. As VIX increases, competition also increases. This increased competition decreases Bid Difference.

As summarized by Table 7, DBE Participation was significant for an average of 6.73 samples. This average was greater than that of the Pearson's Correlation findings of Bid Difference. Although the average was greater for DBE Participation Correlation, the findings were not as consistent as Bid Difference. For instance, the relationship of variables with mostly leaning negative or positive relationships were consistent in the Bid Difference Correlation. However, with all but one variable, this was not the case for DBE Participation Correlation. 83% of the eligible samples in the group had a significant positive relationship between Project Size and DBE Participation. This correlation indicates that, as project dollar value increases, so will DBE Participation Goals. One explanation for this relationship is found in Section 2.2, which indicates that the program has oversight issues, specifically tracking awards. By including larger goals on larger projects, program administrators can focus a high concentration of program dollars on minimal projects. Another possible explanation is the focus on large urban areas for projects and concentration of DBEs in availability studies. A similar but less consistent pattern emerged with project duration. A total of 67% of the sample had a significant positive correlation with DBE Participation. Causation can be explained in a similar method for projecting cost. A natural relationship between a high-cost project and a longer duration would exist. It is a reasonable assumption that projects with an average budget of $3 million would take several years to complete.

Table 7 Variables Significant with DBE Participation by State

Variables Significant with DBE Participation, by State								
State	Bid Diff	Bidders	Wbsize	Duration	NatEmp	Crude	SP	VIX
CA	+	-	+	-	-	-	+	-
CO	+	+	+	+	+	-	-	-
IN	+	-	+	+	-	-	+	-
LA	+	+	+	+	-	-	+	-
MA	+	+	+	-	-	-	+	-
MI	-	+	+	-	+	+	-	+
MN	+	+	+	+	-	-	+	-
MO	-	+	+	+	-	-	+	-
MS	+	+	+	+	+	+	-	-
NC	+	+	+	+	+	+	-	+
NH	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OH	+	+	+	+	-	-	+	-
OR	+	-	+	+	-	-	+	-
RI	+	+	+	+	-	-	+	+
TX	+	+	+	+	-	-	+	+
UID	+	+	+	+	+	+	-	+
UT	-	+	+	+	-	+	+	-
WA	+	-	-	-	-	-	+	-
ANS	+	-	+	-	-	-	+	-
# Sig. +	12	11	15	12	4	4	12	3
# Sig. -	2	3	0	2	12	11	4	10

Gray area indicates significance p *>0.05*

4.5 Linear Regression

Results are presented by each sample group, the cost vector, and their representative dollars of change. Sample specific OLS Regression output data can be found in Appendix F. The format remains consistent, as presented in Section 4.4. Each subsection provides the same format for each subject. Each state is introduced with its respective summary statistics. At a minimum, statistics include the number of bids/observations, total dollar value awarded, and respective rankings amongst states.

The second portion of analysis summarizes OLS statistics and their cost vectors. Each sample reports the adjusted r-squared value, the total sum of squares (SST), and the average total sum of squares (MST) to best illustrate the consistency of the model. Adjusted r-squared values is reported to determine the models' percent values. The SST value provides insight into the spread of each contract awarded. In addition to SST, MST is reported to treat each state's variation in a method proportional to its size. Although there is a direct relationship between adjusted r-squared and MST, MST can provide increased insight on the variability of each result/contract. Each model is deemed low variability if the MST does not exceed 20% of the mean MST of the study. Results are reported in Figure 19.

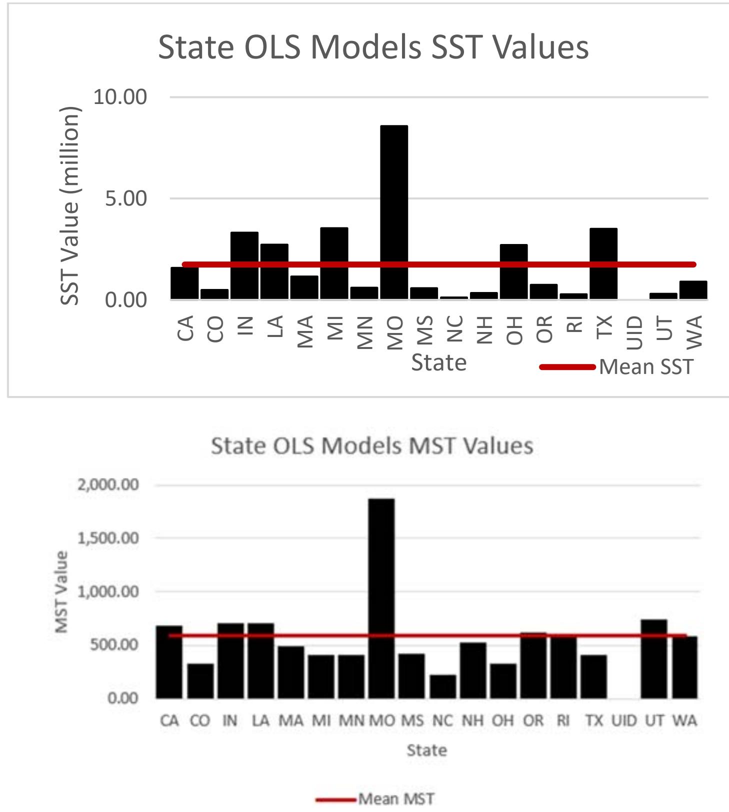


Figure 19 State OLS SST & MST Values (UID omitted)

For clarification, the trailing sections discuss net increases and decreases for values that may have a negative or positive association. There exists the opportunity where the reader can interpret a net increase in negative number as a value going from -7 to -6, or from -7 to -8. For this purpose, the following terms and examples have been provided.

A net surplus/deficit will be used to define any value that decreases the total dollar value of a variable. The explainable net surplus can be used to describe a value that increases in absolute value (i.e., from -7 to -8) to reduce overall cost but increases Bid Difference in absolute value from 0.

Table 8 Reference Table for Cost Vectors

Sample Name	Cost Vector ("Blank" cells are greater than p=0.05)							
	DBE	Bidders	Wbsize	Duration	NatEmpl	Crude	SP	VIX
California	2.305	-12.755	1.204	-1.011				
Colorado		-3.686	1.49					
Indiana		-7.197	-0.394	2.159	-9.375			3.647
Louisiana	1.303	-10.564						
Massachusetts		-5.076	0.524	-5.259	-9.822			
Michigan		-4.128	0.378		-5.164		-8.307	
Minnesota	1.107	-9.167			12.343		20.127	3.496
Missouri	-2.541	-12.505	2.628			17.273	-19.035	4.266
Mississippi		-8.15	1.05					
North Carolina	6.93	-2.858			5.669	10.169		
New Hampshire		-4.458						
Ohio	2.389	-7.767				3.751	-11.102	
Oregon		-5.23						
Rhode Island	4.755	-5.236						5.76
Texas	1.358	-7.603		1.098	10.868	3.617		-2.81
Unidentified State	1.974	-7.081		1.054				
Utah	-3.526	-12.726						
Washington	1.743	-8.904			-17.39		-16.955	-3.172
The National Aggregate Sample	1.195	-7.451	0.139	0.571	-3.436	3.936	-6.342	

4.5.1 Aggregate National Sample

With the information provided for all 18 states, Section 4.5.1 provides the aggregate results when all states are combined into one data set. The ANS represented over $165 billion in contract awards and over 60,188 observations. The average contract cost for The ANS was $3.58 million per project. The ANS averaged a -6.23% Bid Difference during this period. DBE Participation for The ANS averaged 3.73%, totaling $6.8 billion in the 11-year period. Given these averages, the average dollar spent involving DBE Participation Goals equates to an average of $618.46 million spent per year and $133.6k per project.

The ANS's OLS model ranked 6th in the group, with an adjusted r-squared value of 0.2104. The SST value of nearly 40 million was above the 20% threshold, indicating a great deal of variability within the model. With such a large sample size, this high level of variability was expected. The MST in this group was 664.47, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study. This model included the state of Missouri, which presented SST and MST values in an outlier fashion. Further clarification will be provided in Section 4.7.9. Analysis for each state's MST and SST rank excludes Missouri. When the ANS excludes Missouri, the adjusted SST is approximately 36.54 million with an MST of 653.54, which is slightly above the adjusted MST of 627.46. It is important to note that, during this analysis that excluded Missouri, variables that were above or below the MST and adjusted MST remained consistent. Variables that were in their category of above or below average remained as such.

The ANS had seven continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $754.7 million in net surplus, providing an overall savings to the sample.

The ANS's OLS model contained three continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders, Unemployment Rate, and S&P 500. The variable Number of Bidders provided a cost vector of -7.451. Each additional bidder beyond one added represented a 2.1 percentage-point decrease in Bid Difference per each additional bidder beyond one. The ANS averaged 4.54 bidders per project. Number of Bidders yielded an explainable net surplus of $493.84 million. The variable Unemployment Rate provided a cost vector of -3.436. The model observed a 1.1 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.82% for this sample. Unemployment Rate yielded an explainable net surplus of $227.7 million. The variable S&P 500 provided a cost vector of -6.342. The model observed a 0.01 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1687.64 for this sample. The S&P 500 yielded an explainable net surplus of $420.31 million. These combined variables explain a total of $1,141.85 million surplus created during this period.

The ANS's OLS model contained four continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal, Project Size, Project Duration, and Crude Oil. The variable DBE Participation Goal provided a cost vector of 1.195. Each DBE Participation Goal point increase represented a 0.32 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. The ANS averaged 3.73% DBE Participation Goal per project. The DBE Participation Goal yielded an explainable net deficit of $79.19 million. The variable Project Size provided a cost vector of 0.139.

The model observed a 0.05 percentage-point increase in Bid Difference per each million-dollar increment of contract value. The ANS averaged $3.03 million per project. Project Size yielded an explainable net deficit of $9.21 million. The variable Project Duration provided a cost vector of 0.571. The model observed a 0.002 percentage-point increase in Bid Difference per each calendar day increase. The ANS averaged 238.64 calendar days per project. Project Duration yielded an explainable net deficit of $37.88 million. The variable Crude Oil provided a cost vector of 3.936. The model observed a 0.09 percentage-point increase in Bid Difference per each point increase above the minimum observed value. Crude Oil averaged $75.83 per barrel for this sample. Crude Oil yielded an explainable net deficit of $260.87 million. These combined variables explain a total of $387.15 million deficit created during this period.

Table 9 Aggregate National Sample Model

Source	SS	df	MS			
				Number of obs	=	60,188
				F(38, 60149)	=	423.15
Model	8436097.98	38	222002.578	Prob > F	=	0.0000
Residual	31556857.3	60,149	524.644754	R-squared	=	0.2109
				Adj R-squared	=	0.2104
Total	39992955.3	60,187	664.478297	Root MSE	=	22.905

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.3203217	.0250132	12.81	0.000	.2712957	.3693477
Bidders	-2.104903	.0382507	-55.03	0.000	-2.179874	-2.029931
WBsize	.0458868	.009256	4.96	0.000	.027745	.0640286
Duration	.0023948	.0005126	4.67	0.000	.0013901	.0033996
NatEmpl	-1.101179	.2978325	-3.70	0.000	-1.684932	-.5174264
Crude	.0864891	.0121005	7.15	0.000	.062772	.1102063
SP	-.0066578	.0014986	-4.44	0.000	-.009595	-.0037205
VIX	-.006127	.0214001	-0.29	0.775	-.0480714	.0358174
Q2	-.4094774	.2536674	-1.61	0.106	-.9066664	.0877116
Q3	2.496648	.2812909	8.88	0.000	1.945317	3.047979
Q4	2.523536	.3119639	8.09	0.000	1.912086	3.134987
Y08	-13.19516	1.181265	-11.17	0.000	-15.51044	-10.87988
Y09	-13.97716	1.283206	-10.89	0.000	-16.49225	-11.46207
Y10	-9.361625	1.217728	-7.69	0.000	-11.74838	-6.974873
Y11	-4.782449	1.064129	-4.49	0.000	-6.868145	-2.696753
Y12	-3.732283	.8860179	-4.21	0.000	-5.468881	-1.995685
Y13	-4.027656	.6294488	-6.40	0.000	-5.261378	-2.793934
Y15	2.770825	.7760131	3.57	0.000	1.249836	4.291813
Y16	-.8533426	.8853897	-0.96	0.335	-2.58871	.8820243
Y17	.1761981	1.153391	0.15	0.879	-2.084452	2.436848
Y18	3.350277	1.37374	2.44	0.015	.6577409	6.042812
UT	-5.87141	1.254942	-4.68	0.000	-8.331101	-3.411719
CO	8.940705	.7702596	11.61	0.000	7.430993	10.45042
LA	1.163319	.6194742	1.88	0.060	-.0508528	2.37749
MS	4.294944	.8013245	5.36	0.000	2.724345	5.865543
NH	2.149334	1.045185	2.06	0.040	.1007667	4.197901
OH	5.958933	.5552314	10.73	0.000	4.870678	7.047188
OR	4.112212	.8444723	4.87	0.000	2.457043	5.767381
WA	1.960387	.761647	2.57	0.010	.4675567	3.453218
NC	4.944683	1.140976	4.33	0.000	2.708365	7.181001
TX	7.283562	.5562025	13.10	0.000	6.193404	8.373721
MI	6.856247	.5482258	12.51	0.000	5.781722	7.930771
MN	8.57825	.7816617	10.97	0.000	7.04619	10.11031
MA	4.626099	.7266807	6.37	0.000	3.201802	6.050396
MO	36.22366	.5995902	60.41	0.000	35.04846	37.39886
RI	-1.907165	1.185605	-1.61	0.108	-4.230954	.4166242
IN	-2.02086	.5970893	-3.38	0.001	-3.191156	-.8505625
UID	8.405492	.5728904	14.67	0.000	7.282625	9.528359
_cons	9.6683	3.839732	2.52	0.012	2.142413	17.19419

4.5.2 California

California represented over $15.99 billion in contract awards and a total of 2,324 observations. The average contract cost for California was $6.88 million per project. California averaged a -14.07% Bid Difference during this period. DBE Participation for California averaged 7.76%, totaling $1241.66 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goals equates to an average of $1.12 billion spent per year and $534.27k per project.

California's OLS model ranked 2nd in the group, with an adjusted r-squared value of 0.2813. The SST value of nearly 1.57 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 677.56, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

California had four continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $160.04 million in net surplus, providing an overall savings to the sample.

California's OLS model contained two continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders and Project Duration. The variable Number of Bidders provided a cost vector of -12.755. Each additional bidder beyond one added represented a 2.62 percentage-point decrease in Bid Difference per each additional bidder beyond one. California averaged 5.87 bidders per project. The Number of Bidders yielded an explainable net surplus of $199 million. The variable Project Duration provided a cost vector of -1.011. The model observed a 0.01 percentage-point decrease in Bid Difference per each calendar day increase. California averaged 202.25 calendar days per project. Project Duration yielded an explainable net surplus of $15.78 million. These combined variables explain a total of $214.78 million surplus created during this period.

California's OLS model contained two continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal and Project Size. The variable DBE Participation Goal provided a cost vector of 2.305. Each DBE Participation Goal point increase represented a 0.3 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. California averaged a 7.76% DBE Participation Goal per project. DBE Participation Goals yielded an explainable net deficit of

$35.96 million. The variable Project Size provided a cost vector of 1.204. The model observed a 0.18 percentage-point increase in Bid Difference per each million-dollar increment of contract value. California averaged $6.88 million per project. Project Size yielded an explainable net deficit of $18.78 million. These combined variables explain a total of $54.74 million deficit created during this period.

4.5.3 Colorado

Colorado represented over $4.66 billion in contract awards and a total of 1,469 observations. The average contract cost for Colorado was $3.17 million per project. Colorado averaged a -4.98% Bid Difference during this period. DBE Participation for Colorado averaged 4.82%, totaling $224.57 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $20.42 million spent per year and $152.87k per project.

Colorado's OLS model ranked last in the group, with an adjusted r-squared value of 0.0648. The SST value of nearly 0.48 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 329.5, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Colorado had two continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $0.36 million in net surplus, providing an overall savings to the sample.

Colorado's OLS model contained only one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -3.686. Each additional bidder beyond one added represented a 0.98 percentage point decrease in Bid Difference per each additional bidder beyond one. Colorado averaged 4.78 bidders per project. Number of Bidders yielded an explainable net surplus of $0.61 million.

Colorado's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable Project Size provided a cost vector of 1.49. The model observed a 0.47 percentage-point increase in Bid Difference per each million-dollar increment of contract value. Colorado averaged $3.17 million per project. Project Size yielded an explainable net deficit of $0.25 million.

4.5.4 Indiana

Indiana represented over $10.85 billion in contract awards and a total of 4,729 observations. The average contract cost for Indiana was $2.29 million per project. Indiana averaged a -14.53% Bid Difference during this period. DBE Participation for Indiana averaged 5.14%, totaling $557.35 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $50.67 million spent per year and $117.86k per project.

Indiana's OLS model ranked 13th in the group, with an adjusted r-squared value at 0.1216. The SST value of nearly 3.31 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 700.61, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

Indiana had five continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $185.8 million in net surplus, providing an overall savings to the sample.

Indiana's OLS model contained three continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders, Project Size, and Unemployment Rate. The variable Number of Bidders provided a cost vector of -7.197. Each additional bidder beyond one added represented a 2.24 percentage point decrease in Bid Difference per each additional bidder beyond one. Indiana averaged 4.21 bidders per project. Number of Bidders yielded an explainable net surplus of $119.82 million. The variable Project Size provided a cost vector of -0.394. The model observed a 0.17 percentage-point decrease in Bid Difference per each million-dollar increment of contract value. Indiana averaged $2.29 million per project. Project Size yielded an explainable net surplus of $6.56 million. The variable Unemployment Rate provided a cost vector of -9.375. The model observed a 2.95 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.88% for this sample. Unemployment Rate yielded an explainable net surplus of $156.07 million. These combined variables explain a total of $282.45 million surplus created during this period.

Indiana's OLS model contained two continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include Project Duration and VIX. The variable Project Duration provided a cost vector of 2.159. The model observed a 0.007

percentage-point increase in Bid Difference per each calendar day increase. Indiana averaged 308.39 calendar days per project. Project Duration yielded an explainable net deficit of $35.94 million. The variable VIX provided a cost vector of 3.647. The model observed a 0.33 percentage-point increase in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 20.73 for this sample. VIX yielded an explainable net deficit of $60.71 million. These combined variables explain a total of $96.65 million deficit created during this period.

4.5.5 Louisiana

Louisiana represented over $7.91 billion in contract awards and a total of 3,846 observations. The average contract cost for Louisiana was $2.06 million per project. Louisiana averaged a -11.45% Bid Difference during this period. DBE Participation for Louisiana averaged 3.29%, totaling $260.57 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $23.69 million spent per year and $67.75k per project.

Louisiana's OLS model ranked 14th in the group, with an adjusted r-squared value at 0.1073. The SST value of nearly 2.72 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 707.67, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

Louisiana had two continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $61.79 million in net surplus, providing an overall savings to the sample.

Louisiana's OLS model contained only one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -10.564. Each additional bidder beyond one added represented a 3.8 percentage-point decrease in Bid Difference per each additional bidder beyond one. Louisiana averaged 3.78 bidders per project. Number of Bidders yielded an explainable net surplus of $70.48 million.

Louisiana's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable DBE Participation Goal provided a cost vector of 1.303. Each DBE Participation Goal point increase represented a 0.4 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Louisiana averaged a 3.29% DBE Participation Goal per project. DBE Participation Goals yielded an explainable net deficit of $8.69 million.

4.5.6 Massachusetts

Massachusetts represented over $8.82 billion in contract awards and a total of 2,338 observations. The average contract cost for Massachusetts was $3.77 million per project. Massachusetts averaged a -10.25% Bid Difference during this period. DBE Participation for Massachusetts averaged 1.49%, totaling $131.66 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $11.97 million spent per year and $56,310 per project.

Massachusetts's OLS model ranked 10th in the group, with an adjusted r-squared value at 0.1541. The SST value of nearly 1.15 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 491.49, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Massachusetts had four continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $99.14 million in net surplus, providing an overall savings to the sample.

Massachusetts's OLS model contained three continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders, Project Duration, and Unemployment Rate. The variable Number of Bidders provided a cost vector of -5.076. Each additional bidder beyond one added represented a 1.19 percentage-point decrease in Bid Difference per each additional bidder beyond one. Massachusetts averaged 5.28 bidders per project. Number of Bidders yielded an explainable net surplus of $25.63 million. The variable Project Duration provided a cost vector of -5.259. The model observed a 0.01 percentage-point decrease in Bid Difference per each calendar day increase. Massachusetts averaged 584.32 calendar days per project. Project Duration yielded an explainable net surplus of $26.56 million. The variable Unemployment Rate provided a cost vector of -9.822. The model observed a 3.14 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.83% for this sample.

Unemployment Rate yielded an explainable net surplus of $49.6 million. These combined variables explain a total of $101.79 million surplus created during this period.

Massachusetts's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable Project Size provided a cost vector of 0.524. The model observed a 0.14 percentage-point increase in Bid Difference per each million-dollar increment of contract value. Massachusetts averaged $3.77 million per project. Project Size yielded an explainable net deficit of $2.65 million. These combined variables explain a total of $2.65 million deficit created during this period.

4.5.7 Michigan

Michigan represented over $12.59 billion in contract awards and a total of 8,692 observations. The average contract cost for Michigan was $1.45 million per project. Michigan averaged a -7.3% Bid Difference during this period. DBE Participation for Michigan averaged 4.1%, totaling $516.75 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $46.98 million spent per year and $59.45k per project.

Michigan's OLS model ranked 18th in the group, with an adjusted r-squared value at 0.0885. The SST value of nearly 3.54 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 406.76, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Michigan had four continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $68.16 million in net surplus, providing an overall savings to the sample.

Michigan's OLS model contained three continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders, Unemployment Rate, and S&P 500. The variable Number of Bidders provided a cost vector of -4.128. Each additional bidder beyond one added represented a 1.13 percentage-point decrease in Bid Difference per each additional bidder beyond one. Michigan averaged 4.66 bidders per project. Number of Bidders yielded an explainable net surplus of $16.34 million. The variable Unemployment Rate provided a cost vector of -5.164. The model observed a 1.59 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.95% for this sample. Unemployment Rate yielded an explainable net surplus of $20.44 million. The variable S&P 500 provided a cost vector of -8.307. The model observed a 0.01 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1658.11 for this sample. S&P 500 yielded an explainable net surplus of $32.88 million. These combined variables explain a total of $69.66 million surplus created during this period.

Michigan's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. This variable includes Project Size. The variable Project Size provided a cost vector of 0.378. The model observed a 0.26 percentage-point increase in Bid Difference per each million-dollar increment of contract value. Michigan averaged $1.45 million per project. Project Size yielded an explainable net deficit of $1.5 million. These combined variables explain a total of $1.5 million deficit created during this period.

4.5.8 Minnesota

Minnesota represented over $5.42 billion in contract awards and a total of 1,468 observations. The average contract cost for Minnesota was $3.69 million per project. Minnesota averaged a -4.4% Bid Difference during this period. DBE Participation for Minnesota averaged 3.11%, totaling $168.67 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $15.33 million spent per year and $114.9k per project.

Minnesota's OLS model ranked 11th in the group, with an adjusted r-squared value at 0.1295. The SST value of nearly 0.6 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 406.76, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Minnesota had five continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $26.58 million in net surplus, providing an overall savings to the sample.

Minnesota's OLS model contained only one continuous variable which provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -9.167. Each additional bidder beyond one added represented a 3.27 percentage-point decrease in Bid Difference per each additional bidder beyond one. Minnesota averaged 3.8 bidders per project. Number of Bidders yielded an explainable net surplus of $8.73 million.

Minnesota's OLS model contained four continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal, Unemployment Rate, S&P 500, and VIX. The variable DBE Participation Goal provided a cost vector of 1.107. Each DBE Participation Goal point increase represented a 0.36 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Minnesota averaged a 3.11% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $1.05 million. The variable Unemployment Rate provided a cost vector of 12.343. The model observed a 4.42 percentage-point increase in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.49% for this sample. Unemployment Rate yielded an explainable net deficit of $11.76 million. The variable S&P 500 provided a cost vector of 20.127. The model observed a 0.02 percentage point increase in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1741.42 for this sample. S&P 500 yielded an explainable net deficit of $19.17 million. The variable VIX provided a cost vector of 3.496. The model observed a 0.31 percentage-point increase in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 20.75 for this sample. VIX yielded an explainable net deficit of $3.33 million. These combined variables explain a total of $35.31 million deficit created during this period.

4.5.9 Missouri

Missouri represented over $12.56 billion in contract awards and a total of 4,584 observations. The average contract cost for Missouri was $2.74 million per project. Missouri averaged a 24.25% Bid Difference during this period. DBE Participation for Missouri averaged 6.08%, totaling $763.46 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $69.41 million spent per year and $166,550 per project.

Missouri's OLS model ranked 15th in the group, with an adjusted r-squared value at 0.1005. The SST value of nearly 8.57 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 1869.27, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study. Excluding the ANS (as it includes Missouri in the analysis), Missouri saw the largest SST and MST values. In addition, Missouri saw the highest value of MST of 2,366.52. This value is nearly three times greater than the average value in this sample.

Missouri had six continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $468.47 million in net surplus, providing an overall savings to the sample.

Missouri's OLS model contained three continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include DBE Participation Goal, Number of Bidders, and S&P 500. The variable DBE Participation Goal provided a cost vector of -2.541. Each DBE Participation Goal point increase represented a 0.42 percentage-point decrease in Bid Difference per each DBE Participation Goal point increase. Missouri averaged a 6.08% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net surplus of $120.09 million. The variable Number of Bidders provided a cost vector of -12.505. Each additional bidder beyond one added represented a 4.03 percentage-point decrease in Bid Difference per each additional bidder beyond one. Missouri averaged 4.1 bidders per project. Number of Bidders yielded an explainable net surplus of $590.9 million. The variable S&P 500 provided a cost vector of -19.035. The model observed a 0.02 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1686.82 for this sample. S&P 500 yielded an explainable net surplus of $899.42 million. These combined variables explain a total of $1,610.41 million surplus created during this period.

Missouri's OLS model contained three continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include Project Size, Crude Oil, and VIX. The variable Project Size provided a cost vector of 2.628. The model observed a 0.96 percentage-point increase in Bid Difference per each million-dollar increment of contract value. Missouri averaged $2.74 million per project. Project Size yielded an explainable net deficit of $124.16 million. The variable Crude Oil provided a cost vector of 17.273. The model observed a 0.38 percentage-point increase in Bid Difference per each point increase above the minimum observed value. Crude Oil averaged $75.42 per barrel for this sample. Crude Oil yielded an explainable net deficit of $816.2 million. The variable VIX provided a cost vector of 4.266. The model observed a 0.36 percentage-point increase in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 21.23 for this sample. VIX yielded an explainable net deficit of $201.58 million. These combined variables explain a total of $1,141.94 million deficit created during this period.

4.5.10 Mississippi

Mississippi represented over $5.65 billion in contract awards and a total of 1,360 observations. The average contract cost for Mississippi was $4.15 million per project. Mississippi averaged a -7.74% Bid Difference during this period. DBE Participation for Mississippi averaged 2.25%, totaling $126.99 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $11.54 million spent per year and $93.37k per project.

Mississippi's OLS model ranked 9th in the group, with an adjusted r-squared value at 0.16. The SST value of nearly 0.57 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 421.93, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Mississippi had two continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $15.44 million in net surplus, providing an overall savings to the sample.

Mississippi's OLS model contained only one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -8.15. Each additional bidder beyond one added represented a 3.35 percentage point decrease in Bid Difference per each additional bidder beyond one. Mississippi averaged 3.43 bidders per project. Number of Bidders yielded an explainable net surplus of $17.72 million.

Mississippi's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable Project Size provided a cost vector of 1.05. The model observed a 0.25 percentage-point increase in Bid Difference per each million-dollar increment of contract value. Mississippi averaged $4.15 million per project. Project Size yielded an explainable net deficit of $2.28 million.

4.5.11 North Carolina

North Carolina represented over $2.21 billion in contract awards and a total of 513 observations. The average contract cost for North Carolina was $4.31 million per project. North Carolina averaged a -7.03% Bid Difference during this period. DBE Participation for North Carolina averaged 4.05%, totaling $89.64 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $8.15 million spent per year and $174.74k per project.

North Carolina's OLS model ranked 3rd in the group, with an adjusted r-squared value at 0.2238. The SST value of nearly 0.11 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 221.17, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

North Carolina had four continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $37.5 million in net surplus, providing an overall savings to the sample.

North Carolina's OLS model contained only one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -2.858. Each additional bidder beyond one added represented a 0.91 percentage-point decrease in Bid Difference per each additional bidder beyond one. North Carolina averaged 4.13 bidders per project. Number of Bidders yielded an explainable net surplus of $5.38 million. These combined variables explain a total of $5.38 million surplus created during this period.

North Carolina's OLS model contained three continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal, Unemployment Rate, and Crude Oil. The variable DBE Participation Goal provided a cost vector of 6.93. Each DBE Participation Goal point increase represented a 1.71 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. North Carolina averaged a 4.05% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $13.05 million. The variable Unemployment Rate provided a cost vector of 5.669. The model observed a 5.67 percentage-point increase in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 4.7% for this sample. Unemployment Rate yielded an explainable net deficit of $10.68 million. The variable Crude Oil provided a cost vector of 10.169. The model observed a 0.2 percentage-point increase in Bid Difference per each point increase above the minimum observed value. Crude Oil averaged $80.66 per barrel for this sample. Crude Oil yielded an explainable net deficit of $19.15 million. These combined variables explain a total of $42.88 million deficit created during this period.

4.5.12 New Hampshire

New Hampshire represented over $2.24 billion in contract awards and over 6,44 observations. The average contract cost for New Hampshire was $3.48 million per project. New Hampshire averaged a -11.1% Bid Difference during this period. DBE Participation for New Hampshire was excluded because the state does not track participation goals.

New Hampshire's OLS model ranked 7th in the group, with an adjusted r-squared value at 0.1865. The SST value of nearly 0.34 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 526.99, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

New Hampshire had only one continuous variable that met the 95% confidence interval. The variable Number of Bidders provided a cost vector of -4.458. Each additional bidder beyond one added represented a 1.6 percentage-point decrease in Bid Difference per each additional bidder beyond one. New Hampshire averaged 3.79 bidders per project. Number of Bidders yielded an explainable net surplus of $11.05 million.

4.5.13 Ohio

Ohio represented over $17.17 billion in contract awards and a total of 8,131 observations. The average contract cost for Ohio was $2.11 million per project. Ohio averaged a -6.22% Bid Difference during this period. DBE Participation for Ohio averaged 4.4%, totaling $756.13 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $68.74 million spent per year and $92,990 per project.

Ohio's OLS model ranked 8th in the group, with an adjusted r-squared value at 0.1656. The SST value of nearly 2.7 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 332.1, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Ohio had four continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $93.23 million in net surplus, providing an overall savings to the sample.

Ohio's OLS model contained two continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders and S&P 500. The variable Number of Bidders provided a cost vector of -7.767. Each additional bidder beyond one added represented a 2.53 percentage-point decrease in Bid Difference per each additional bidder beyond one. Ohio averaged 4.07 bidders per project. Number of Bidders yielded an explainable net surplus of $56.89 million. The variable S&P 500 provided a cost vector of -11.102. The model observed a 0.01 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1744.37 for this sample. S&P 500 yielded an explainable net surplus of $81.31 million. These combined variables explain a total of $138.2 million surplus created during this period.

Ohio's OLS model contained two continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal and Crude Oil. The variable DBE Participation Goal provided a cost vector of 2.389. Each DBE Participation Goal point increase represented a 0.54 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Ohio averaged a 4.4% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $17.5 million. The variable Crude Oil provided a cost vector of 3.751. The model observed a 0.08 percentage-point increase in Bid Difference per each point increase above the minimum observed value. Crude Oil averaged $75.51 per barrel for this sample. Crude Oil yielded an explainable net deficit of $27.47 million. These combined variables explain a total of $44.97 million deficit created during this period.

4.5.14 Oregon

Oregon represented over $3.9 billion in contract awards and a total of 1,184 observations. The average contract cost for Oregon was $3.3 million per project. Oregon averaged a -12.77% Bid Difference during this period. DBE Participation for Oregon averaged 1.03%, totaling $40.08 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $3.64 million spent per year and $33.85k per project.

Oregon's OLS model ranked 4th in the group, with an adjusted r-squared value at 0.2164. The SST value of nearly 0.74 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 627.04, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

Oregon had only one continuous variable that met the 95% confidence interval. The variable Number of Bidders provided a cost vector of -5.23. Each additional bidder beyond one added represented a 1.14 percentage point decrease in Bid Difference per each additional bidder beyond one. Oregon averaged 5.58 bidders per project. Number of Bidders yielded an explainable net surplus of $25.39 million.

4.5.15 Rhode Island

Rhode Island represented over $1.29 billion in contract awards and a total of 453 observations. The average contract cost for Rhode Island was $2.85 million per project. Rhode Island averaged a -11.81% Bid Difference during this period. DBE Participation for Rhode Island averaged 7.82%, totaling $101.08 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $10.11 million spent per year and $223,140 per project.

Rhode Island's OLS model ranked 16th in the group, with an adjusted r-squared value at 0.0961. The SST value of nearly 0.27 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 600.31, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

Rhode Island saw one variable that provided an explainable net surplus within the specified confidence interval. Number of Bidders provided an explainable net surplus of 5.95 percentage points, with each additional bidder beyond one added representing a 1.94 percentage-point decrease in Bid Difference per estimate. Rhode Island averaged 4.07 bidders per project. When compared using the same methods described earlier in this section, Number of Bidders yielded an explainable net surplus of $11.20 million.

Rhode Island's explainable net surplus of $11.20 million had one variable that created a deficit. The lone variable to create a deficit was DBE Participation Goal, which increased Bid Difference for a total of 6.01 percentage points, reflecting an explainable deficit of $11.31 million. DBE Participation Goal adjusted the total explainable net surplus from $11.2 million to a total explainable net deficit of $107,512.

Rhode Island had three continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $8.52 million in net surplus, providing an overall savings to the sample.

Rhode Island's OLS model contained only one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -5.236. Each additional bidder beyond one added represented a 1.71 percentage-point decrease in Bid Difference per each additional bidder beyond one. Rhode Island averaged 4.06 bidders per project. Number of Bidders yielded an explainable net surplus of $8.44 million.

Rhode Island's OLS model contained two continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal and VIX. The variable DBE Participation Goal provided a cost vector of 4.755. Each DBE Participation Goal point increase represented a 0.61 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Rhode Island averaged a 7.82% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $7.67 million. The variable VIX provided a cost vector of 5.76. The model observed a 0.68 percentage-point increase in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 17.98 for this sample. VIX yielded an explainable net deficit of $9.29 million. These combined variables explain a total of $16.96 million deficit created during this period.

4.5.16 Texas

Texas's sample represented the largest dollar value of the sample. Texas represented over $42.43 billion in contract awards and a total of 8,579 observations. The average contract cost for Texas was $4.95 million per project. Texas averaged a -7.66% Bid Difference during this period. DBE Participation for Texas averaged 2.07%, totaling $876.94 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $79.72 million spent per year and $102,220 per project.

Texas's OLS model ranked 5th in the group, with an adjusted r-squared value at 0.2118. The SST value of nearly 3.5 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 408.26, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Texas had six continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $124.76 million in net surplus, providing an overall savings to the sample.

Texas's OLS model contained two continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders and VIX. The variable Number of Bidders provided a cost vector of -7.603. Each additional bidder beyond one added represented a 1.88 percentage-point decrease in Bid Difference per each additional bidder beyond one. Texas averaged 5.04 bidders per project. Number of Bidders yielded an explainable net surplus of $145.32 million. The variable VIX provided a cost vector of -2.81. The model observed a 0.27 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 19.88 for this sample. VIX yielded an explainable net surplus of $53.71 million. These combined variables explain a total of $199.03 million surplus created during this period.

Texas's OLS model contained four continuous variables that provided an explainable net deficit within the specified confidence interval. Theses variables include DBE Participation Goal, Project Duration, Unemployment Rate, and Crude Oil. The variable DBE Participation Goal provided a cost vector of 1.358. Each DBE Participation Goal point increase represented a 0.66 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Texas averaged a 2.07% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $25.95 million. The variable Project Duration provided a cost vector of 1.098. The model observed a 0.007 percentage-point increase in Bid Difference per each calendar-day increase. Texas averaged 156.91 calendar days per project. Project Duration yielded an explainable net deficit of $20.99 million. The variable Unemployment Rate provided a cost vector of 10.868. The model observed a 3.52 percentage-point increase in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.79% for this sample. Unemployment Rate yielded an explainable net deficit of $207.71 million. The variable Crude Oil provided a cost vector of 3.617. The model observed a 0.08 percentage-point increase in Bid Difference per each point increase above the minimum observed value. Crude Oil averaged $74.98 per barrel for this sample. Crude Oil yielded an explainable net deficit of $69.14 million. These combined variables explain a total of $323.79 million deficit created during this period.

4.5.17 Unidentified State

Due to a non-disclosure agreement, specific statistics will not be revealed in this analysis. Where applicable, a range of statistics will be given to best understand the magnitude of the study, but the study will not provide specific details that may accidentally provide details of the state.

UID represented over $10 billion in contract awards and over 5,000 observations. The average contract cost for UID was $2 million per project. DBE Participation for UID averaged 2.35% in DBE Participation. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $30 million spent per year and over $50,000 per project.

UID's OLS model ranked 17th in the group, with an adjusted r-squared value at 0.0894. The SST value of nearly 3.43 million was above the 20% threshold, indicating a great deal of variability within the model. The MST in this group was 432.49, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

UID had two continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted approximately $30 million in net surplus, providing an overall savings to the sample.

UID's OLS model contained one continuous variable that provided an explainable net surplus within the specified confidence interval. The variable Number of Bidders provided a cost vector of -7.081. Each additional bidder beyond one added represented a 1.83 percentage-point decrease in Bid Difference per each additional bidder beyond one. UID averaged 4.88 bidders per project. Number of Bidders yielded an explainable net surplus of approximately $55 million.

UID's OLS model contained one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable DBE Participation Goal provided a cost vector of 1.974. Each DBE Participation Goal point increase represented a 0.84 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. DBE Participation Goal yielded an explainable net deficit of approximately $15 million.

4.5.18 Utah

Utah represented over $2.14 billion in contract awards and a total of 404 observations. The average contract cost for Utah was $5.31 million per project. Utah was unique as one project was valued at over $1 billion. Checks for outliers for variables were made, but no outliers were present. Utah averaged a -25.93% Bid Difference during this period. DBE Participation for Utah averaged 2.57%, totaling $55.15 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $18.38 million spent per year and $136,520 per project.

Utah's OLS model ranked 12th in the group, with an adjusted r-squared value at 0.1266. The SST value of nearly 0.3 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 739.34, which did not meet the +20% threshold of 586.67, indicating that this model has high variability and should be limited as an aggregate representation of the states involved in this study.

Utah had two continuous variables that met the 95% confidence interval. Theses variables include DBE Participation Goal and Number of Bidders. The variable DBE Participation Goal provided a cost vector of -3.526. Each DBE Participation Goal point increase represented a 1.37 percentage-point decrease in Bid Difference per each DBE Participation Goal point increase. Utah averaged a 2.57% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net surplus of $9.62 million. The variable Number of Bidders provided a cost vector of -12.726. Each additional bidder beyond one added represented a 3.61 percentage-point decrease in Bid Difference per each additional bidder beyond one. Utah averaged 4.53 bidders per project.

Number of Bidders yielded an explainable net surplus of $34.71 million. These combined variables explain a total of $44.33 million surplus created during this period.

4.5.19 Washington State

Washington represented over $8.78 billion in contract awards and a total of 1,534 observations. The average contract cost for Washington was $5.72 million per project. Washington averaged a -11.49% Bid Difference during this period. DBE Participation for Washington averaged 5.01%, totaling $440.13 million in an 11-year period. Given these averages, the average dollar spent involving DBE Participation Goal equates to an average of $40.01 million spent per year and $286,920 per project.

Washington's OLS model ranked 1st in the group, with an adjusted r-squared value at 0.2938. The SST value of nearly 0.89 million was not above the 20% threshold, indicating minimal variability within the model. The MST in this group was 582.77, which met the +20% threshold of 586.67, indicating that this model is well defined as an aggregate representation of the states involved in this study.

Washington had five continuous variables that met the 95% confidence interval. These competing deficits and surpluses netted a total of $634.31 million in net surplus, providing an overall savings to the sample.

Washington's OLS model contained four continuous variables that provided an explainable net surplus within the specified confidence interval. Theses variables include Number of Bidders, Unemployment Rate, S&P 500, and VIX. The variable Number of Bidders provided a cost vector of -8.904. Each additional bidder beyond one added represented a 2.69 percentage-point decrease in Bid Difference per each additional bidder beyond one. Washington averaged 4.31 bidders per project. Number of Bidders yielded an explainable net surplus of $126.41 million. The variable Unemployment Rate provided a cost vector of -17.39. The model observed a 5.56 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. The national Unemployment Rate averaged 6.83% for this sample. Unemployment Rate yielded an explainable net surplus of $246.9 million. The variable S&P 500 provided a cost vector of -16.955. The model observed a 0.02 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. S&P 500 averaged an index of 1677.02 for this sample. S&P 500 yielded an explainable net surplus of $240.71 million. The variable VIX provided a cost vector of -3.172. The model observed a 0.29 percentage-point decrease in Bid Difference per each point increase above the minimum observed value. VIX averaged an index of 20.64 for this sample. VIX yielded an explainable net surplus of $45.04 million. These combined variables explain a total of $659.06 million surplus created during this period.

Washington's OLS model contained only one continuous variable that provided an explainable net deficit within the specified confidence interval. The variable DBE Participation Goal provided a cost vector of 1.743. Each DBE Participation Goal point increase represented a 0.35 percentage-point increase in Bid Difference per each DBE Participation Goal point increase. Washington averaged a 5.01% DBE Participation Goal per project. DBE Participation Goal yielded an explainable net deficit of $24.75 million.

4.6 Results Summary

The summary statistics listed in Section 4.1 identified ranges of observed statistics. Mean summary statistics for the 19 samples included DBE Participation Goal at 0-3.74%, Number of Bidders at 3.43 to 5.87, Bid Size at $1.45m to $6.88m, and Duration at 85-584 days. Macroeconomic indicators included mean averages of Unemployment at 4.7% to 8.52%, Crude Oil at $69.91 to $870.66, S&P 500 at 1,077 to 2,053, and VIX at 17.48 to 30.34.

Sections 4.2 & 4.3 tested the soundness of the data. The samples met most of the qualifications of the Gauss-Markov theorem. The data was normally distributed, linear, random, non-colinear, and distribution of error has zero mean. The data presented a heteroskedastic pattern. While the data regression is not considered BLUE, it still provides significant insight.

Section 4.4 tested Pearson's Correlation. The section determined Bid Difference averaged 6.15 significant variables per sample. Many variables were significant with DBE Participation Goal, not all had the same direction of relationship (i.e. positive or negative). Number of Bidders was significantly correlated with all samples in a negative manner. In addition, all but one sample significantly correlated with VIX in a negative relationship. DBE Participation was significantly correlated for an average of 6.73 samples. 15 samples were significantly correlated with DBE Participation Goal and Bid Size. Many of the variables were similarly correlated at approximately 60% of the samples.

Section 4.5 provided insight into each sample cost vectors. The results for all 19 samples are summarized in this section. Figure 20 serves as the summary by sample as observed in Section 4.5

summarized by each sample, Section 4.6 summarizes the observations by variables included in this study. These results provide a refresher for the audience while providing the opportunity to transition to the research answers. Explainable cost deficits/surpluses are presented utilizing the ANS. The rationale for this method of presentation is to prevent inflation on the magnitude of cost deficits/surpluses. If the ANS were summarized along with each state, the results would be double accounted.

DBE Participation Goal was significant for 12 samples. DBE Participation Goal is the only continuous variable that does not include all 19 samples in the study. New Hampshire was excluded in analysis because they do not track DBE Participation Goal. The study determined that 67% of samples were significant with DBE Participation Goal. 55.56% of the samples had positive cost vectors. DBE Participation Goal explained $79.19 million in deficit/loss. This relationship states that, as DBE Participation Goals increase, costs increase.

The Number of Bidders was significant for all samples in the study. The Number of Bidders is the only variable to be 100% significant. In addition, The Number of Bidders is the only variable to have consistent direction of cost vectors. 100% of the samples had negative cost vectors. The Number of Bidders explained $493.84 million in surplus/savings. This relationship reveals that, as The Number of Bidders increase, costs decrease.

Project Size was significant for 7 (36.84%) samples. 31.58% of the samples had positive cost vectors. Project Size explained $9.21 million in deficit/loss. This relationship reveals that, as Project Size increase, costs increase. Project Duration was significant for 6 (31.58%) samples. 21% of the samples had positive cost vectors. Project Duration explained $37.88 million in deficit/loss. This relationship reveals that, as Project Duration increase, costs increase.

Unemployment Rate was significant for 8 (42.11%) samples. 26.32% of the samples had negative cost vectors. Unemployment Rate explained $227.70 million in surplus/savings. This relationship reveals that, as Unemployment Rate increases, costs decrease. Crude Oil was significant for 5 (26.32%) samples. 26.32% of the samples had positive cost vectors. Crude Oil explained $260.87 million in deficit/loss. This relationship reveals that, as Crude Oil prices increase, costs increase.

S&P 500 was significant for 6 (31.58%) samples. 26.32% of the samples had negative cost vectors. S&P 500 explained $420.31 million in surplus/savings. This relationship reveals that, as S&P 500 indexes increases, costs decrease. VIX was significant for 7 (36.84%) samples. 21% of the samples had positive cost vectors. VIX explained $221.19 million in deficit/loss. This relationship reveals that, as VIX indexes prices increase, costs increase.

Impacts for seasonal/quarterly effects were sporadic. Quarter 2 was significant for 5 (26.32%) samples (MO, NH, OH, TX, ANS). 15.79% of the samples had negative cost vectors. Quarter 2 explained $27.11 million in surplus/savings. This relationship reveals that contracts awarded in Quarter 2 were typically less expensive that contracts awarded in Quarter 1. Quarter 3 was significant for 10 (52.63%) samples (CO, IN, MA, MI, NC, OH, TX, UID). 47.37% of the samples had positive cost vectors. Quarter 3 explained $165.49 million in deficit/loss. This relationship reveals that contracts awarded in Quarter 3 were typically more expensive than contracts awarded in Quarter 1. Quarter 4 was significant for 9 (47.37%) samples (MI, MN, MO, MS, OH, TX, UID, WA, ANS). 47.37% of the samples had positive cost vectors. Quarter 4 explained $167.28 million in deficit/loss. This relationship reveals that contracts awarded in Quarter 3 were typically more expensive that contracts awarded in Quarter 1. These combined quarters accounted for $305.66 million in deficit/loss.

Yearly impacts followed a general trend with seasonal/quarterly impacts. From 2008 to 2013, each variable had positive cost vectors. There was a total of $3.25 billion in savings during this period. These savings translate to $542.09 million in surplus/savings per year. States that had consistent patterns for this yearly trend included Ohio, Michigan, Texas, and UID. This relationship reveals that contracts awarded in 2008 to 2013 were typically less expensive that contracts awarded in 2014. Bid data from 2015 to 2018 had mixed results, with some states indicated a surplus, while other states indicated a deficit. Values will not be reported for this period as the ANS was not significant with each year.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

Chapter 5 answers the research questions posed in Section 1.4, provides conclusions, and provides recommendations based on the findings. In the answer to research questions, the results of the OLS are briefly provided. In addition, insights on significant variables are presented to provide market trends during this period. The conclusions provide a simple validation regarding the unforeseen limitations of the study. Validation provides an additional contribution to the research. The discussion section provides rationale regarding the lack of changes within the program.

To reiterate the study, the data in this research consisted of over 60,000 awarded contracts for dollar value in excess of $165 billion. This data covers a wide characteristic of conditions that are homogenous of the nation. They cover large and small states, each with their respective large and small budgets. The data is evenly represented in state geography and budget. The data encompasses major cycles of the economy. Through this research, simple statistics regarding the average contract value, DBE Participation Goal, Number of Bidders, and several other insightful statistics have been summarized. As Figure 20 indicates, all samples have different levels are variables significantly correlated to Bid Difference.

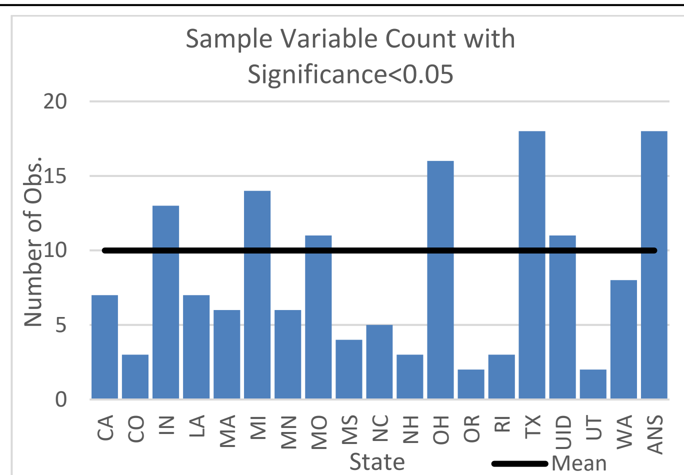


Figure 20 Histogram of Variables with Significance, by State

The summary statistics provide insight over the 11 years examined in this study. At a minimum, the trends provided by summary statistics in this study advance the research in heavy-highway project procurement. At a maximum, the study advances research by providing quantitative analysis on these

The consistency and reliability of the test and pre-test methods for this study have been proven in previous sections of this paper. Although the OLS regression model is not considered BLUE, it can still be determined reliable. This reliability is supported through the Gauss-Markov theorem, along with parallel statistical tests, such as Pearson's Correlation. Although the results do not provide identical results, they do provide general and consistent trends of the 60,000 observations in this study. Given this understanding, we can assume that the data is reliable.

As indicated by Figure 21, each state provides a different analysis based on their size, geography, needs, operating budget, and local economic conditions. Some of these states provided complete and accurate data, whereas others provided partial accurate data. However, due to all these differences, a consistent trend emerges throughout the research. The Number of Bidders actively pursuing a project has a direct correlation to how much Bid Difference will be reduced. This case is true for large states like Texas and for small states like Rhode Island. This is supported for states located in the Pacific Northwest, as well as states located in the Southeast. This rings true for projects being solicited in poor economic periods as well as those in healthy economic periods. The Number of Bidders for the ANS reflects a $500 million explainable net surplus in Bid Difference.

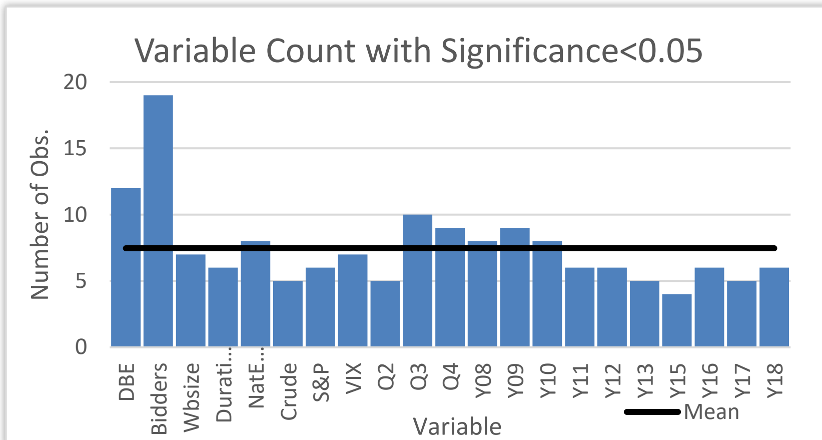


Figure 21 Histogram of Variables with Significance

5.1 Answers to Research Questions

5.1.1 Question 1: What relationship, if any, does DBE Participation Goals have with Bid Difference?

H0: There is not a relationship between DBE Participation Goals and Bid Difference.

H1: There is a relationship between DBE Participation Goals and Bid Difference.

By examining the ANS OLS regression, we can determine that DBE Participation Goals are significantly correlated on a national scale. DBE Participation Goal was correlated with a *p* value of 0.000, indicating high significance. DBE Participation Goals increase project costs by nearly a third of a percentage point for every percentage point increase in DBE Participation Goal. This relationship accounted for nearly $80 million in increased costs when observed by the ANS from 2008 to 2018. For this reason, the null hypothesis is rejected.

5.1.2 Question 2: Does this relationship vary state by state? If so, how many states?

H0: Relationships between DBE Participation Goals and Bid Difference do not vary by state.

H1: Relationships between DBE Participation Goals and Bid Difference do vary by state.

As indicated by Figure 22, the relationship between DBE Participation Goal and Bid Difference vary by state. Out of the 17 qualified states, 55% of states had positive correlation. Positive correlation is an indication that, as DBE Participation Goal increases, so does Bid Difference. These states include CA, LA, MN, NC, OH, RI, TX, UID, and WA. In other states, such as MO and UT, there was negative correlation. Negative correlation indicates that, as DBE Participation Goal increase, Bid Difference decreases. Other states had no significant correlation with DBE Participation Goal and Bid Difference. Given these results, we can state that DBE Participation Goal does not impact each state in an identical manner. For this reason, the null hypothesis is rejected.

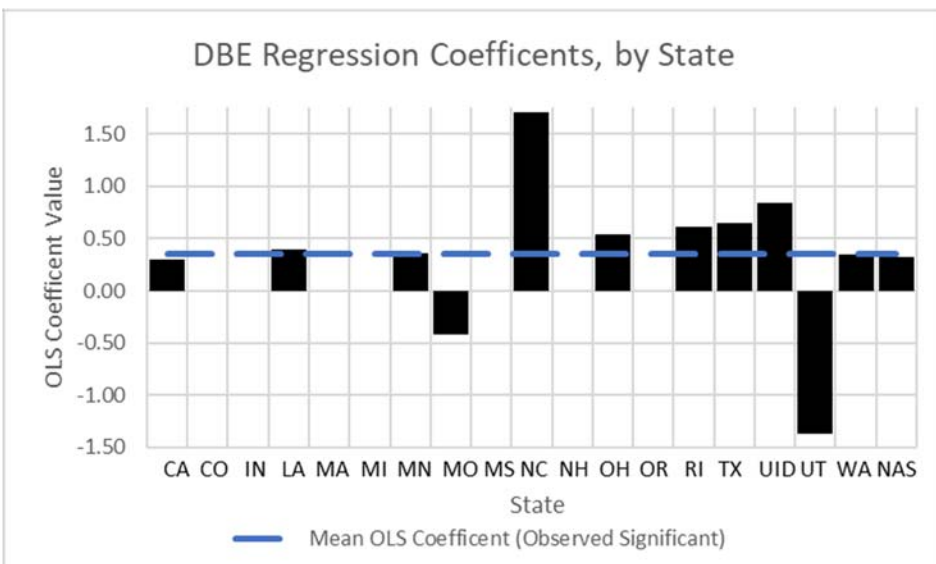


Figure 22 DBE Regression Coefficients by State

5.1.3 Question 3: Do other variables have a more impactful relationship with Bid Difference on a program scale?

H0: Other variables do not have a more impactful relationship with Bid Difference on a program scale.

H1: Other variables have a more impactful relationship with Bid Difference on a program scale.

As a reminder, the term *impactful relationship* is determined by each variable's dollar impact. This question is answered by determining the total dollar impact of DBE Participation Goal. Other variables are compared for their absolute value in explainable difference. If variables exceed the explainable value of DBE Participation Goal, then it is determined that they have a more impactful relationship.

DBE Participation Goal provided a cost vector of 0.32. DBE Participation Goal explained nearly $80 in deficit. Macroeconomic variables provided a great deal of explainable values. For instance, the years 2008 through 2010 explained an average of $800 million of surplus per year. Given the understanding that 2008 to 2010 was during the Great Recession, these surpluses can be explained. In terms of microeconomic indicators, the Number of Bidders for ANS provided a cost vector of -2.10, Number of Bidders explained $493 million in surplus. Given this understanding, it can be determined that other variables have a more impactful relationship to Bid Difference. For this reason, the null hypothesis is rejected.

5.1.4 Question 4: Do other variables have a more consistent relationship with Bid Difference on a state level?

H0: Other variables do not have a more consistent relationship with Bid Difference on a state level.

H1: Other variables have a more consistent relationship with Bid Difference on a state level.

As a reminder, the term *consistent* relates to the total amount of observations of each variable on a by-sample basis. This question is answered by determining the total number of significant observations of DBE Participation Goal. DBE Participation Goal is further observed for similar direction (i.e., negative or positive correlation). Other variables will be compared in the same manner. If significant variables exceed the recorded observations of DBE Participation Goal, then it is determined that they have a more consistent relationship.

DBE Participation Goal was significant for 67% of the qualified samples in the study. As question 2 indicates, this relationship was not consistent. Some relationships resulted in positive correlation while others resulted in negative correlation. Having some samples with negative and positive correlation is not singular to DBE Participation Goal. Several variables had mixed correlations. However, one variable remained consistent: Number of Bidders had negative correlation for each sample. This relationship indicates that, as more bidders participate in procurement, the more likely the Bid Difference will decrease. Bid Difference's cost vector ranged from -4.03 to -0.913. DBE Participation Goal cost vector ranged from -1.372 to +1.711. Given this analysis, we can state that Number of Bidders has a more consistent relationship than DBE Participation Goal. For this reason, the null hypothesis is rejected.

5.2 Conclusions

This study examined DBE Participation Goals to determine whether there are additional economic costs associated with the DBE Program. To ensure completeness, additional variables were included in this study to best represent the status of the micro and macroeconomic factors present during the procurement process.

The DBE program is well documented to have administrative issues. There is a lack of administration within the program. These issues have been longstanding and frequent. Little has changed in the 35+ years of the program. Issues include economic impacts, lack of administration, fraud, and lack of social equity. Issues that were documented in the 1980s are still present and documented today. To date, the program is not in published compliance with Executive Order 12291. Compliance with this Executive Order is important to the reputation of the program because it quantifies the costs and benefits of the program. Cost in this case can be described as economic or social. Components of the program are identified in terms of their costs. These costs include additional economic costs with DBE utilization, economic, and social costs to investigate and prosecute fraud, and the social cost of burden on the federal court system. As Chapter 2 indicates, the DBE program has expended substantial social costs. Few studies have quantified the economic costs of the program. Currently, no published social benefits for the program have been published. FOIA requests were filed but did not lead to resolution. Without an established basis to determine program benefits, the DBE program is left to answer to the costs without providing a defense of benefit.

This research examined the economic costs of the DBE program. This study is the first of its kind to analyze the depth and breadth of the impact of DBE Participation Goals. The study determined that the economic costs of the DBE program are minimal. Over the 11 years examined, the DBE program cost $4.18 million per state per year. The study determined the following:

- DBE Participation Goal create additional costs on a project level. As DBE Participation Goals increase, Bid Difference increases. Although these costs are statistically proven, they are minimal.
- The Number of Bidders on a project is the most common and strongest relationship that impacts project cost amongst competition. Project costs decrease as more bidders attempt to procure work.
- The Great Recession and the recovery, particularly the years of 2008 to 2012, created increased competition. This competition greatly decreased project costs as a result of contractors struggling to remain in business. Projects were aggressively pursued.
- Competitive variables, while not universal, are consistent in their intents. Statistics that are suspected to relate to the health of the economy often reflected the level of competition. For instance, when the S&P 500 is high, it is an indication the economy is healthy. High S&P 500 values increased Bid Difference, indicating procurement attempts are less competitive during a healthy economy. This trend is consistent with other macroeconomic variables including Crude Oil, Unemployment Rate, and VIX.
- Although the OLS model was comprehensive, it cannot fully represent the procurement environment. OLS models provided less-than-ideal adjusted r-squared values. The estimating process for contractors cannot be summarized from this level of analysis. Attempts to measure the intricates were captured using variables discovered and/or confirmed through the literature review. These variables provided objective and measurable units of measurements. The model cannot account for subjective decisions a contractor makes while in the procurement process.

5.3 Recommendations

Recommendations are provided for the administration of the program, as well as advancing the research. Although these recommendations are specific, they are not comprehensive. These recommendations are based on the opinions of a researcher and industry professional.

5.3.1 Administrative Recommendations

What remains unclear are the specific plans and approaches DOTs use to ensure DBE's success. The author recommends program administrators do the following:

- Redefine the eight objectives of the DBE Program. Objectives are intended to act as a mission statement. The eight objectives are noble, but they lack specific planning and implementation that a program as large as the DBE Program requires.
- Publish a cost-benefit analysis of the DBE program. This publication will demonstrate to stakeholders that the program is adequately managed and complying in federal accordance. This publication will illustrate the program's legitimacy.
- Develop a plan of action for ensuring DBE success. This plan should ensure that DBEs are given the opportunity to procure contracts in gradual value. By utilizing a gradual value, DBEs can gradually procure projects that will give them the opportunity to start small with minimal risk, while being able to grow their company.
- In addition, DOTs and the FHWA should provide the opportunity to set DBEs up to procure the *right* types of contracts that will bolster their company into a competitive position, both in the short and long term.

5.3.2 Research Recommendations

Throughout this process the research was adjusted and modified. The methods and variables at the start of this research have changed throughout the work. The intent of the research began as the absolute answer to the DBE program. As statistical methods increased in complexity, the research transitioned into the introductory answer to the DBE program. The current research considerably advances the subject. However, additional methods could further advance the study. The recommendations to advance the study are below:

- The research could be better developed using more complex regression methods. Complex methods, such as Marion's (2007) will provide smaller residuals and be better able to analyze the data set. For the intents of this research, it was decided that complex regression would require the elimination of the use of the OLS regression models presented in this study. This required omission would have interrupted the flow of the paper by skipping several steps in the statistical process. Complex regression was used as a method to test the reliability of the data. The use of complex regression would not have allowed the fundamental building blocks of statistical analysis to be included in this research. Complex regression will likely expand and further discover relationships that the OLS model could not.
- Identify additional market indicator variables. Additional variables may better explain the trends of specific samples.

5.4 Discussion

As the research shows, there are additional costs associated with DBE Participation Goals. These costs are minimal when compared with other variables in this study. With the first level of knowledge obtained in this study, additional research can determine whether these costs warrant amendment to the DBE Program as it stands today.

When the research began, the author was left perplexed as to why a program with so many documented issues would remain unchanged. The DBE program accounts for nearly a third of investigations by the Office of the Attorney General, and there is a lack of documentation of DBEs succeeding in the market (i.e., graduation from the program).

As the research developed into results, the answer became apparent. It is the author's opinion that the overhaul of the DBE program is not worth the social capital to amend it. Although the program is large, the costs imposed by the program are minimal. The costs explained in this study account for approximately $4 million per state, per decade. These costs represent nearly the same costs of the average size of a contract awarded in this sample. With this information at hand, it is likely that policy makers weigh the importance of one additional simple project in a decade versus the continuation of a program that enables the disadvantaged.

In addition to the above scenario, policy makers likely weigh the social capital of the program. As the 1998 hearings indicate, changes must come from the Senate. Given the complexities in our nation, there are likely more important topics to be covered in Senate. Although a Senator may agree that the program needs changes to be fiscally responsible, the social capital may exceed the amount they are willing to spend given the small impact of the program. Although it is the author's opinion as to why this program lacks change, it is not the author's opinion to suggest whether this lack of action is reasonable.

As indicated by Figure 23, the greatest limiter regarding this research is the multiple OLS models with low adjusted r-squared values. The initial study had many continuous variables to attempt to capture local impacts. These omitted variables included mortgage rates, construction price indices, and several leading financial indicators. The initial use of these variables attempted to capture the subjective decisions in contract procurement. These variables were deemed insignificant after initial regression. The research was left with adjusted r-squared values lower than desired. Values ranged from 0.06 to 0.29. With such low adjusted r-squared values, it can be determined that the OLS model(s) does not fully capture all the complexities of competitive highway construction procurement. Although this study provided statistics concerning the general trends of Winning Bids throughout this period, it was limited to the amount of power to explain how much these variables impact Bid Difference.

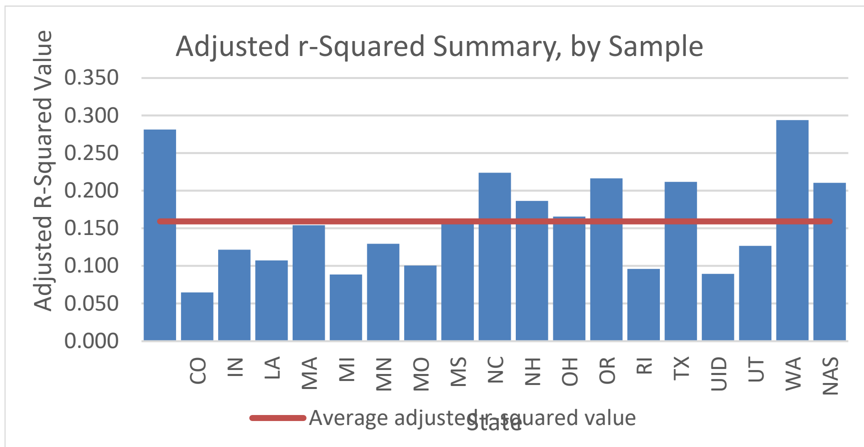


Figure 23 Sample Adjusted r-Squared Values

Subjective decisions could be a contractor's desire to aggressively pursue local work, measure of risk, the desire to pursue work to keep a company solvent in tough economic times, and a quantity imbalance, a mis-specified line item that contractors took advantage of during the estimating process. Furthermore, the OLS model does not reflect the final cost of the project. By omitting the final cost, the best comparison for the Engineer's intended scope versus the Contractor's final scope is omitted. There are a variety of issues in addition to those mentioned that could be explained but not objectively measured that could provide an increase in the adjusted r-squared value.

The use of disparity studies has flawed the methodology to increase DBE participation. Disparity studies do not examine the factual or underlying cause for determining whether DBEs have enough work. Disparity studies do not examine whether DBEs are capable of executing the work. Disparity studies aim to grow the DBE market but do not adequately enable those who are disadvantaged. Disparity studies scratch the surface of DBE availability; it does not consider if DBE's availability is due to issues with a lack of means to financing, bonding, insurance, and other needs of business owners. Disparity studies do not cover the basic intent of the program: to effectively measure methods in which the disadvantaged are no longer at a disadvantage. This claim is supported through the findings of Keen et al. (2019). Keen et al. (2019) state that the DBE Program does not track who has graduated from the program. As indicated by Figure 24, there is a growing increase in DBE Participation Goal requirements, along with a documented lack of oversight and of means or desires to fix these oversight issues, the program lends itself to fraud and unnecessary costs.

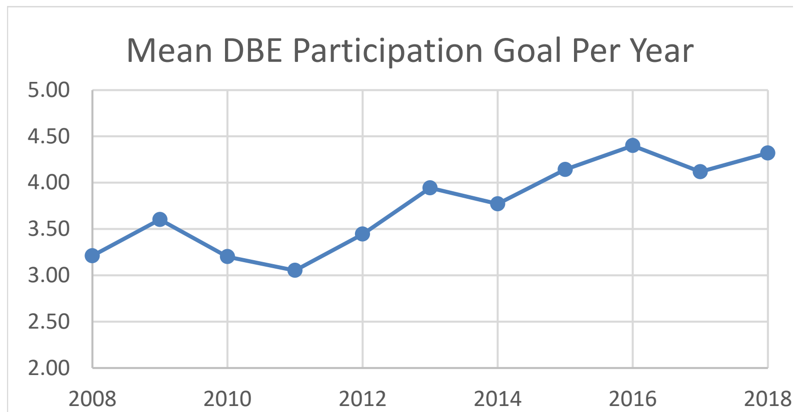


Figure 24 Mean DBE Participation Goal by Year

Economic impact studies have determined that the DBE program creates an additional burden on project costs. Lack of administration has resulted in DBE firms not advancing to self-reliant companies. Graduation rates for the program are less than 1%. DBEs are not tracked for participation. In addition, the lack of administration has opened the program to fraud. The lack of tracking further compounds program administration because goals are increased without being met. While noble, this increase of DBE Participation Goals creates the opportunity for increased fraud. A great example of creating too much DBE participation is present in Illinois. Illinois has increased DBE Participation Goals for several years despite never meeting a state-wide goal. This lack of goal meeting has resulted in an increase of DBE-related fraud, as stated in Chapter 2.

This research has identified the financial costs of the program. Benefits of the program have not been adequately identified in this study. The author provides recommendations regarding the benefits of the program. The pros of the program are that they offer those deemed disadvantaged an opportunity to procure business that they may not have otherwise had. The program appears to be working in that DBE Participation Goals have increased, along with the number of participants in the program. In terms of cons, the program costs each state an average of $4.3 million per year. In addition, there is an association with fraud investigations, a documented lack of oversight, numerous lawsuits, and an ambiguous understanding of who should and should not benefit from the program. Since the inception of the program, there has been little research done to explain how the program will affect the market. There is a lack of understanding both in benefit and in social cost.

Regardless of the cost-benefit analysis of the program, there are enough documented case studies to determine that the DBE program has foundational issues. A well-intended cause has now developed into a multi-billion-dollar program rampant with fraud and no means or methods to proactively fix the issue. These analyses should have been performed when the DBE program was created in the early 1980s. Instead of analysis, a gradual arbitrary increase in DBE Participation Goals has occurred as the program matures, as indicated by Figure 24.

Two conclusions can confidently be drawn from this study: The Number of Bidders and DBE Participation Goals have significant impacts on Bid Difference. The more bidders participating in submitting an estimate for a project will lower the cost more than if fewer bidders were competing. The strongest variable of Number of Bidders is consistent amongst the entire data set, no matter the state of the economy, season, size of the project, size of the state, geography, and so forth. The research determined that an increase in the Number of Bidders per project decreased the Bid Difference. The second consistent variable, DBE Participation Goal, is correlated with an increase in Bid Difference. This correlation indicates that, as DBE Participation Goal increases, Bid Difference increase and create a deficit. The study observes as DBE Participation Goal increases, the cost of the project increases.

APPENDIX A: FOIA LOG & NOTEABLE RESPONSES

Correspondence included where publication was not a violation of privacy conditions.

State	Date FOIA Filed	Status
Virginia	1/26/2019	Denied
District of Columbia	1/31/2019	Denied
Arizona	1/26/2019	Incomplete - Missing Engineer's Estimate
North Carolina	1/26/2019	Approved, Missing Partial Data
Tennessee	1/26/2019	Denied
Louisiana	1/26/2019	Approved
Alabama	1/26/2019	Incomplete - Missing Engineer's Estimate
Florida	1/26/2019	Incomplete - Missing Engineer's Estimate
Georgia	1/26/2019	Incomplete - Missing Engineer's Estimate
California	1/26/2019	Approved
Oregon	1/26/2019	Approved
Iowa	1/26/2019	Denied
Wisconsin	1/26/2019	Incomplete - Missing Engineer's Estimate
Pennsylvania	1/26/2019	Denied
South Carolina	1/26/2019	Denied
New Mexico	1/30/2019	Incomplete - Missing Engineer's Estimate
Wyoming	2/2/2019	No Response
Washington (State)	2/2/2019	Approved
Mississippi	2/2/2019	Approved
Ohio	1/30/2019	Approved
South Dakota	2/2/2019	No Response
Indiana	2/2/2019	Approved
Utah	1/30/2019	Approved, Missing Partial Data
Oklahoma	2/9/2019	Incomplete - Missing Engineer's Estimate
Alaska	2/9/2019	Incomplete - Missing Engineer's Estimate
Idaho	2/9/2019	Incomplete - Missing Engineer's Estimate
Michigan	2/9/2019	Approved
Massachusetts	2/9/2019	Approved, Missing Partial Data
North Dakota	2/9/2019	Incomplete - Missing Engineer's Estimate
Hawaii	2/9/2019	Incomplete - Missing Engineer's Estimate
Kansas	1/30/2019	Incomplete - Missing Engineer's Estimate
Illinois	1/30/2019	Denied
Delaware	2/9/2019	Denied
Nevada	2/9/2019	Incomplete - Missing Engineer's Estimate

Montana	2/9/2019	Incomplete - Missing Engineer's Estimate
Maryland	1/30/2019	Incomplete - Missing Engineer's Estimate
Nebraska	2/9/2019	Incomplete - Missing Engineer's Estimate
New York	1/30/2019	Incomplete - Missing Engineer's Estimate
Texas	1/30/2019	Approved
Arkansas	1/30/2019	Denied
Minnesota	2/9/2019	Approved, Missing Partial Data
Maine	2/10/2019	Incomplete - Missing Engineer's Estimate
Rhode Island	2/20/2019	Approved, Missing Partial Data
Missouri	2/10/2019	Approved
Vermont	2/19/2019	Incomplete - Missing Engineer's Estimate
Kentucky	2/10/2019	Incomplete - Missing Engineer's Estimate
New Hampshire	2/10/2019	Approved
West Virginia	2/10/2019	Incomplete - Missing Engineer's Estimate
Connecticut	2/10/2019	Denied
Colorado	2/10/2019	Approved
New Jersey	2/10/2019	Denied
Puerto Rico	2/14/2019	Incomplete - Missing Engineer's Estimate
FED FOIA	**2/1/2019**	**FOIA for Survey Methodology/Stratified selection**
FED FOIA	**2/11/2019**	**FOIA for Reg. Impact Analysis as it pertains to DBE program and EO 12291**

FOIA Request Letter Template

Robert Ryan
Purdue University
Knoy Hall of Technology
401 Grant Street
West Lafayette, IN 47907

PURDUE UNIVERSITY
Polytechnic Institute

[Date]

[Name of Custodian of Records]
[Title]
[Company Name]
[Street Address]
[City, ST ZIP Code]

Dear [custodian of records]:

My name is Robert Ryan, I am a PhD Candidate at Purdue University. I am currently researching my Doctoral Dissertation that involves DBE participation on Department of Transportation projects. I have selected your state for statistical analysis and require further information from your awarded construction contracts. I am writing you today to formally request all bid results for construction contracts awarded from January 1, 2008 to December 31, 2018 (or date most recently available). I request that the results for each contract/project awarded include the winning bidder's cost estimate, engineer/DOT cost estimate, DBE participation goal, number of bids received, & contract duration.

The preferred medium for transmission would be through electronic method, via email or FTP site. Electronic file formats such as Microsoft or a CSV file would be greatly appreciated. I can receive files and correspondence at: Ryan92@purdue.edu

The statute requires a response in a reasonable time period. If access to the records I am requesting will take longer, please contact me with information about when I might expect copies or the ability to inspect the requested records.

If you deny any or all of this request, please cite each specific exemption you feel justifies the refusal to release the information and notify me of the appeal procedures available to me under the law.

An acknowledgement of receipt would be greatly appreciated.

Thank you for considering my request.

Sincerely,

U.S. Department of Transportation

Office of Inspector General
Washington, D.C. 20590

March 27, 2019

Robert T. Ryan,

ryan92@purdue.edu

RE: FOIA Request, Control No.: FI-2019-0058

Dear Mr. Ryan:

This is in response to your Freedom of Information Act (FOIA) request, dated February 1, 2019, sent to the U.S. Department of Transportation (DOT) Office of Inspector General (OIG). You requested: "the breakdown of each state/territory that fall under the tiers "good, bad or unknown" as referenced in DOT OIG Audit Report ZA-2013-072 issued April 23, 2013, titled "Weaknesses in the Department's Disadvantaged Business Enterprise Program Limit Achievement of Its Objectives." You also requested "the backup statistical data to prove/show work of the statistical sampling method" as referenced in DOT OIG Audit Report ZA-2013-072."

Enclosed are documents responsive to your request. There were 4 pages of documents responsive to your request. We are providing the 4 pages in full, without redaction.

For your information, Congress excluded three discrete categories of law enforcement and national security records from the requirements of the FOIA. See 5 U.S.C. 552(c) (2006 & Supp. IV 2010). This response is limited to those records that are subject to the requirements of the FOIA. This is a standard notification that is given to all our requesters and should not be taken as an indication that excluded records do, or do not, exist.

You may contact the DOT OIG FOIA Office to discuss any aspect of your request at:

FOIA Requester Service Center
Office of Inspector General
Department of Transportation
1200 New Jersey Avenue, S.E., 7th Floor
Washington, DC 20590
Tel: (202) 366-6131
Fax: (202) 366-1975

You may also contact FOIA Public Liaison, Seth Kaufman at (202) 366-8751, Seth.Kaufman@oig.dot.gov for any further assistance.

If you are not satisfied with the DOT OIG's determination in response to this request, you may administratively appeal by writing to Amy Berks, Acting General Counsel for the U.S. Department of Transportation Office of Inspector General, 7th Floor West (J3), 1200 New Jersey Avenue, S.E. Washington, DC 20590. Appeals to Ms. Berks should be prominently marked as a "FOIA Appeal." If you prefer, your appeal may be sent via electronic mail to FOIAAPPEALS@oig.dot.gov. An appeal must be received within 90 days of this determination and should contain any information and arguments you wish to rely on. The Acting General Counsel's determination will be administratively final.

You also have the right to seek dispute resolution services from the FOIA Public Liaison (contact information shown above) or the Office of Government Information Services (https://ogis.archives.gov) via phone—202-741-5770 / toll free—1-877-684-6448; fax—202-741-5769; or email— ogis@nara.gov.

Sincerely,

Siera Griffin

Government Information Specialist

Enclosure

U.S. Department
of Transportation

Office of the Secretary
of Transportation (OST)

1200 New Jersey Ave., S.E.
Washington, DC 20590

OST FOIA Contact Information

FOIA Requester Service Center
202-366-4542; ost.foia@dot.gov

Michael C. Bell, FOIA Officer
202-366-5546; michael.bell1@dot.gov

Fern Kaufman, FOIA Public Liaison
202-366-8067; fern.kaufman@dot.gov

May 21, 2019

Robert Thomas Ryan

FOIA No.: FY 2019-153

Dear Mr. Ryan:

This is in response to your Freedom of Information Act (FOIA) request that was received electronically by the Federal Highway Administration (FHWA) FOIA office and forwarded to the Office of the Secretary of Transportation (OST) FOIA office for processing on February 19, 2019. You requested records relating to:

- All pertinent information/backup for each Disadvantaged Business Enterprise (DBE) program's Regulatory Impact Analysis as it pertains to Executive Order 12291 and their amended Orders which include 12866, 13422, 1353 and 13563;
- Documentation in determining the annual effect on the economy and if it is anticipated that this major rule would affect the economy of $100 million or more;
- Or if it was determined that the DBE program would create a major increase in costs or prices for consumers, individual industries, Federal, State or local government agencies or geographic regions;
- The definition of what constitutes a major increase in costs;
- The list of economic impacts/potential costs identified including any adverse effects that cannot be quantified in monetary terms;
- The list of potential benefits associated with the DBE Program; and
- The method of determining if the potential benefits to society outweigh the potential costs to society.

The releasable responsive records are publicly available on DOT's website at : https://www.transportation.gov/civil-rights/disadvantaged-business-enterprise/dbe-laws-policy-and-guidance.

Internal predecisional drafts and records that are deliberative are being withheld pursuant to FOIA Exemption 5. The deliberative process prong of Exemption 5 of the FOIA protects "inter-agency or intra-agency memoranda or letters which would not be available by law to a party other than an agency in litigation with the agency." Three policy purposes consistently have been held to constitute the bases for this privilege: (1) to encourage open, frank discussions on matters of policy between subordinates and superiors; (2) to protect against premature disclosure of proposed policies before they are finally adopted; and (3) to protect against public confusion that might result from disclosure of reasons and rationales that were not in fact ultimately the grounds for the agency's action. Logically flowing from the foregoing policy considerations is the privilege's protection of the decision-making processes of government agencies. 5 U.S.C. § 552(b)(5) and 49 CFR 7.23(c)(5).

I am the person responsible for this determination. If you are dissatisfied with this response, you may appeal to Judith S. Kaleta, Deputy General Counsel, U.S. Department of Transportation, 1200 New Jersey Ave., S.E., Washington, DC 20590. If you prefer, your appeal may be sent via electronic mail to ost.foia.appeals@dot.gov. An appeal must be received within 90 days of the date of this determination and should contain any information and arguments you wish to rely on. The Deputy General Counsel's determination will be administratively final.

You also have the right to seek dispute resolution services from the FOIA Public Liaison (contact information shown above) or the Office of Government Information Services (https://ogis.archives.gov) via phone--202-741-5770 / toll-free--1-877-684-6448; fax--202-741-5769; or email--ogis@nara.gov.

Sincerely,

MICHAEL CHARLES BELL

Digitally signed by MICHAEL CHARLES BELL
Date: 2019.05.21 07:54:59 -04'00'

Michael C. Bell
FOIA Officer

Enclosure

Robert Ryan
Purdue University
Knoy Hall of Technology
401 Grant Street
West Lafayette, IN 47907

PURDUE
UNIVERSITY
Polytechnic Institute

February 15, 2019
REF 2019 PAC 56687

Ms. Barbra J. Smith
FOIA Officer
Illinois Department of Transportation
Office of the Chief Counsel, Room 317
2300 South Dirksen Parkway
Springfield, IL 62764

Ms. Smith,

Upon phone conversations with Assistant Attorney General Edie Steinberg from the Office of the Illinois Attorney General, I am writing you today for further amend my FOIA request. In the appeal process to AAG Steinberg, I had appealed IDOT's initial findings and further amended my request to include the information in a summary type electronic file. During this appeal and amendment process, AAG Steinberg stated that I needed to notify IDOT (you) of my amendment as well. Please consider this letter formal notification of amendment.

Per Illinois statue, Federal Highway Administration (FHWA) policy, and experience with FOIA requests from other states, IDOT should be keeping an electronic log/summary/database of the information I have requested. Although IDOT is correct that the information can be found online, it is not the most direct source of information. By referring me to the 1000's of pdf files, this request is not in accordance with my interpretation of 5 ILCS 140/8.5(b):

"If the person requesting the public record is unable to reasonably access the record online after being directed to the website pursuant to subsection (a) of this Section, the requester may re-submit his or her request for the record stating his or her inability to reasonably access the record online, and the public body shall make the requested record available"

My FOIA request included results for each contract/project awarded. These variables include: the winning bidder's cost estimate, engineer/DOT cost estimate, DBE participation goal, number of bids received, & contract duration. By compiling this information in the manner IDOT suggests has the potential of discovery of errors and/or omissions, even the possibility of needing further clarification, thus resulting in more FOIA requests. I will illustrate the circumstance below:

Robert Ryan
Purdue University
Knoy Hall of Technology
401 Grant Street
West Lafayette, IN 47907

PURDUE
UNIVERSITY
Polytechnic Institute

A rough approximation of anticipated bid results for Illinois will provide over 5,600 results. This approximation is based on an average of 70 projects per letting, with 8 lettings per year, for 10 total years. To compile the information requested, I would need to sift through each letting to find portions of the variables throughout several documents. For instance, I could find the variables of winning bidder's cost estimate and number of bids received in the "As Accepted Tabulation of Bids" document. I would then have to cross reference each contract ID and investigate each project specific specification to find the DBE goal and contract duration.

To perform this task as IDOT suggests would take months to compile the requested data. There are thousands of pages of documents. I did a trial data collection and discovered it took 8 minutes to compile the data for one awarded project. If the anticipated results of 5,600 samples exist, it would take 750 hours of data entry to compile the information I am requesting. This estimated 750 hours does not include any additional time to problem solve any potential errors in the files, research missing files, or time to create additional FOIA requests to clarify these errors. To further illustrate the cumbersomeness of compiling this data, I have included the above referenced files.

This is nearly 6 months of work, which cannot be considered a reasonable method of collecting data, especially when IDOT should be maintaining a list that should be readily accessible to an IDOT/public employee. Through my research, I have found that DOTs are required to keep a log of contracts that are awarded summarize their project awards to remain in compliance with FHWA Order 1324.1B (Records Management) and FHWA Order 2-4 (Clearance and Release of Public Information Material). Further ILCS 140/5 states the following:

> "each public body shall maintain and make available for inspection and copying a reasonably current list of all types or categories of records under its control. The list shall be reasonably detailed in order to aid persons in obtaining access to public records pursuant to this Act"

You will note that my FOIA request asked for a reasonably detailed list that IDOT should be maintaining. Further, if IDOT refuses to release the file, they are in violation of 5 ILCS 140/6(a) as well:

> "When a person requests a copy of a record maintained in an electronic format, the public body shall furnish it in the electronic format specified by the requester, if feasible."

Per the letter to IDOT issued by Ms. Dolores Samuel on February 15, 2019, the Engineer's Estimate must be included in my FOIA request. In

Robert Ryan
Purdue University
Knoy Hall of Technology
401 Grant Street
West Lafayette, IN 47907

PURDUE
UNIVERSITY
Polytechnic Institute

addition, I am requesting all the data in the FOIA be issued in a summary type spreadsheet as required per the above-mentioned regulations.

If these requests are denied, or need further clarification, please respond in writing.

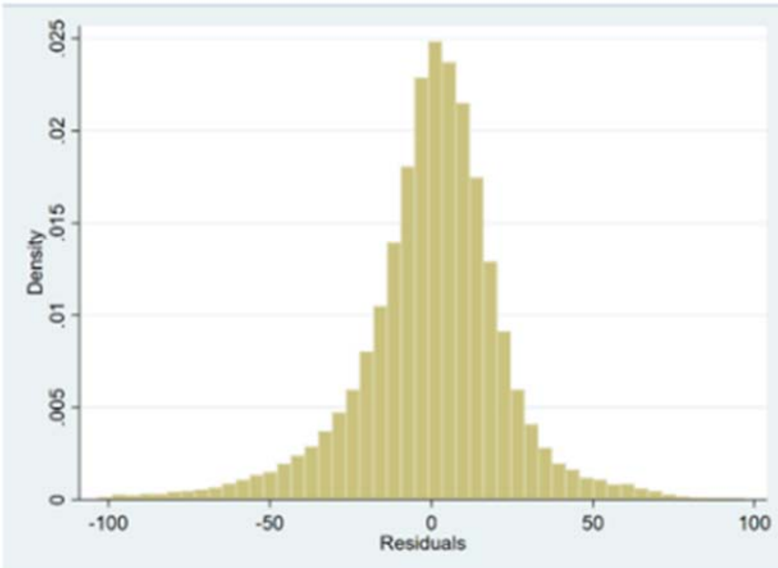
Sincerely,

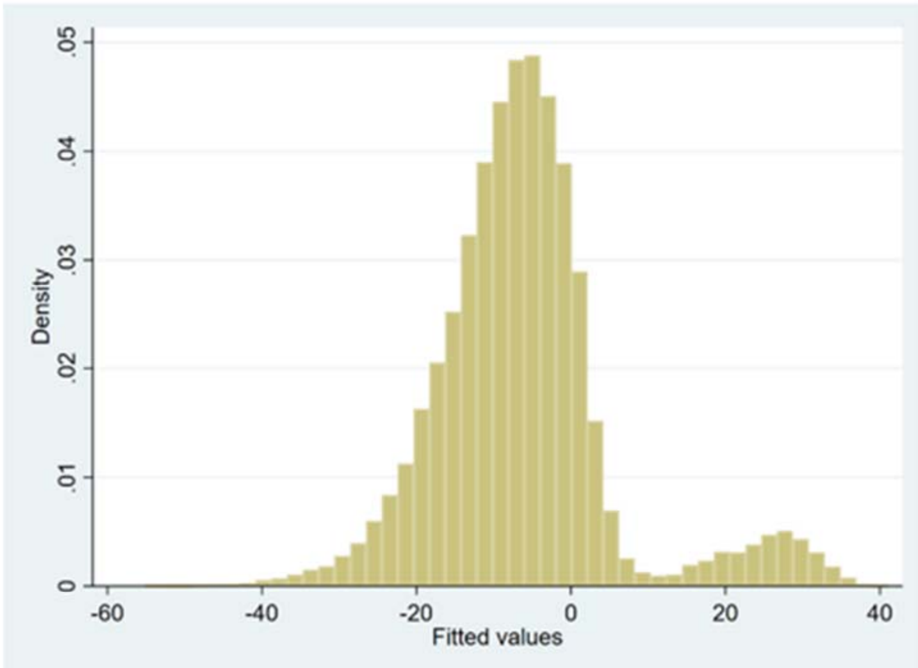
Robert T Ryan

Robert T Ryan

Ryan92@purdue.edu

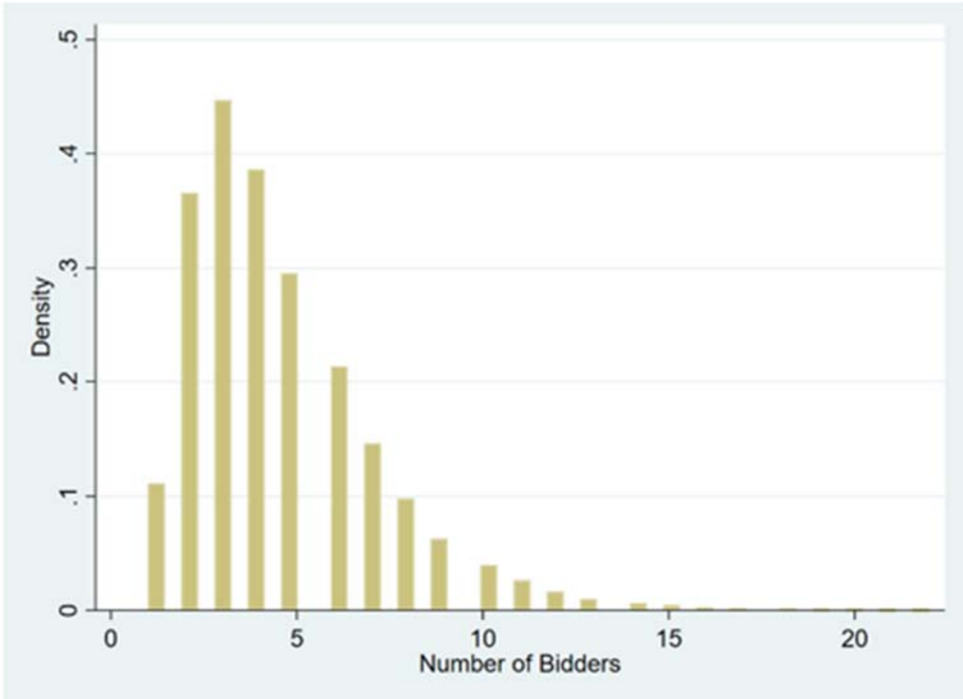
APPENDIX B: STATE STATISTICAL RESULTS FOR TESTS IN SECTION 4.2



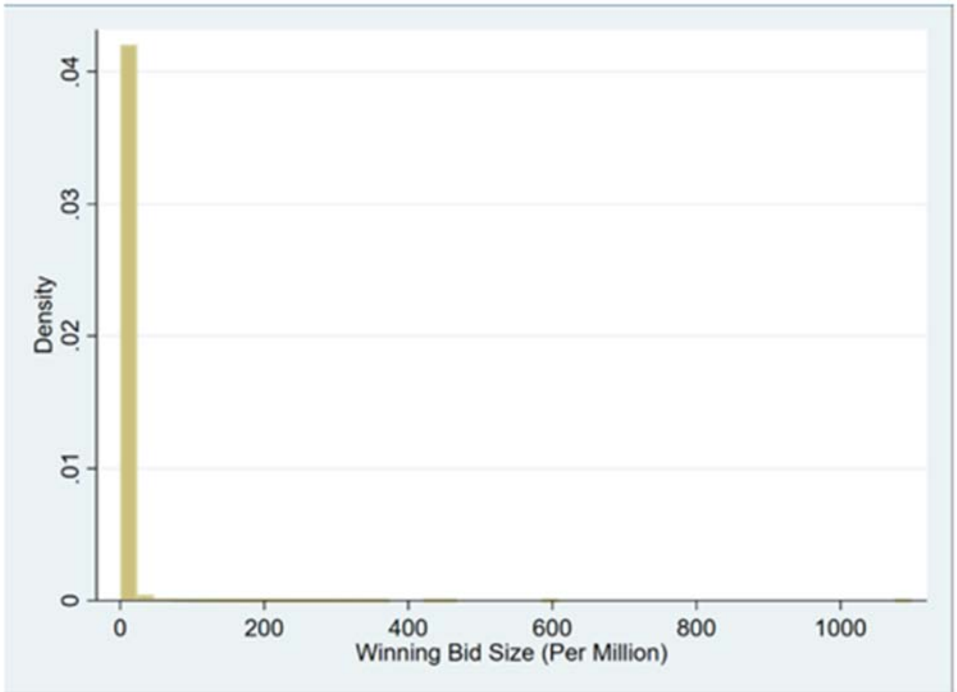


Density
.05
.04
.03
.02
.01
0
-60
-40
-20
0
20
40
Fitted values

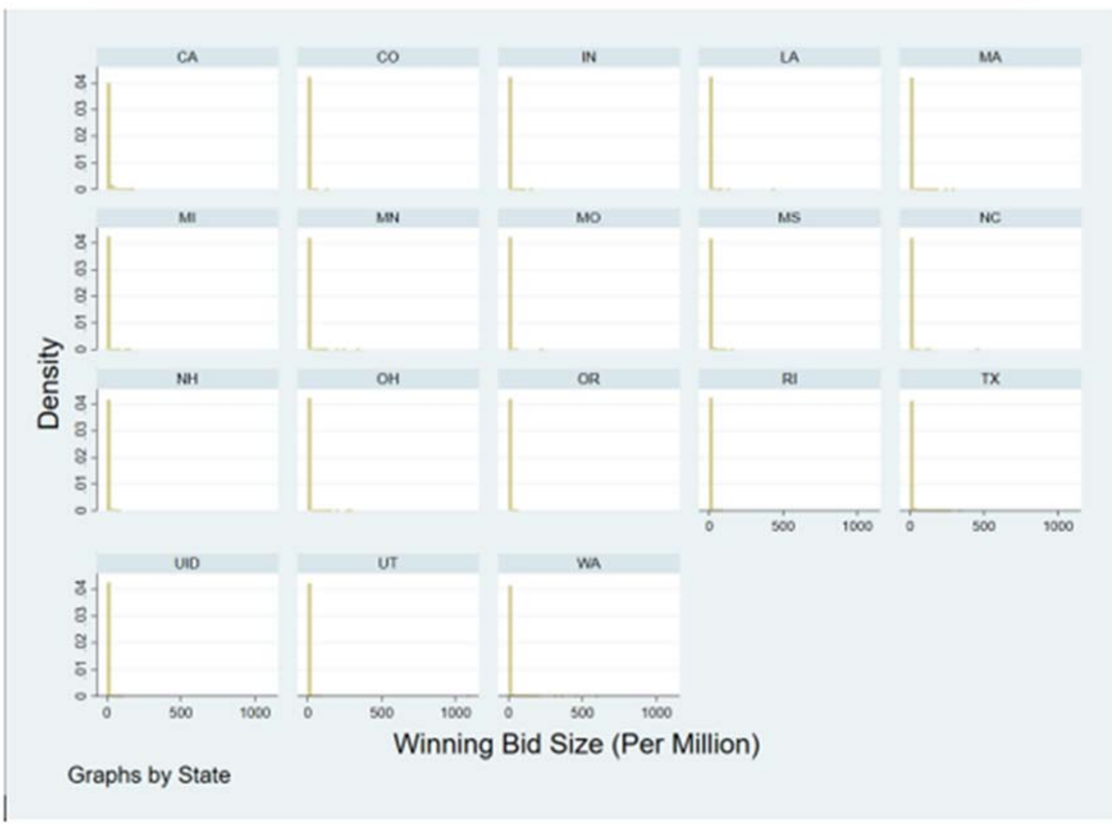
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Fitted values
Graphs by State


Density
Number of Bidders

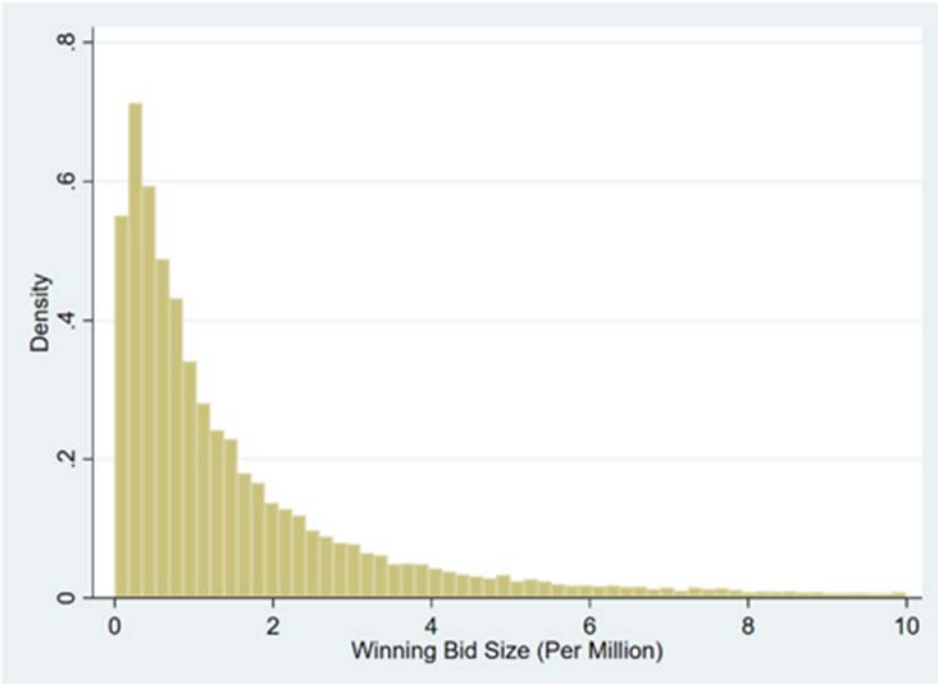

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Number of Bidders
Graphs by State

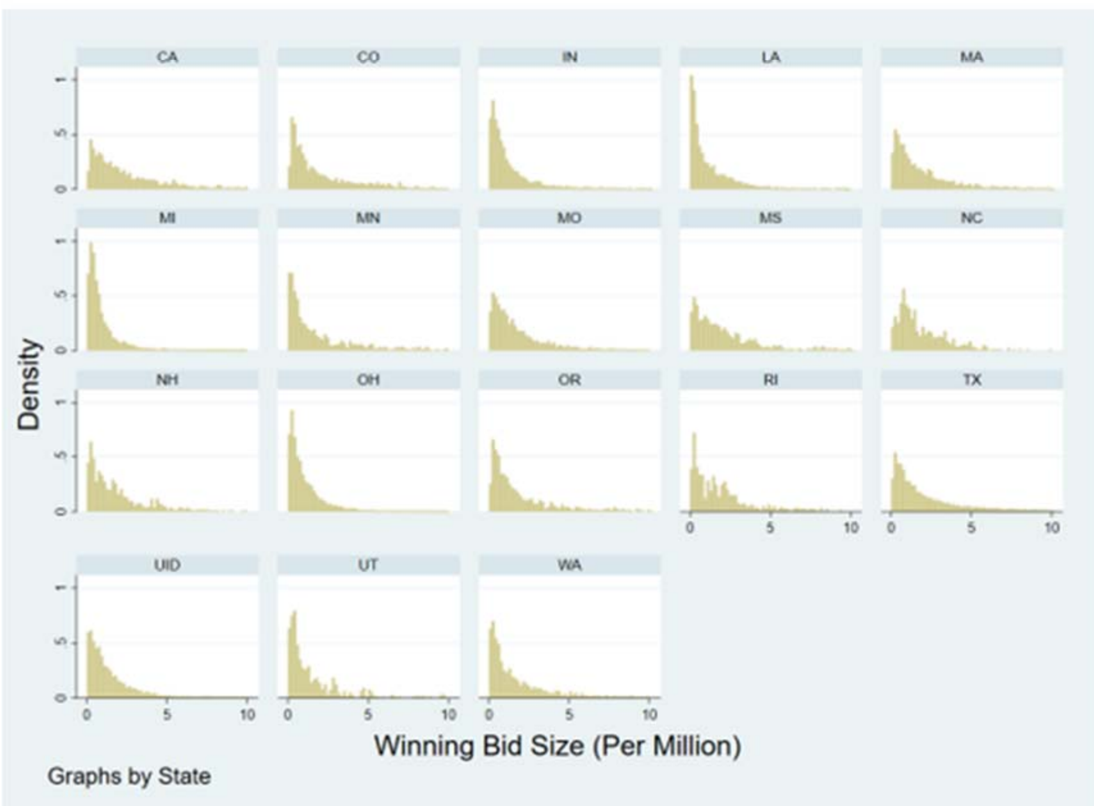


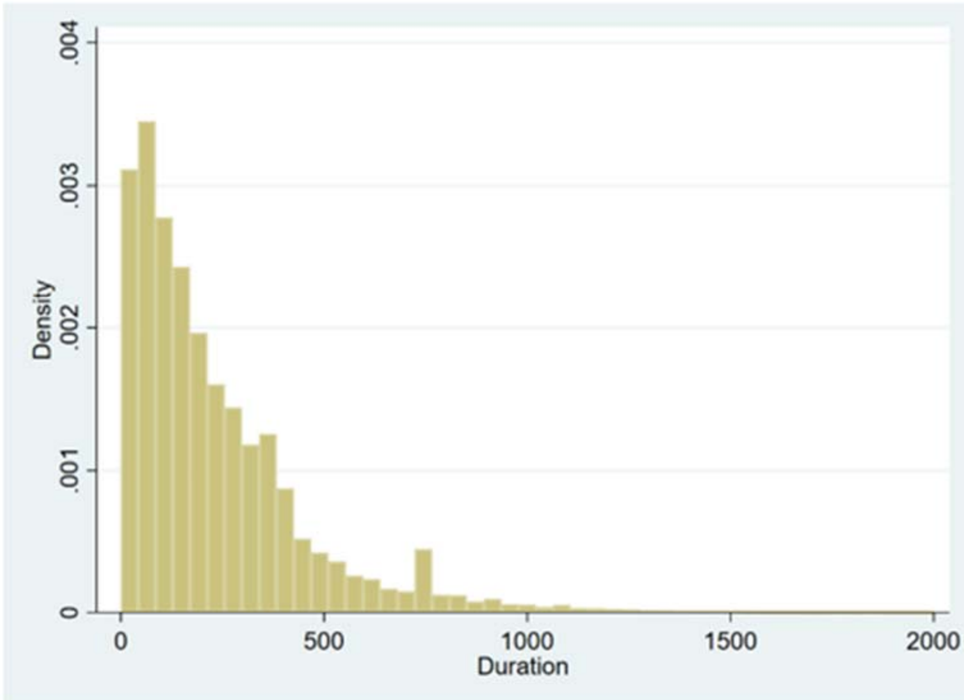
Density
0
.01
.02
.03
.04
0
200
400
600
800
1000
Winning Bid Size (Per Million)

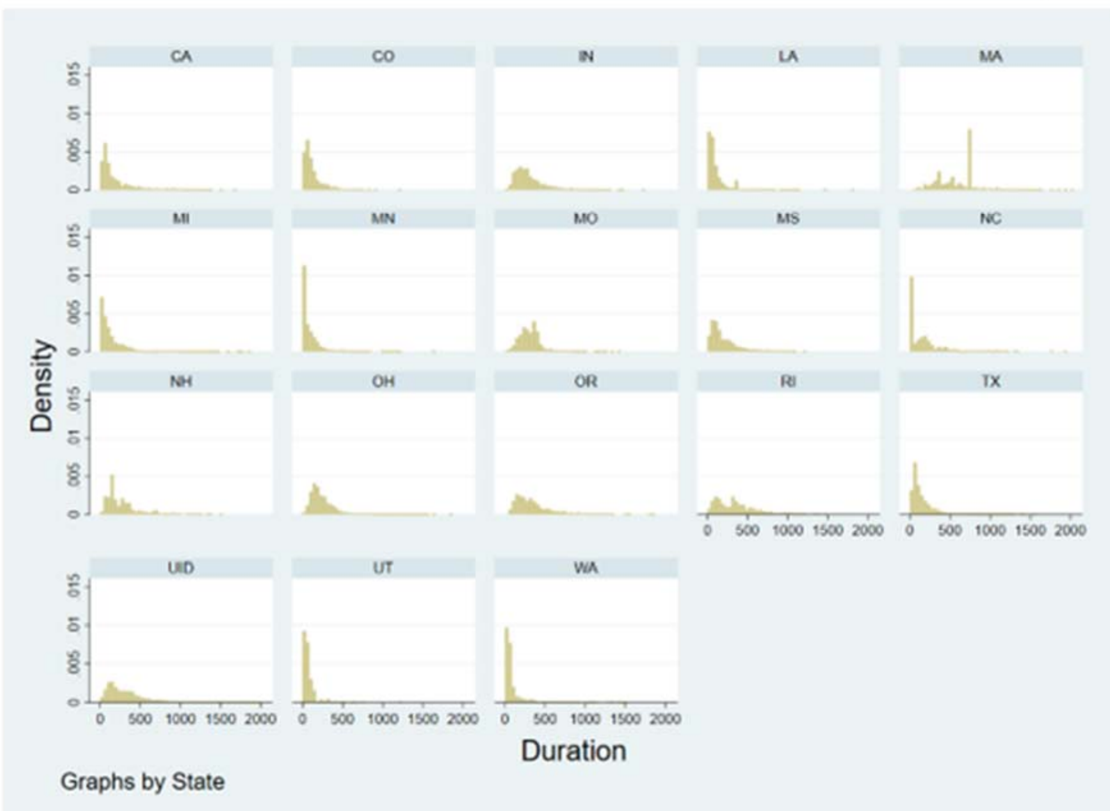


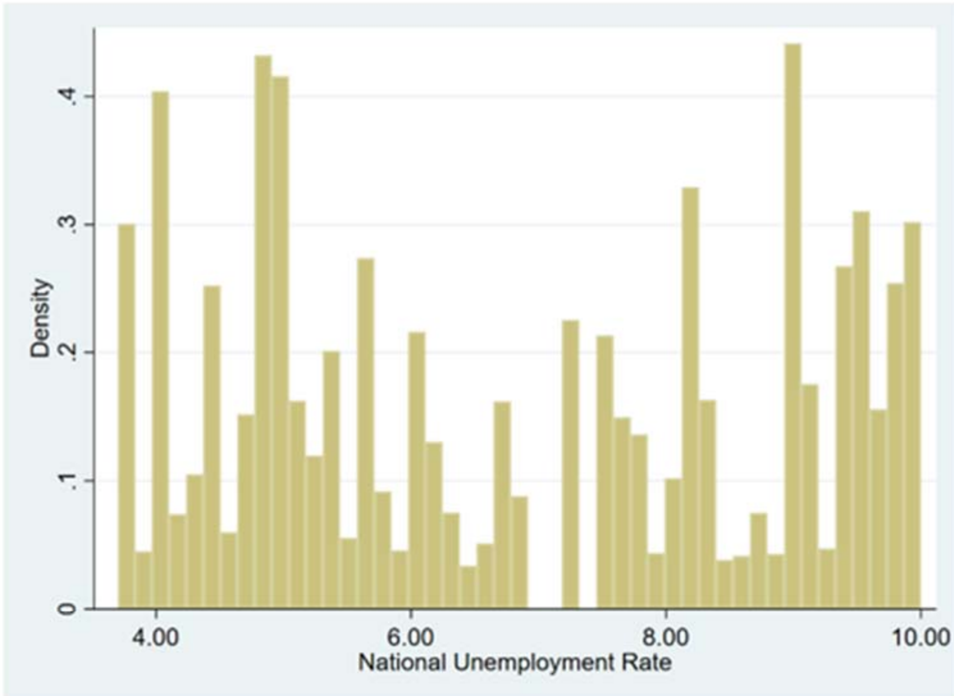
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Winning Bid Size (Per Million)
Graphs by State

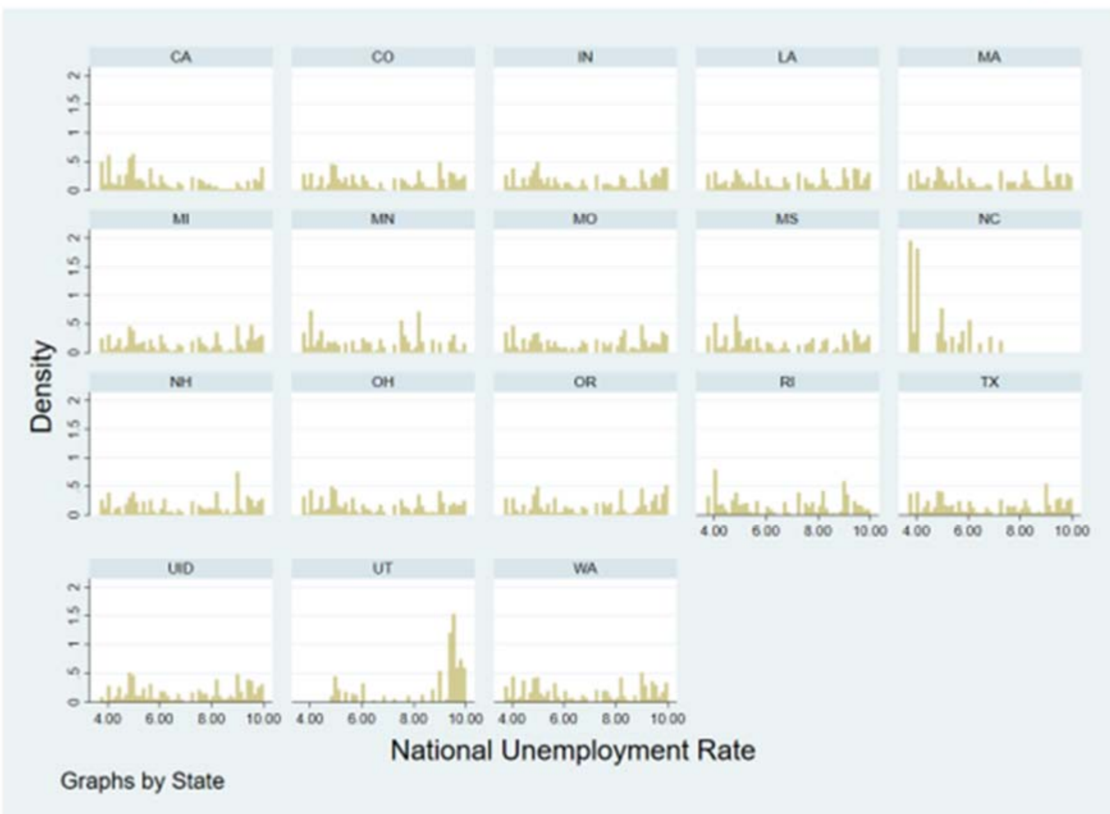

Density
0
.2
.4
.6
.8
0
2
4
6
8
10
Winning Bid Size (Per Million)

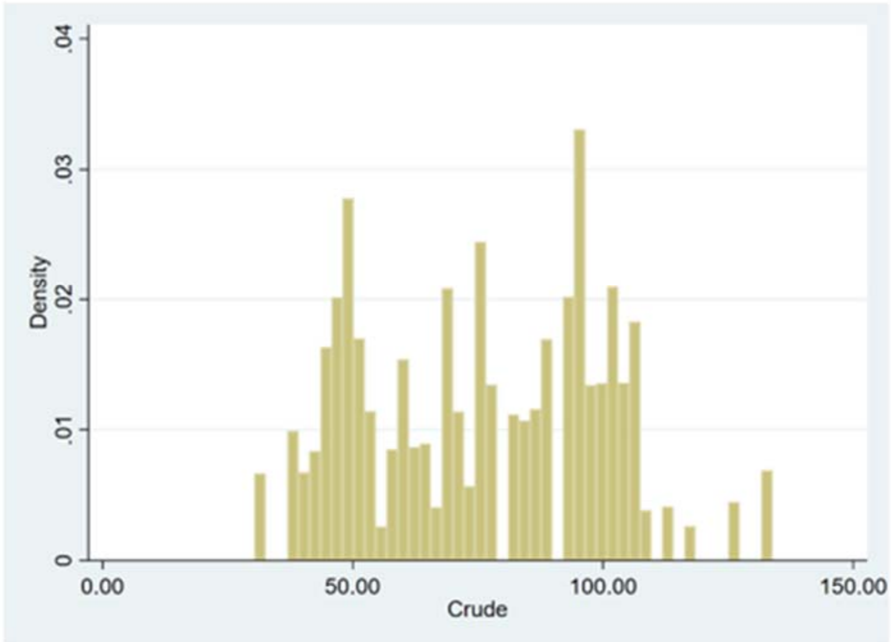

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Winning Bid Size (Per Million)
Graphs by State

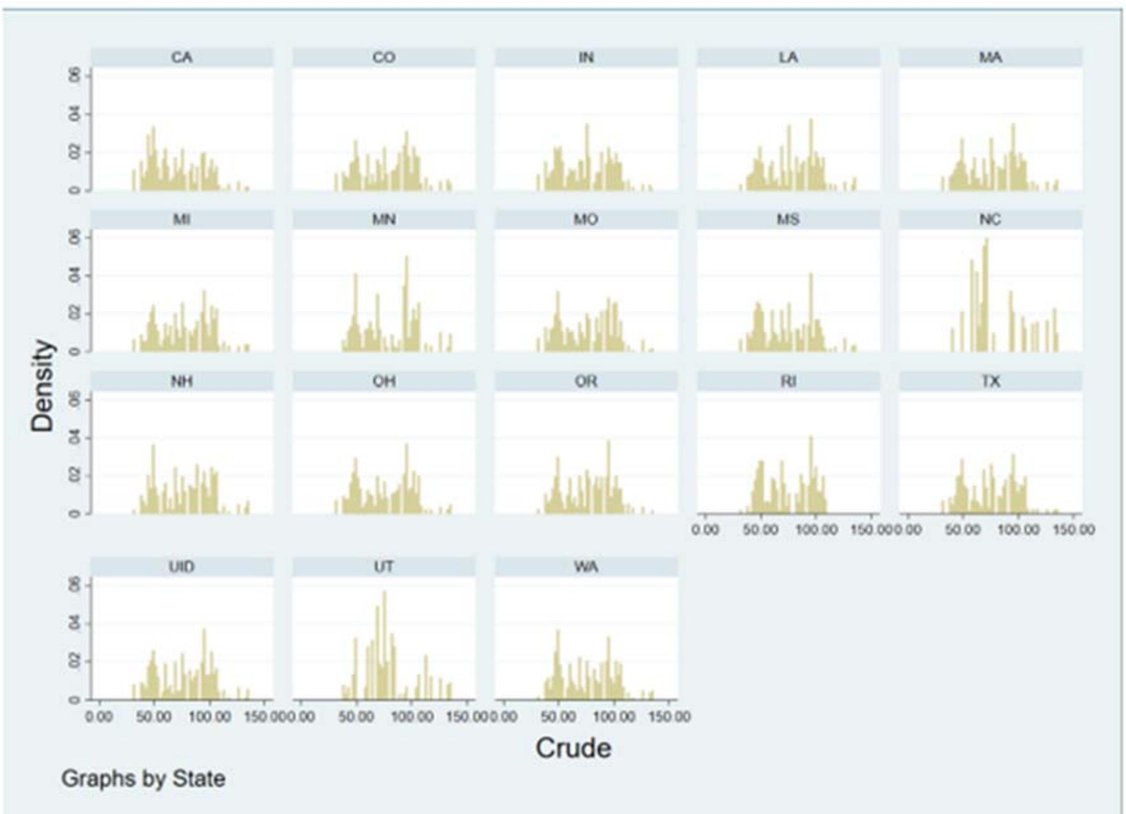

Density
.004
.003
.002
.001
0
0
500
1000
1500
2000
Duration

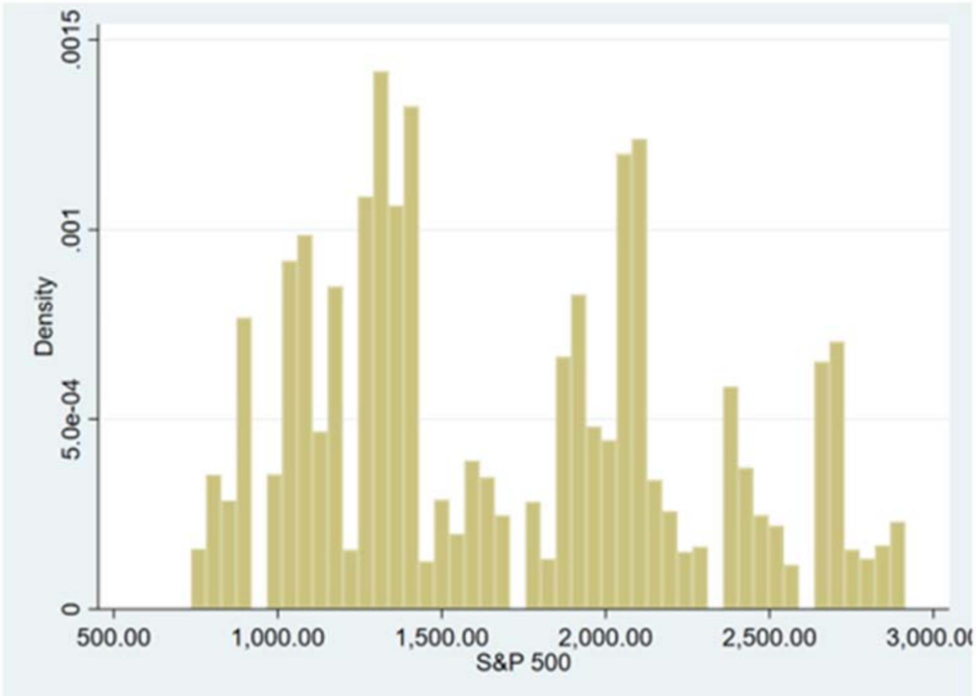

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Duration
Graphs by State

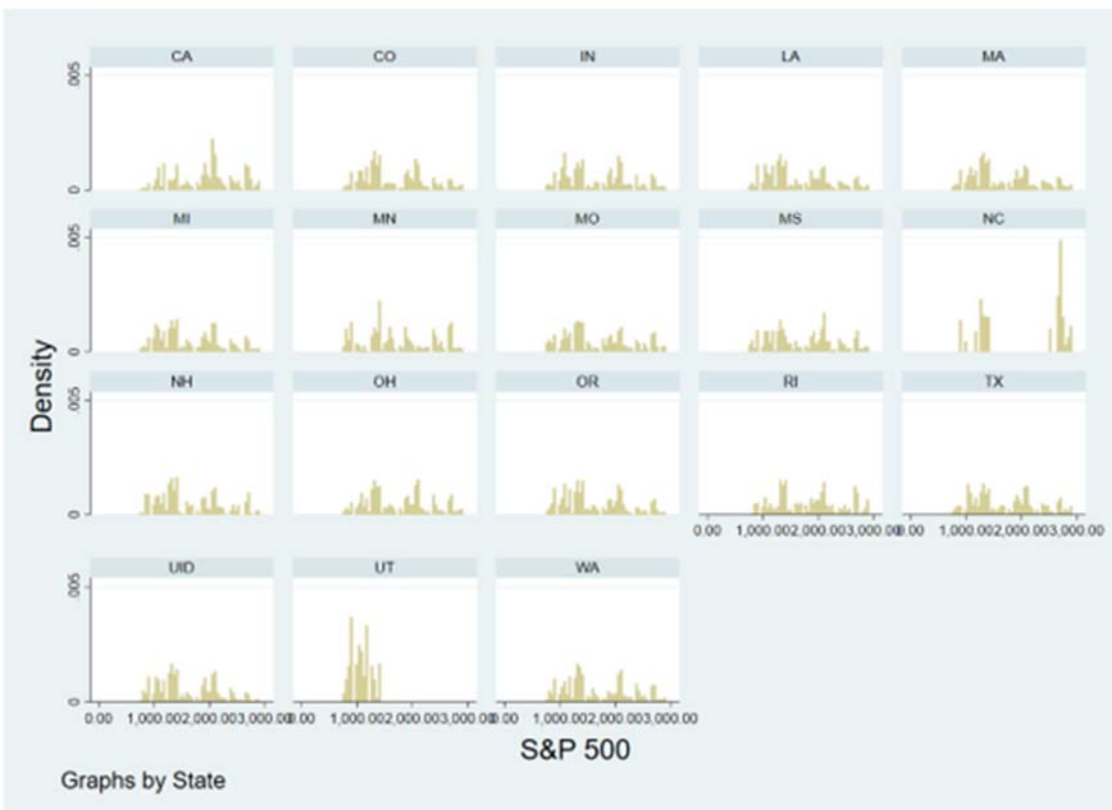

Density
0
.1
.2
.3
.4
4.00
6.00
8.00
10.00
National Unemployment Rate

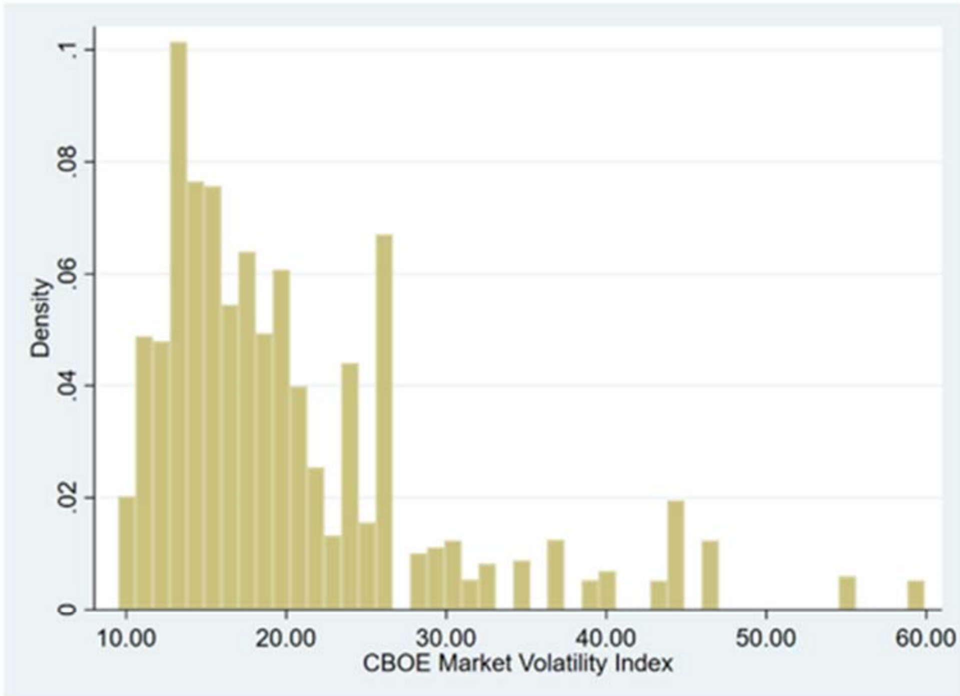

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
National Unemployment Rate
Graphs by State


Density
.04
.03
.02
.01
0
0.00
50.00
100.00
150.00
Crude

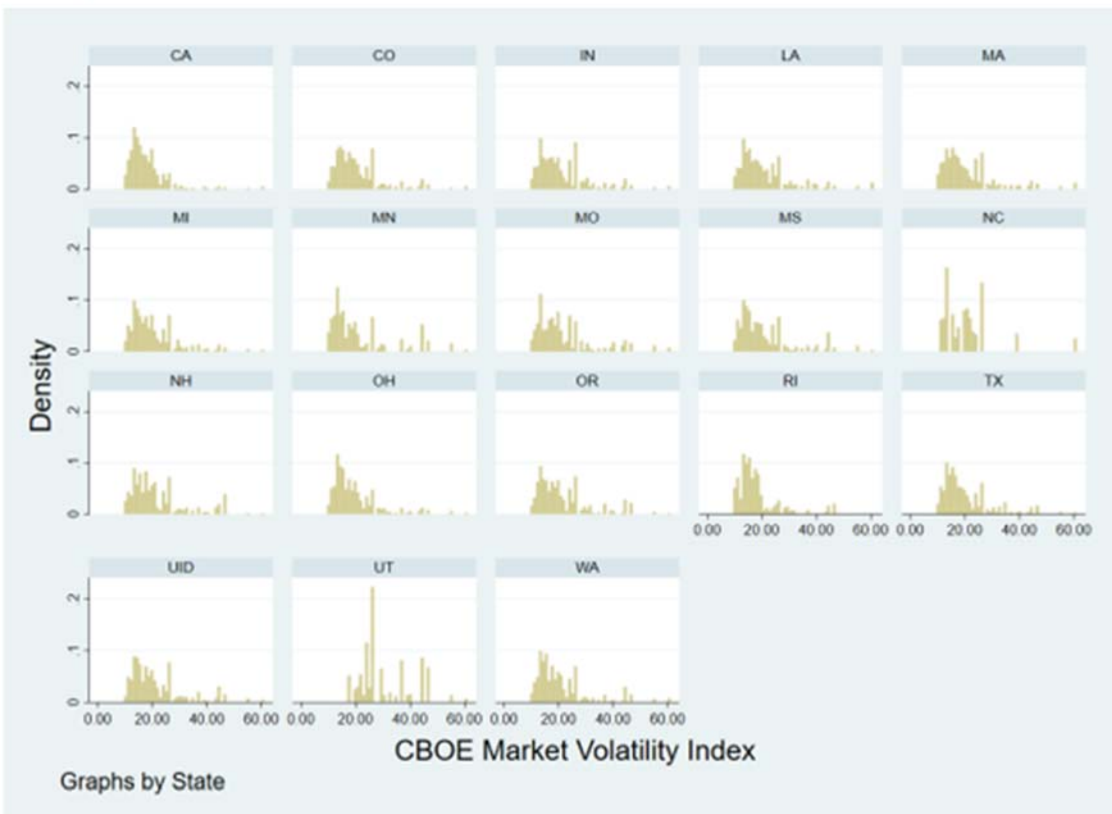

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Crude
Graphs by State


Density
S&P 500
0
5.0e-04
.001
.0015
500.00
1,000.00
1,500.00
2,000.00
2,500.00
3,000.00


CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
S&P 500
Graphs by State

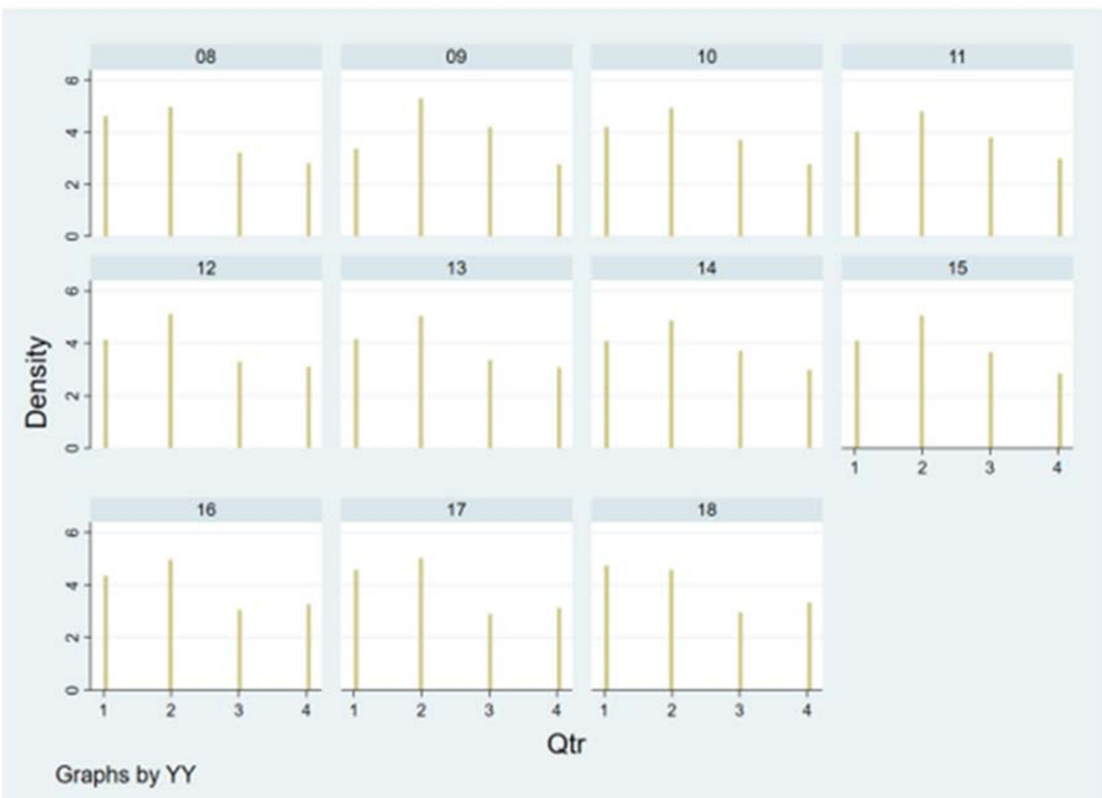


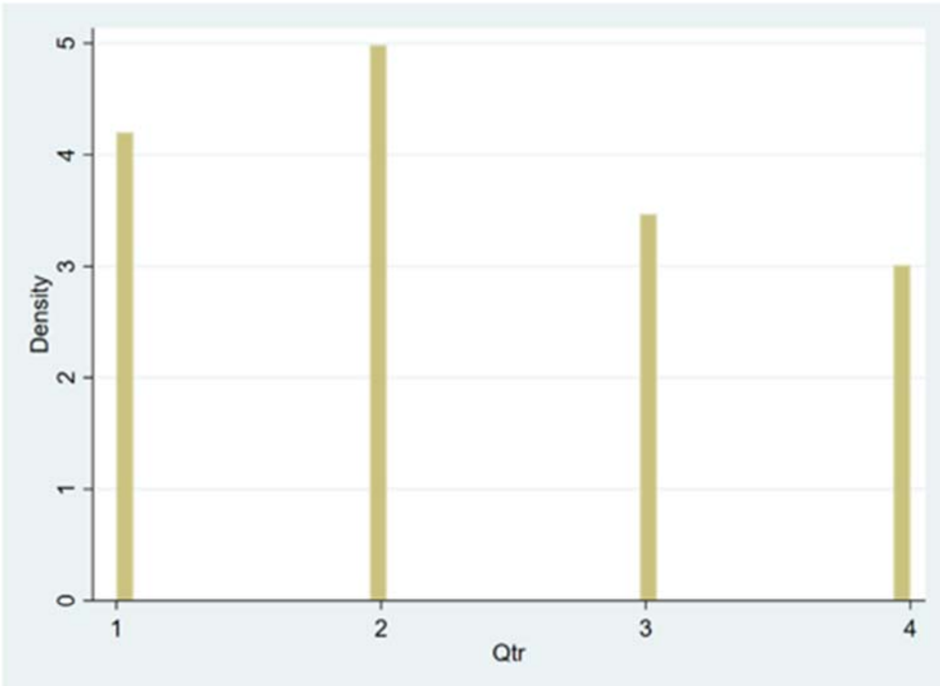
Density
0
.02
.04
.06
.08
.1
10.00
20.00
30.00
40.00
50.00
60.00
CBOE Market Volatility Index



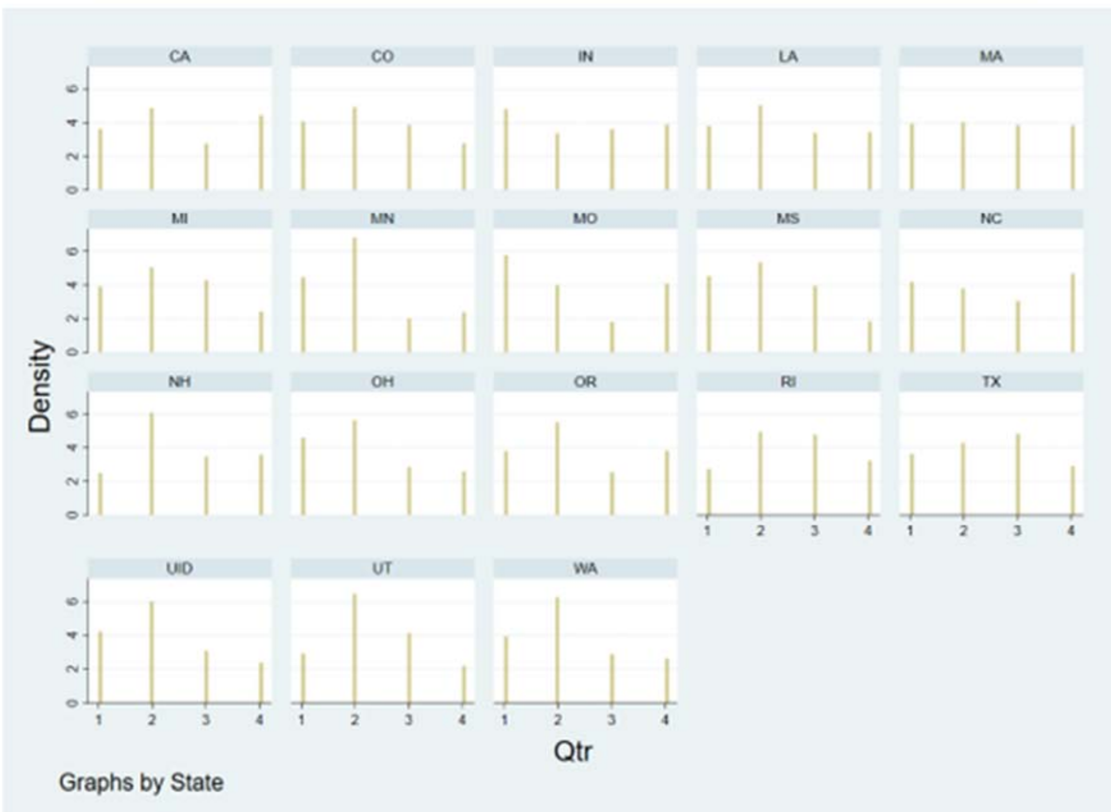
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
CBOE Market Volatility Index
Graphs by State


08
09
10
11
12
13
14
15
16
17
18
Density
Line
Graphs by YY


08
09
10
11
12
13
14
15
16
17
18
Density
Qtr
Graphs by YY

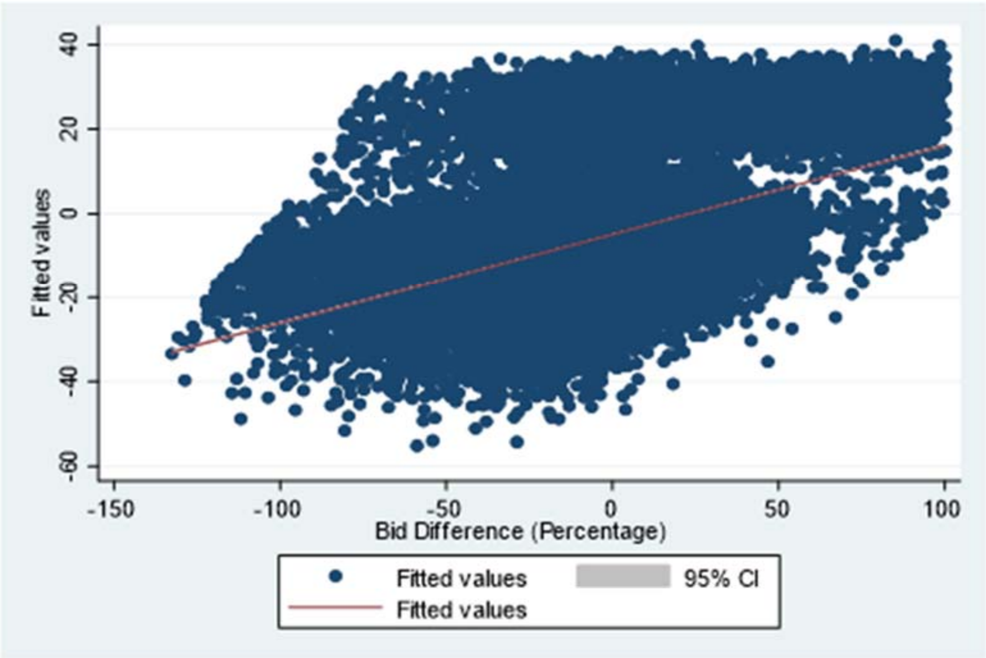


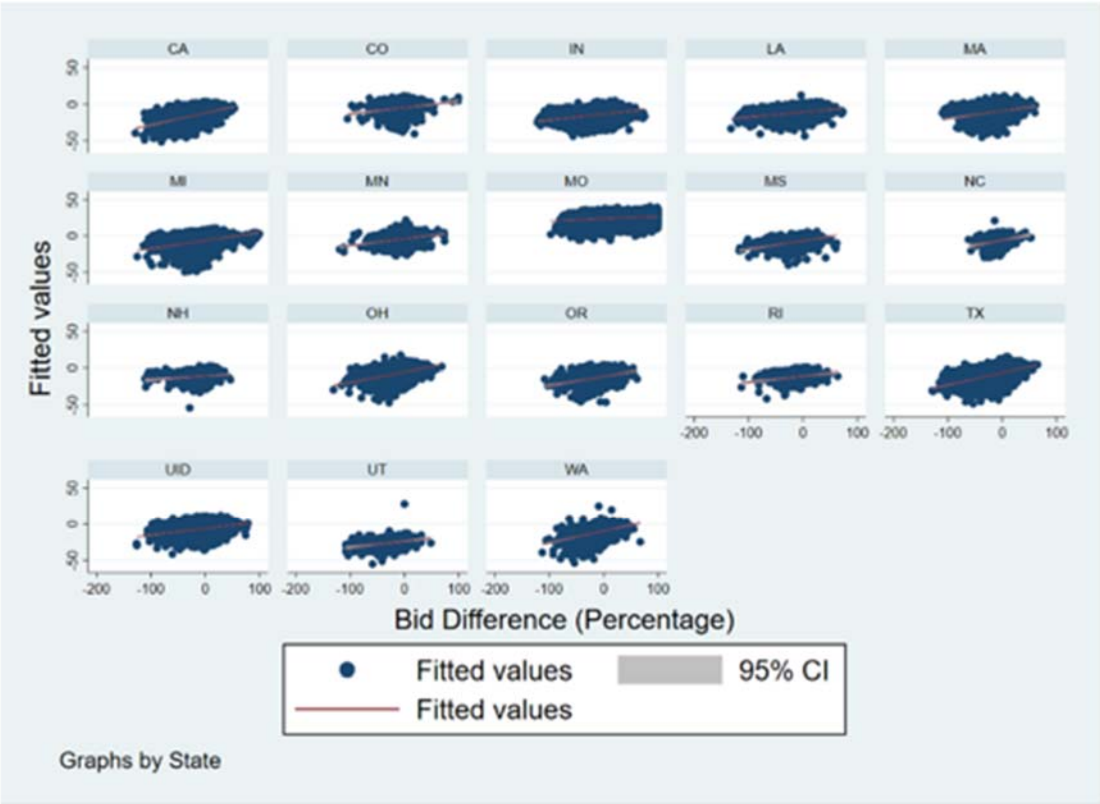
Density
0
1
2
3
4
5
1
2
3
4
Qtr

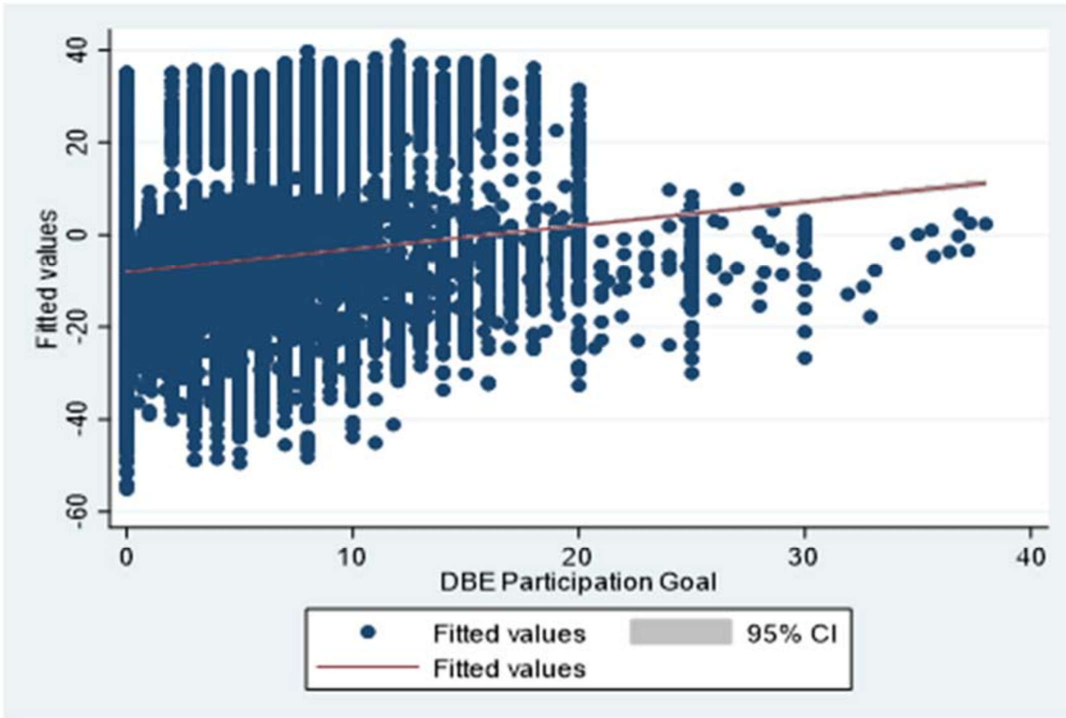


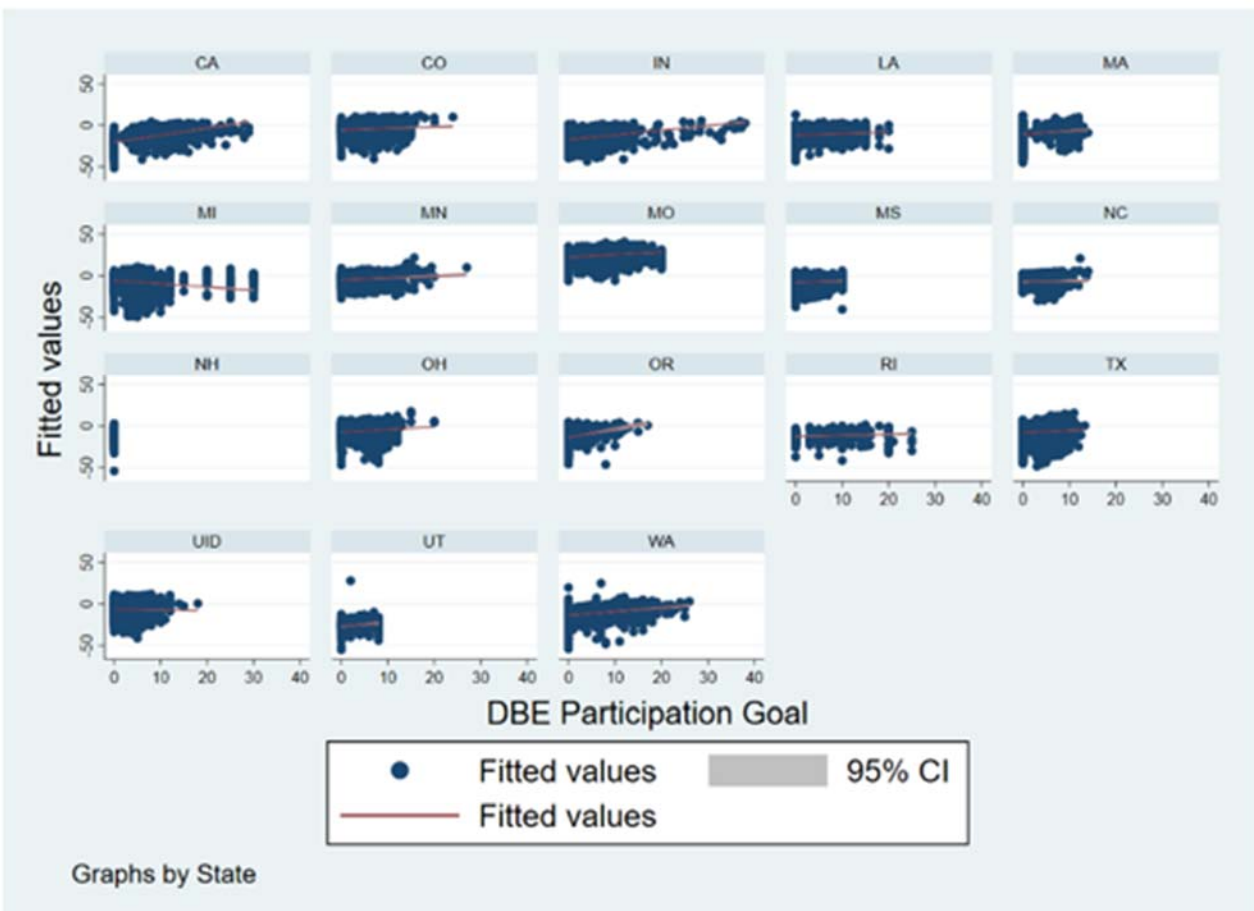
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Density
Qtr
Graphs by State

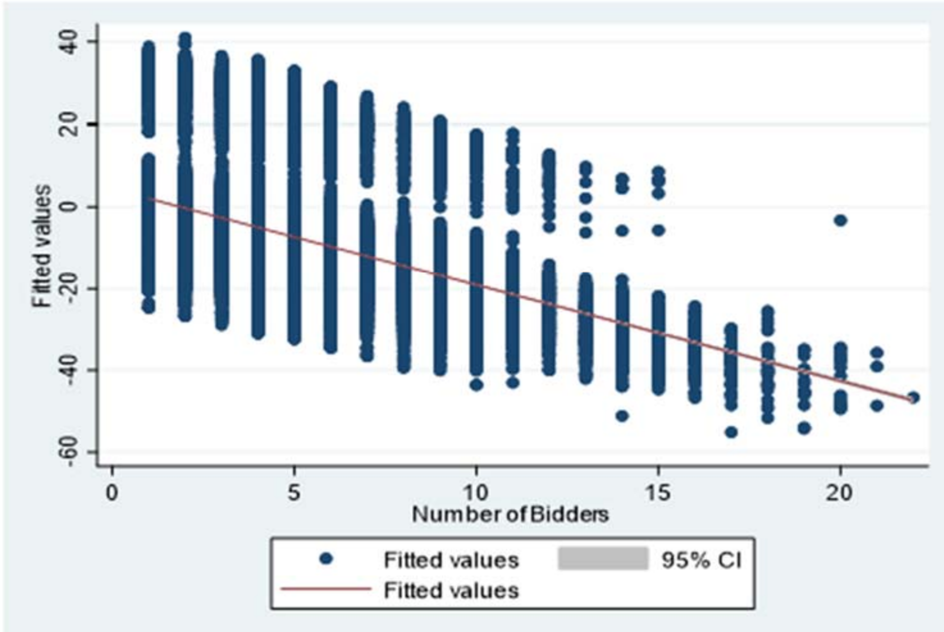
APPENDIX C: STATE STATISTICAL RESULTS FOR TESTS IN SECTION 4.3

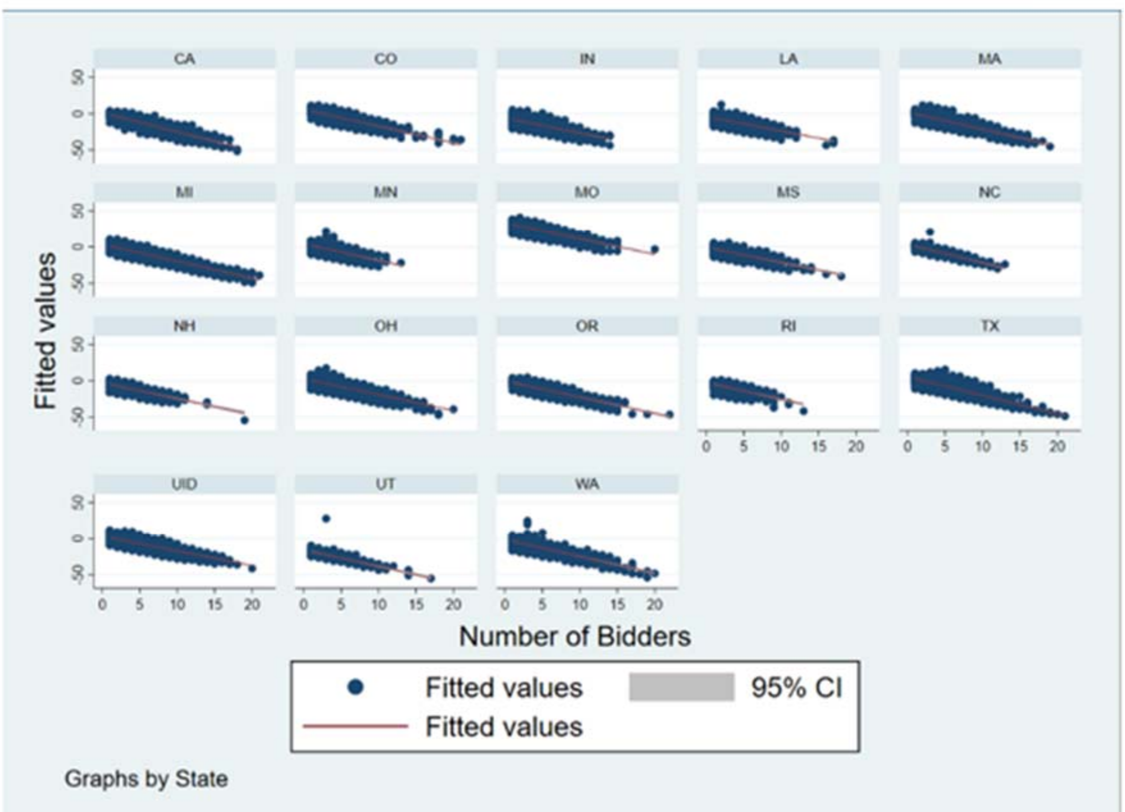


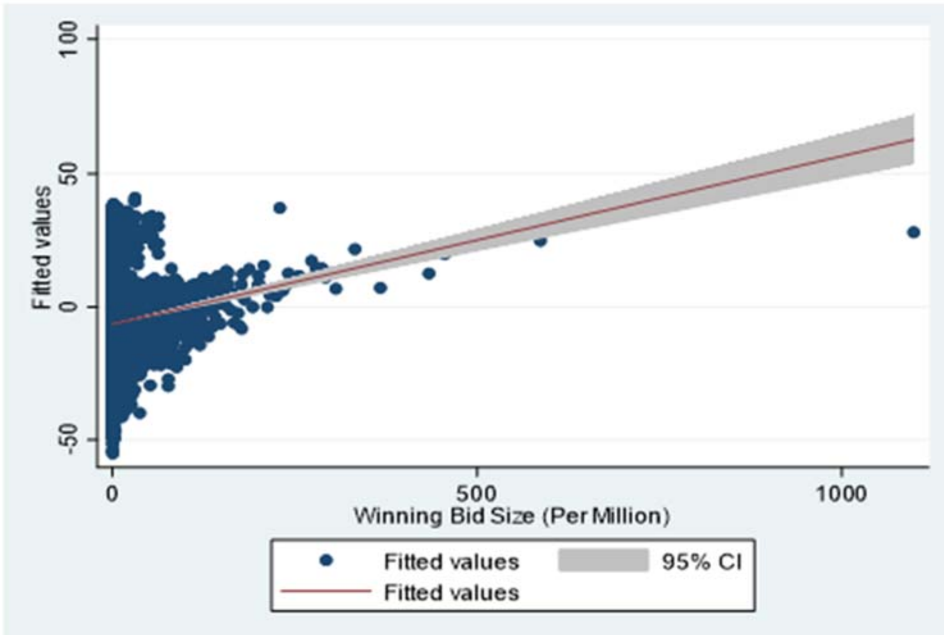


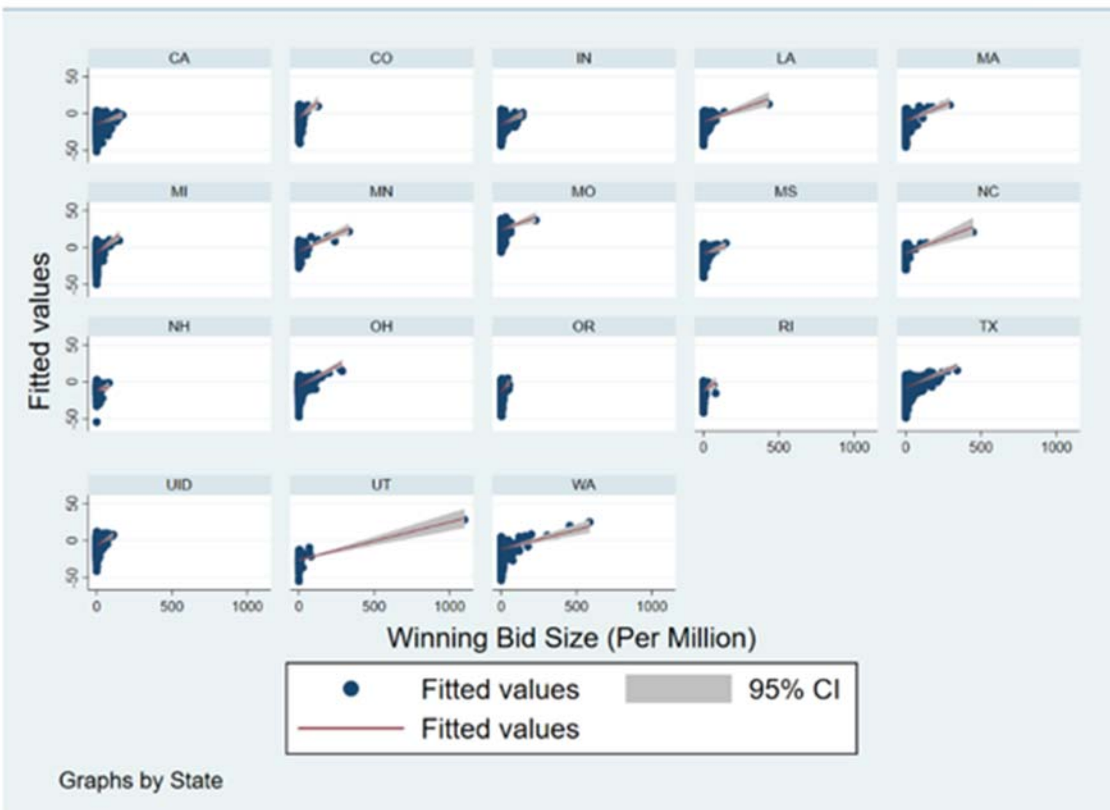

Fitted values
DBE Participation Goal
Fitted values
95% CI
Fitted values

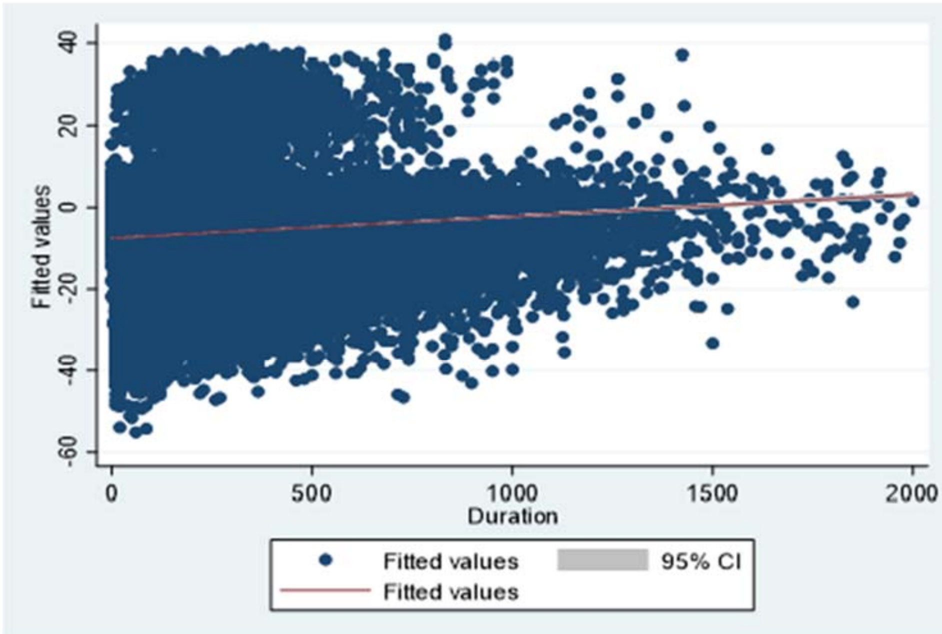

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
DBE Participation Goal
Fitted values
95% CI
Fitted values
Graphs by State


Fitted values
Number of Bidders
Fitted values
95% CI
Fitted values

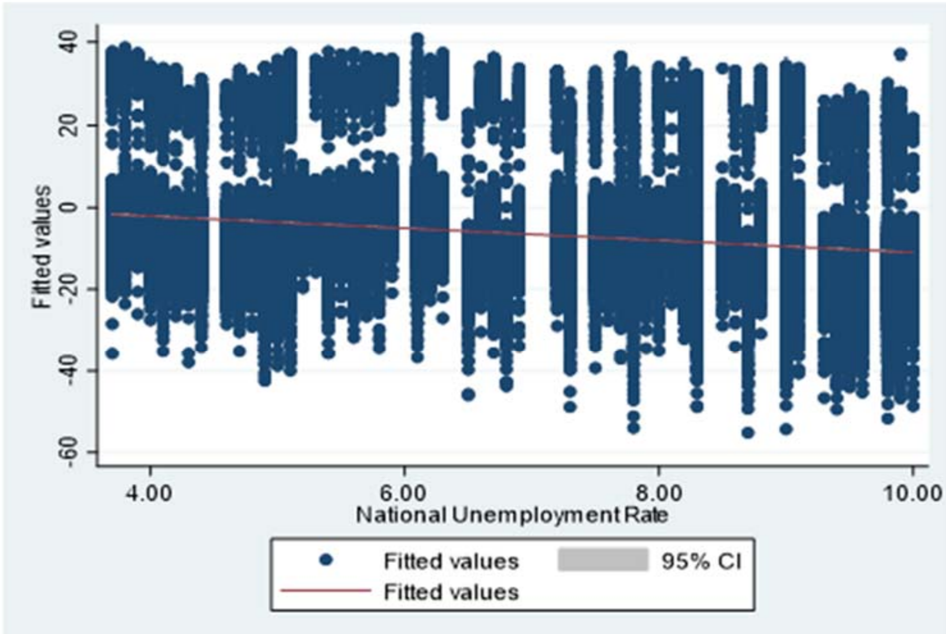

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
Number of Bidders
Fitted values
95% CI
Fitted values
Graphs by State


Fitted values
100
50
0
-50
0
500
1000
Winning Bid Size (Per Million)
Fitted values
95% CI
Fitted values

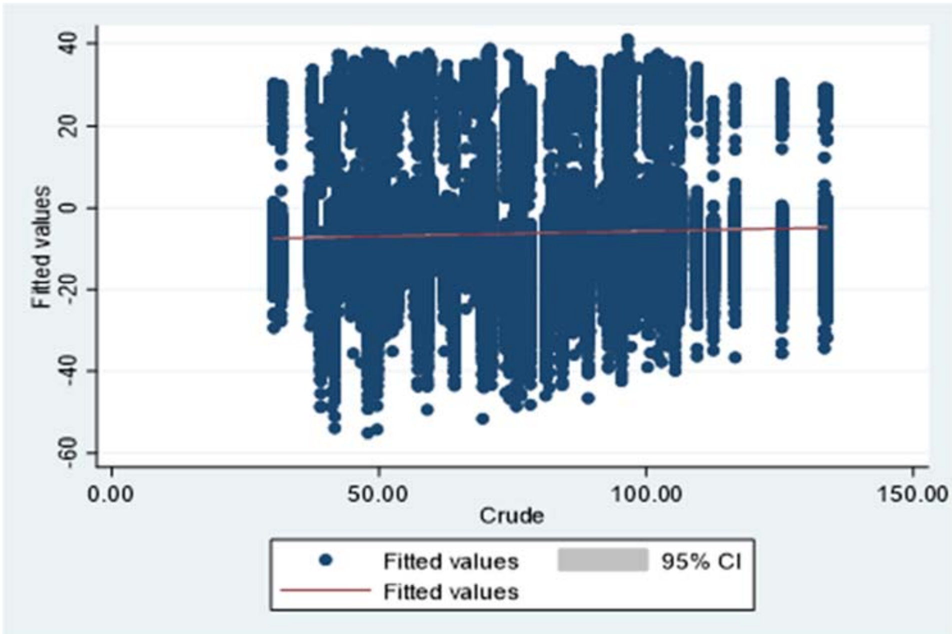

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
Winning Bid Size (Per Million)
Fitted values
95% CI
Fitted values
Graphs by State


Fitted values
Duration
Fitted values
95% CI
Fitted values

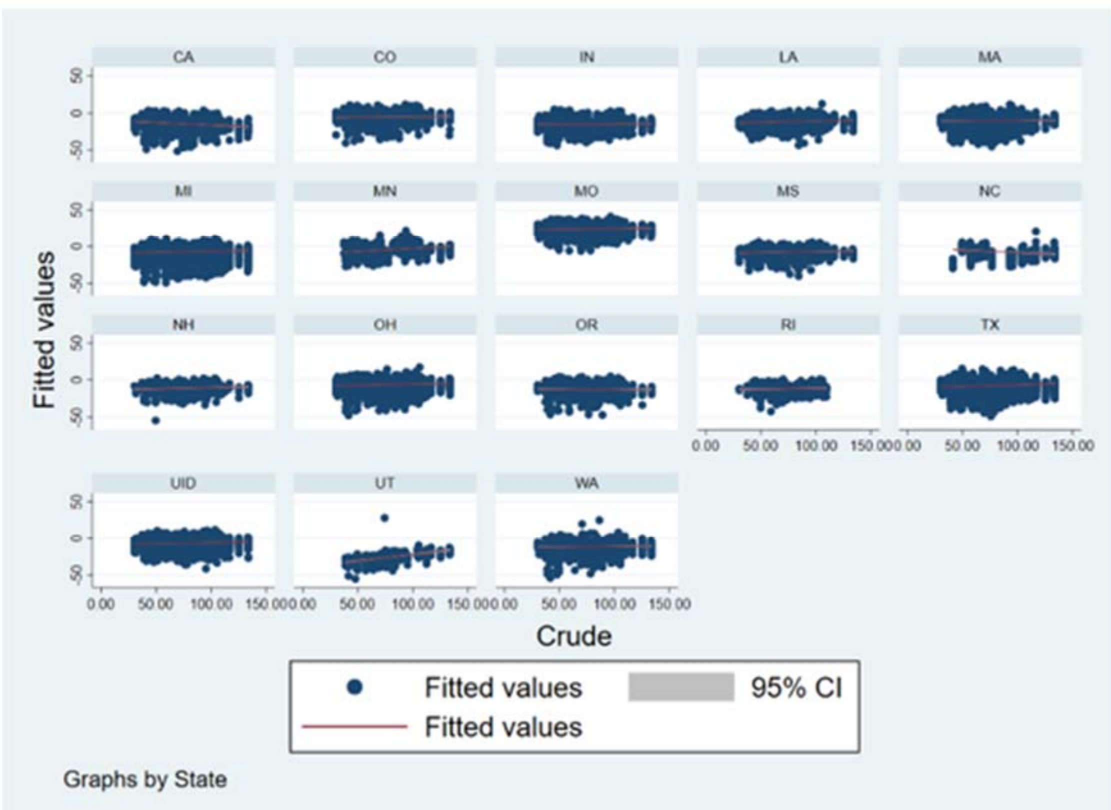

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
Duration
Fitted values
95% CI
Fitted values
Graphs by State


Fitted values
National Unemployment Rate
4.00
6.00
8.00
10.00
-60
-40
-20
0
20
40
Fitted values
95% CI
Fitted values

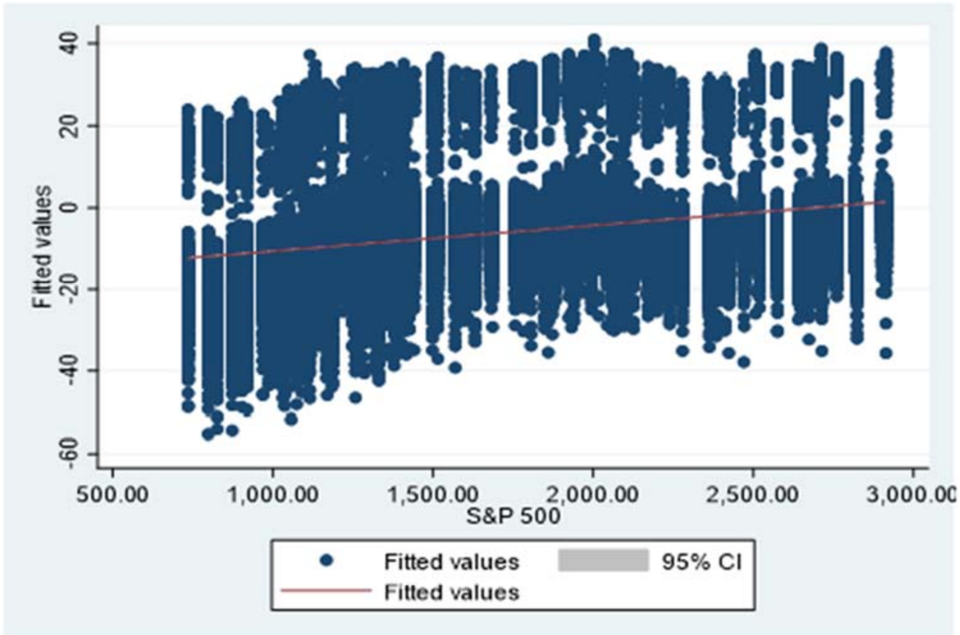

CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
National Unemployment Rate
Fitted values
95% CI
Fitted values
Graphs by State

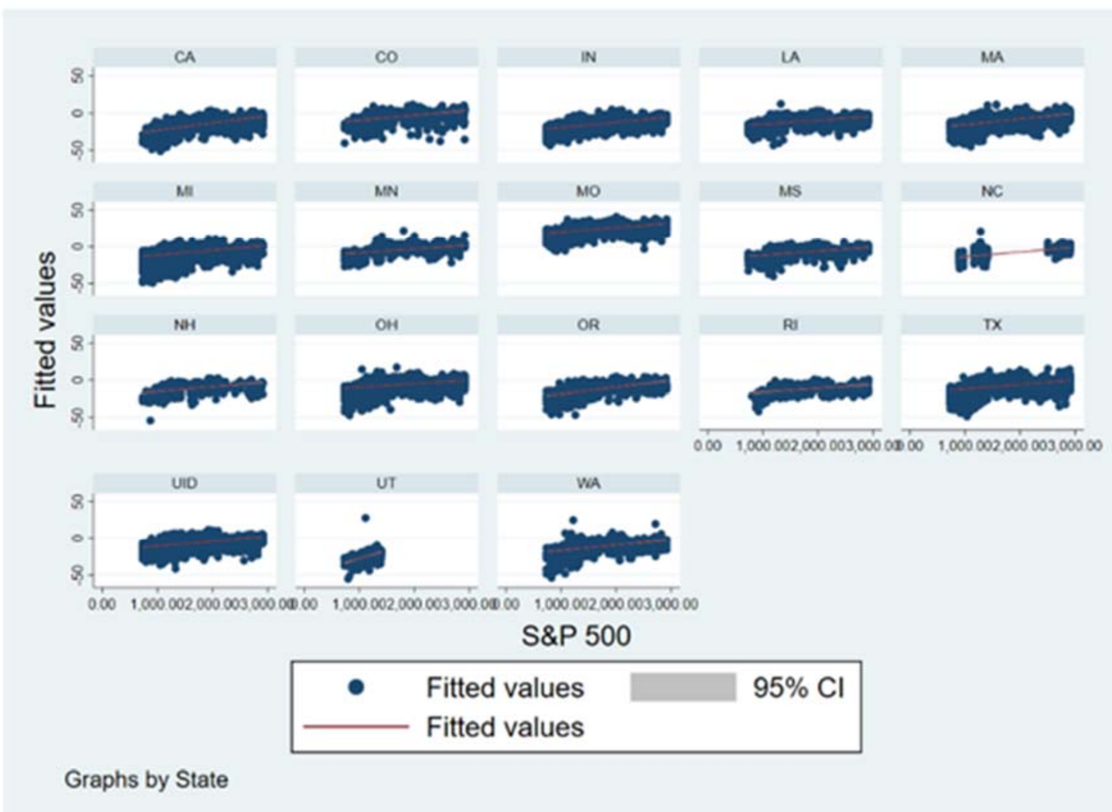


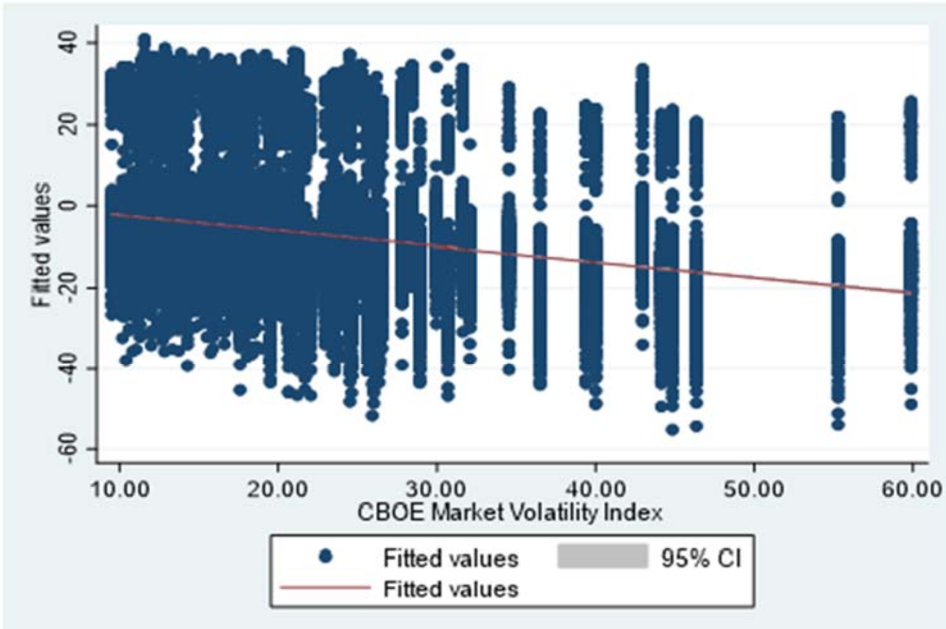
Fitted values
Crude
Fitted values
95% CI
Fitted values

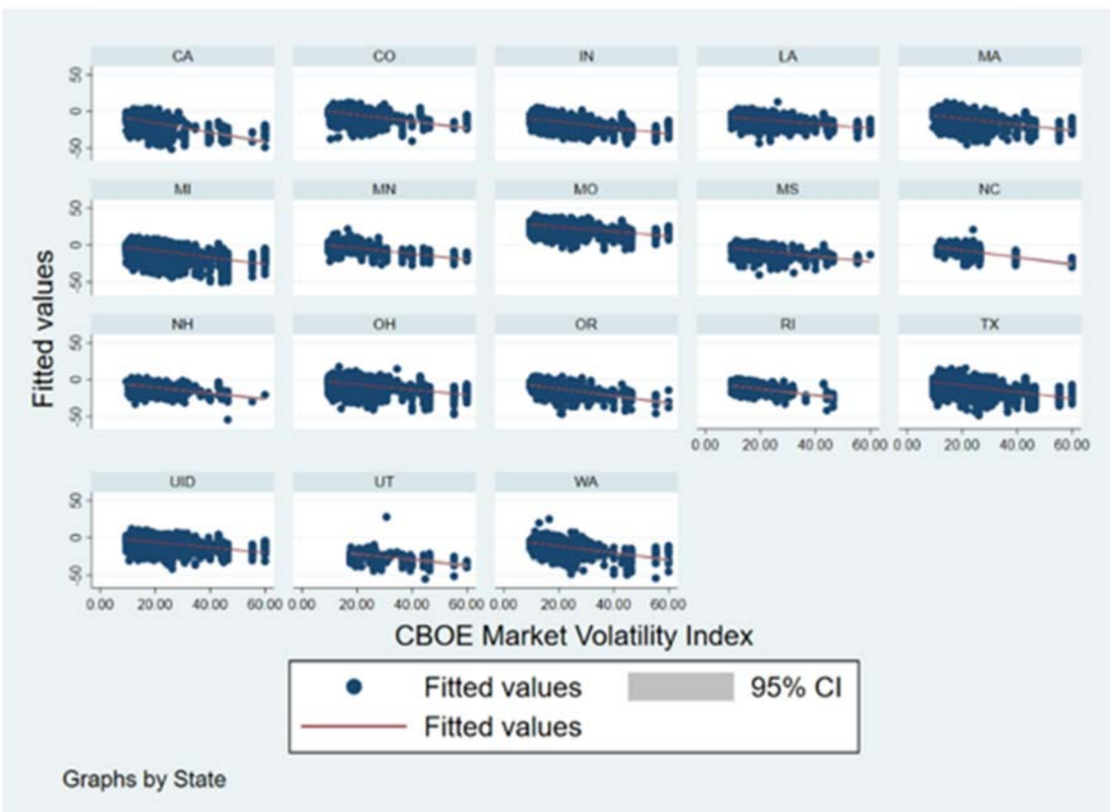


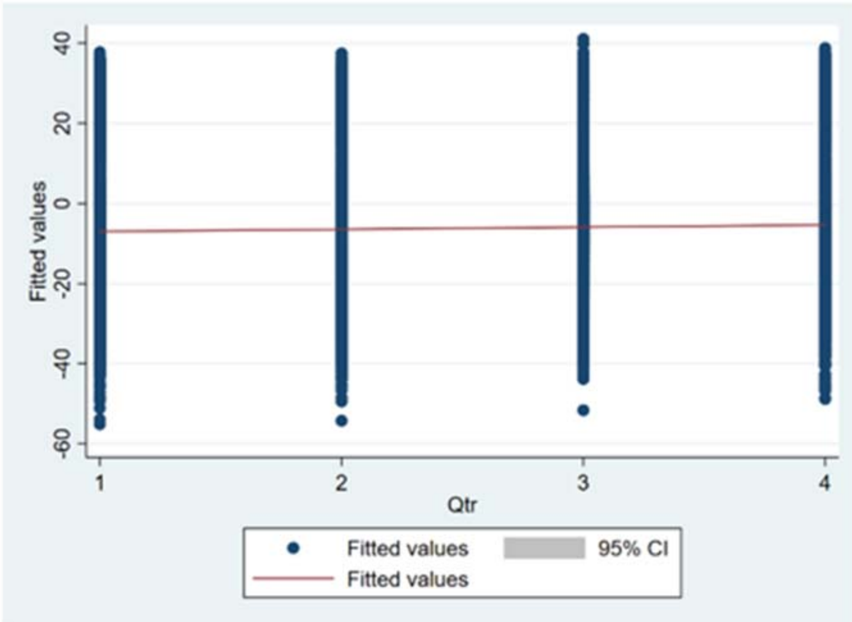
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
Crude
Fitted values
95% CI
Fitted values
Graphs by State

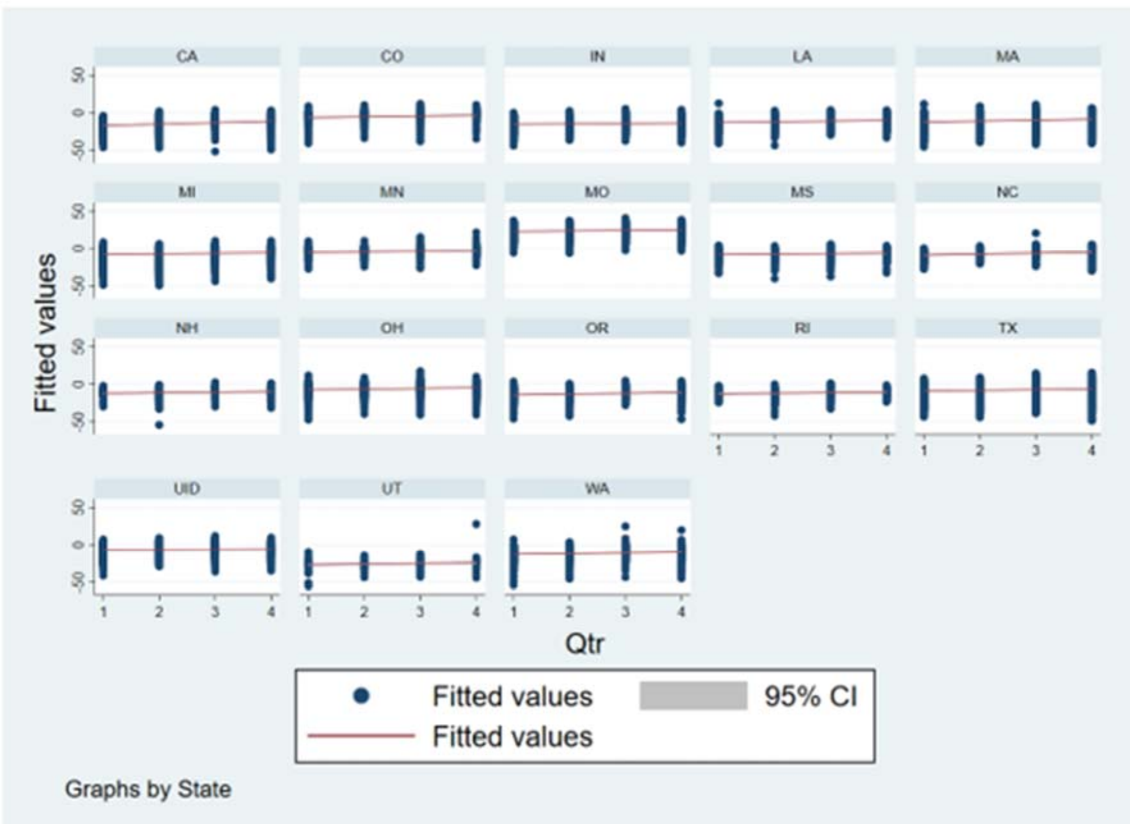

Fitted values
S&P 500
Fitted values
95% CI
Fitted values


CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
S&P 500
Fitted values
95% CI
Fitted values
Graphs by State

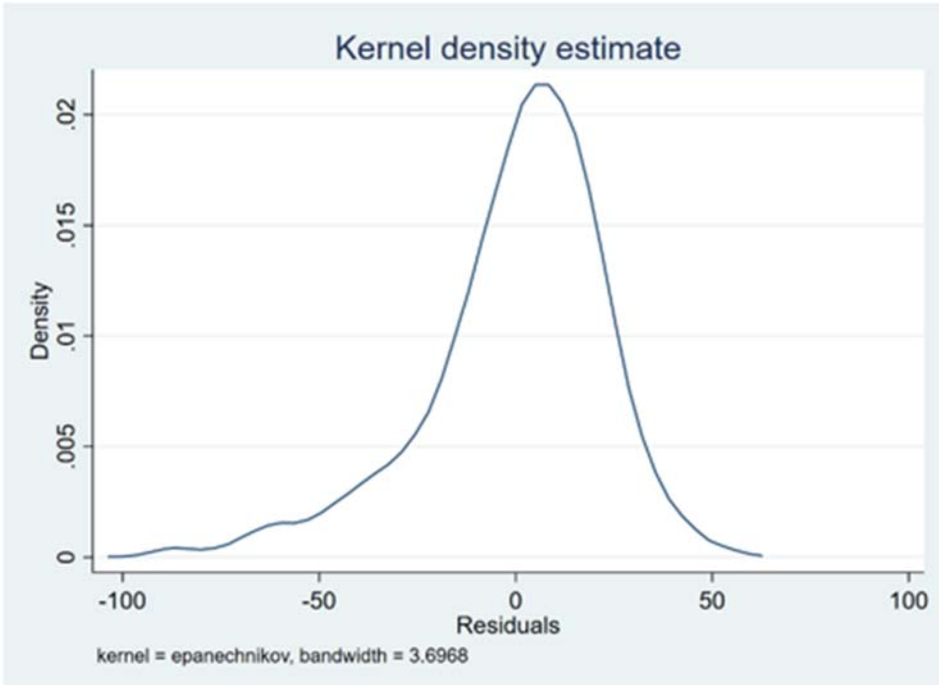

Fitted values
40
20
0
-20
-40
-60
10.00
20.00
30.00
40.00
50.00
60.00
CBOE Market Volatility Index
Fitted values
95% CI
Fitted values


CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
CBOE Market Volatility Index
Fitted values
95% CI
Fitted values
Graphs by State

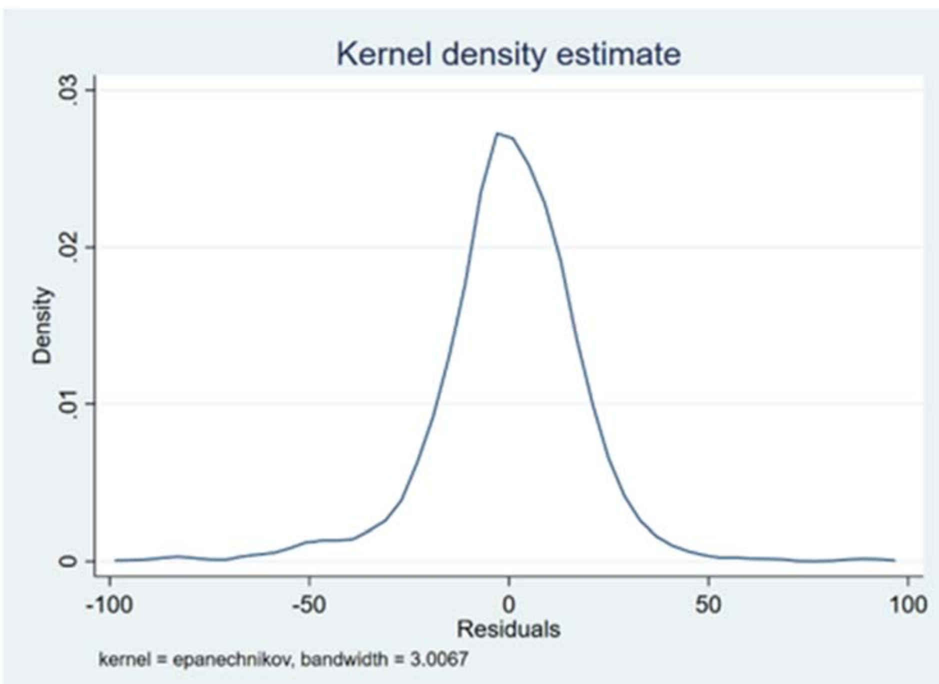

Fitted values
40
20
0
-20
-40
-60
1
2
3
4
Qtr
Fitted values
95% CI
Fitted values


CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Fitted values
Qtr
Fitted values
95% CI
Fitted values
Graphs by State

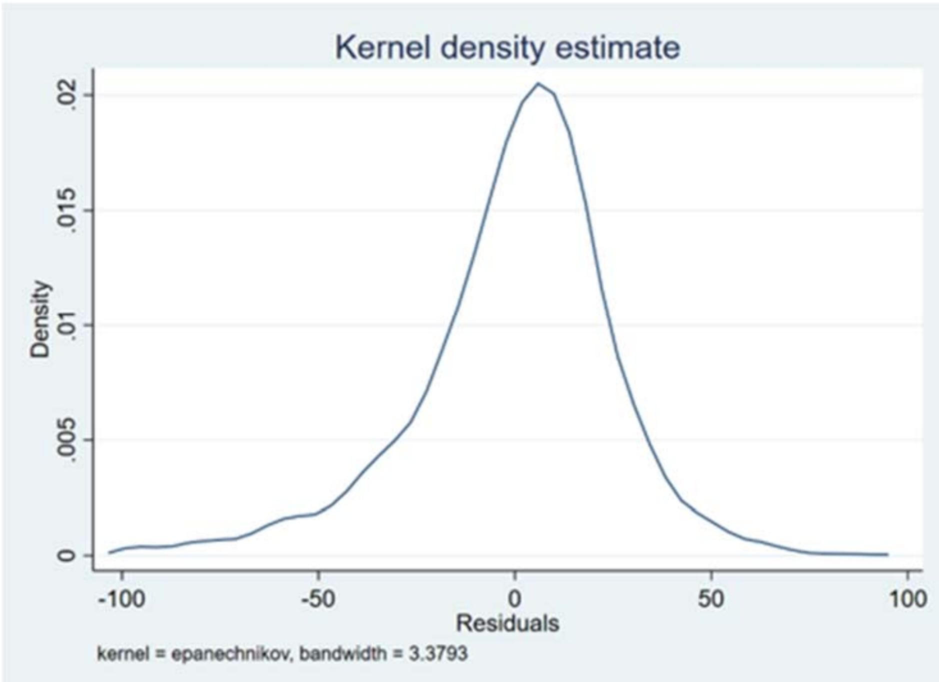
CA


Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.6968

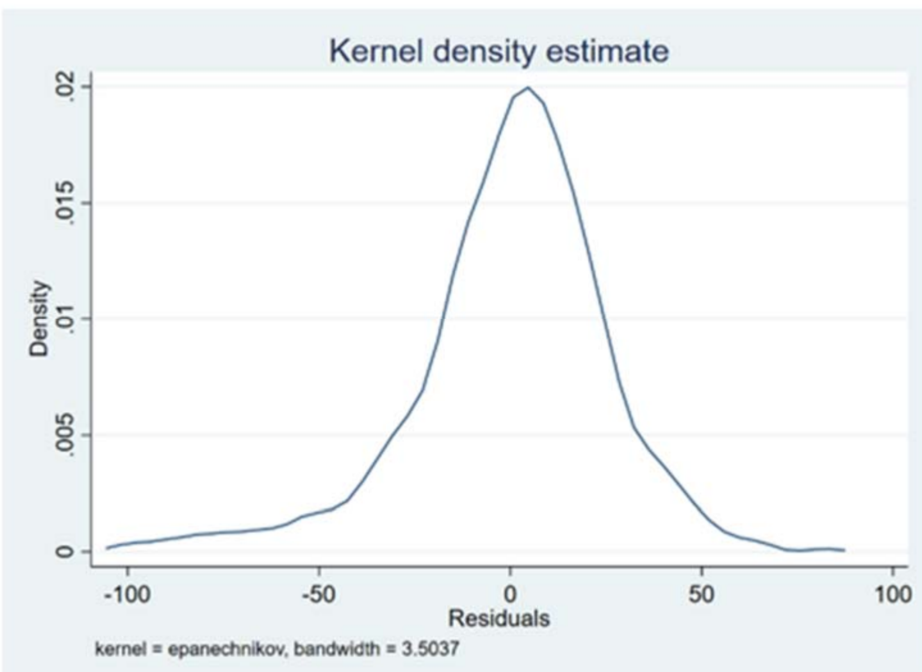
CO


Kernel density estimate
Density
0
.01
.02
.03
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.0067

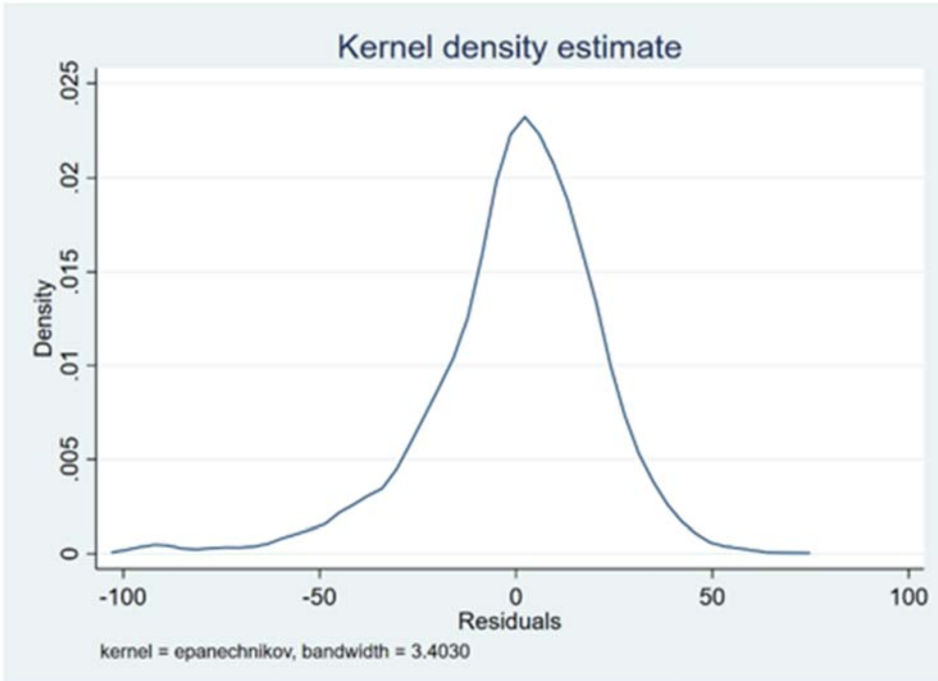
IN


Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.3793

LA

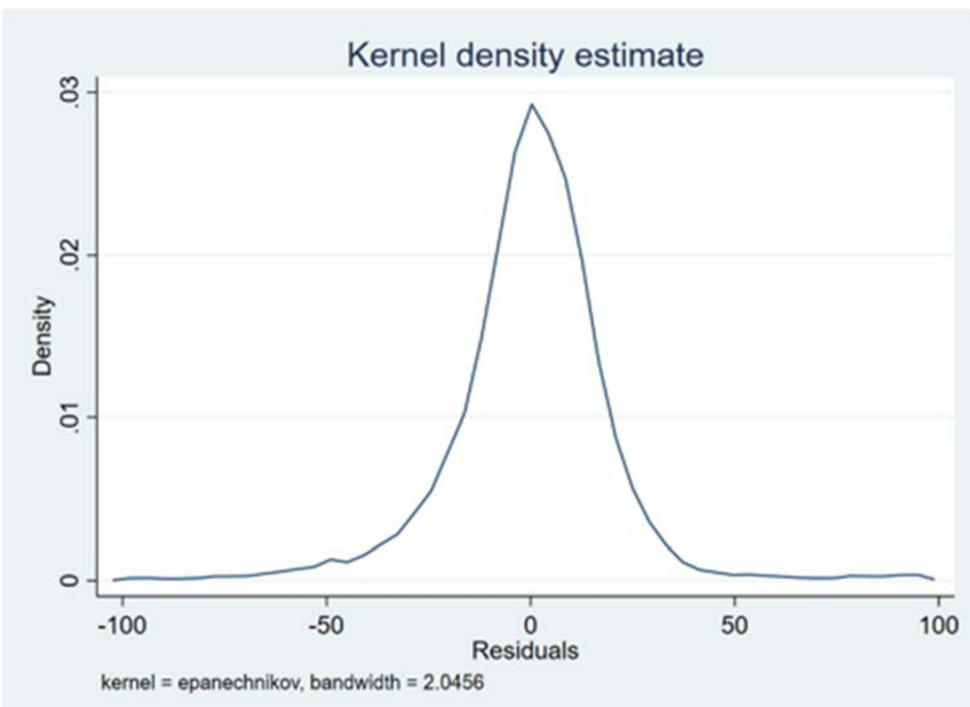

Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.5037

MA



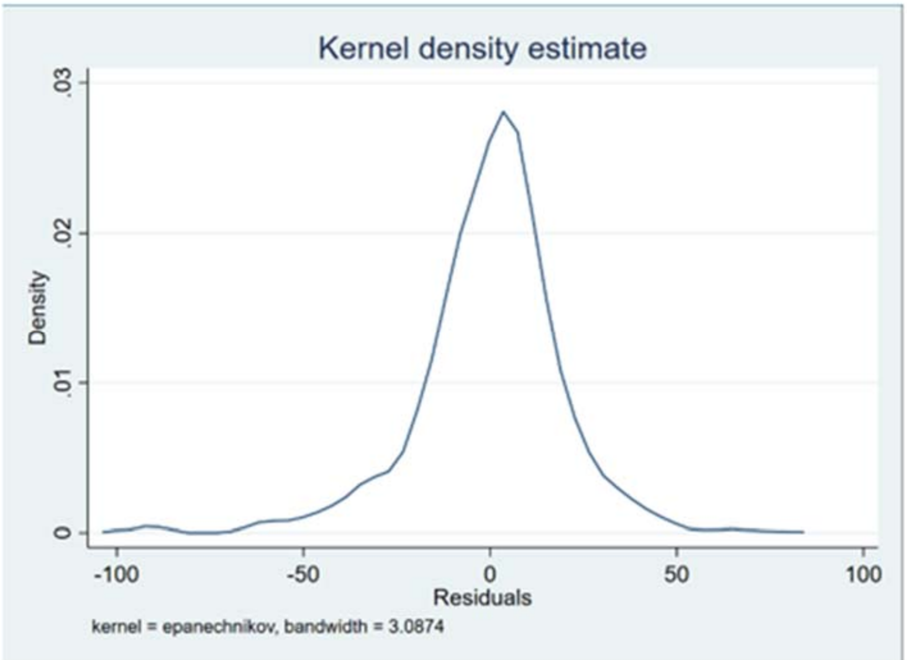
Kernel density estimate
Density
.025
.02
.015
.01
.005
0
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.4030

MI

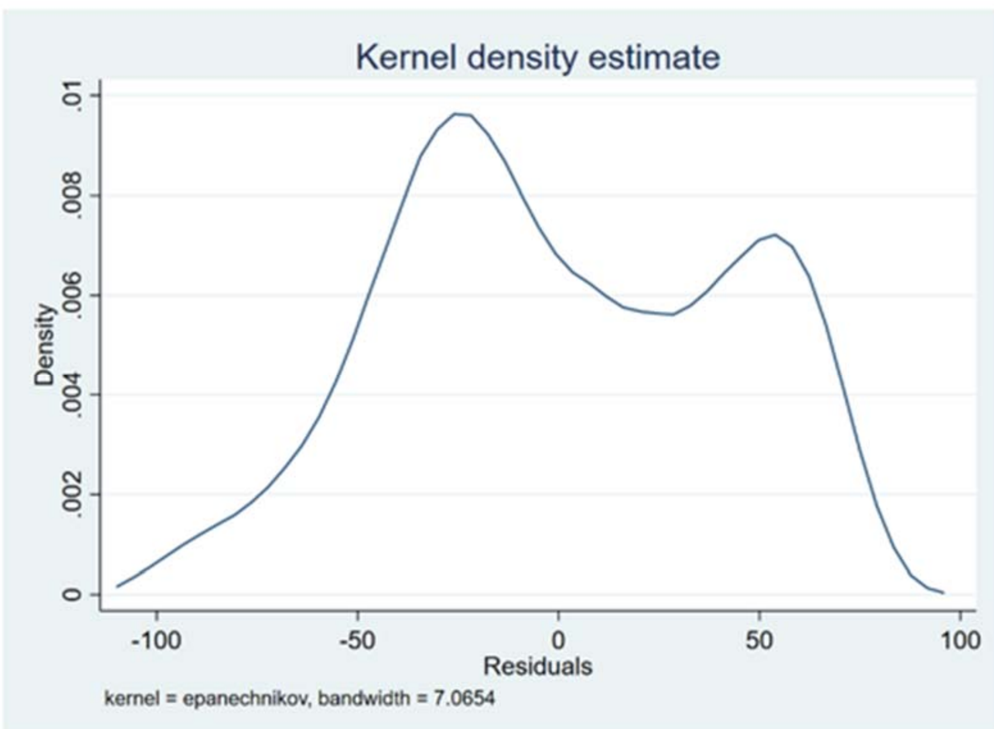


Kernel density estimate
Density
.03
.02
.01
0
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 2.0456

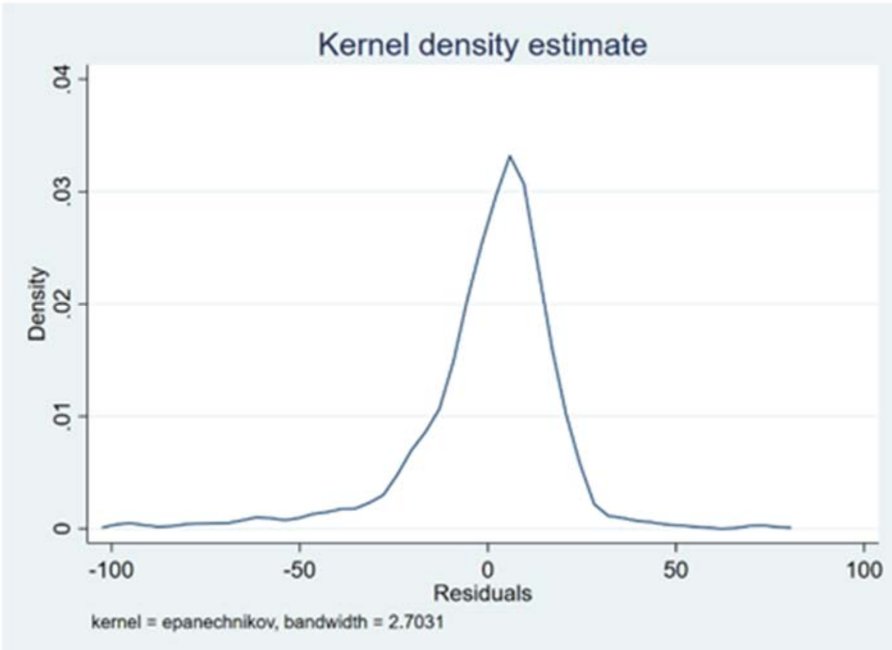
MN


Kernel density estimate
Density
.03
.02
.01
0
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.0874

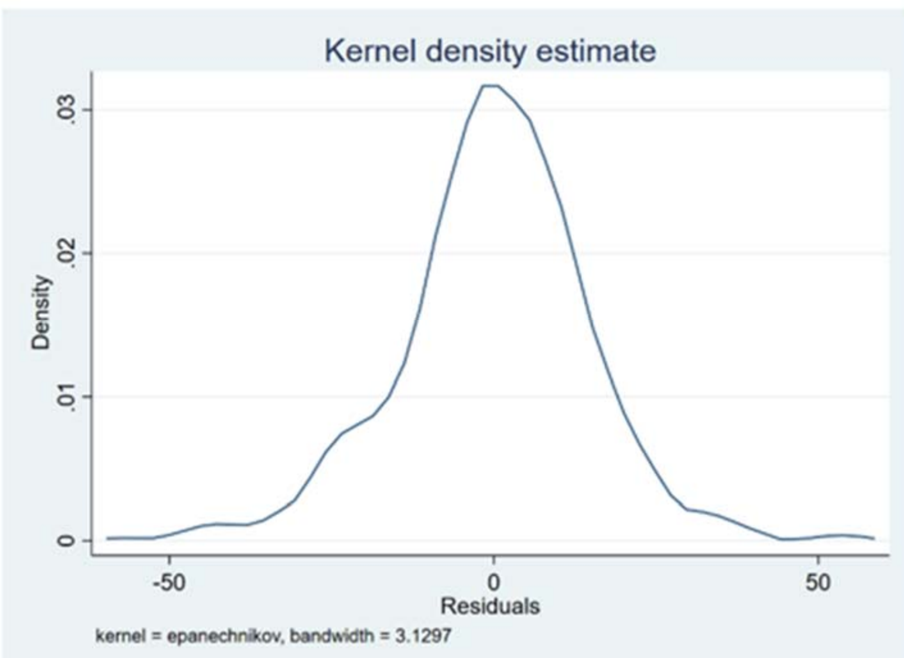
MO


Kernel density estimate
Density
.01
.008
.006
.004
.002
0
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 7.0654

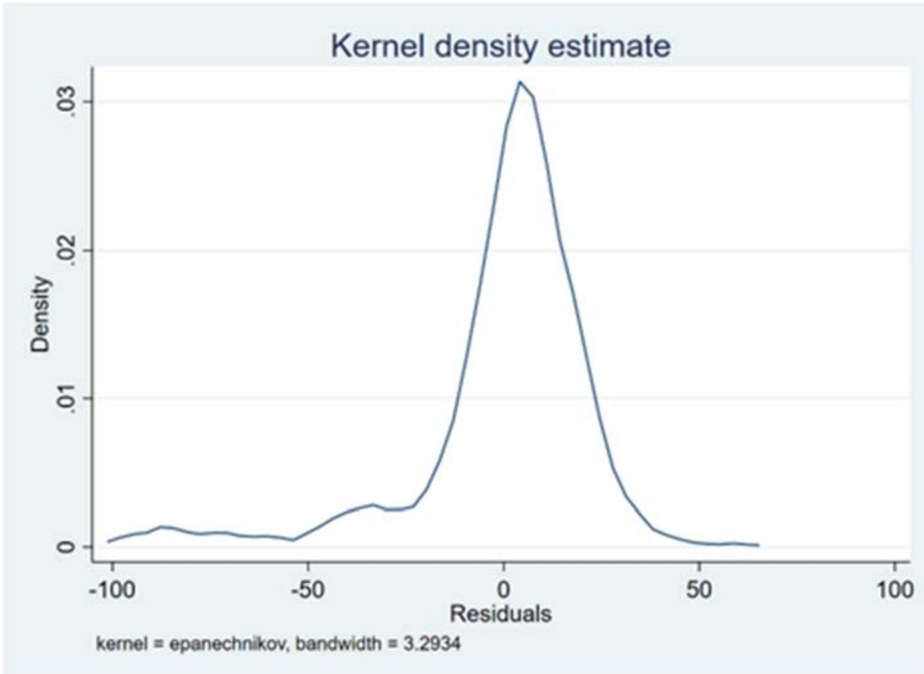
MS


Kernel density estimate
Density
.04
.03
.02
.01
0
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 2.7031

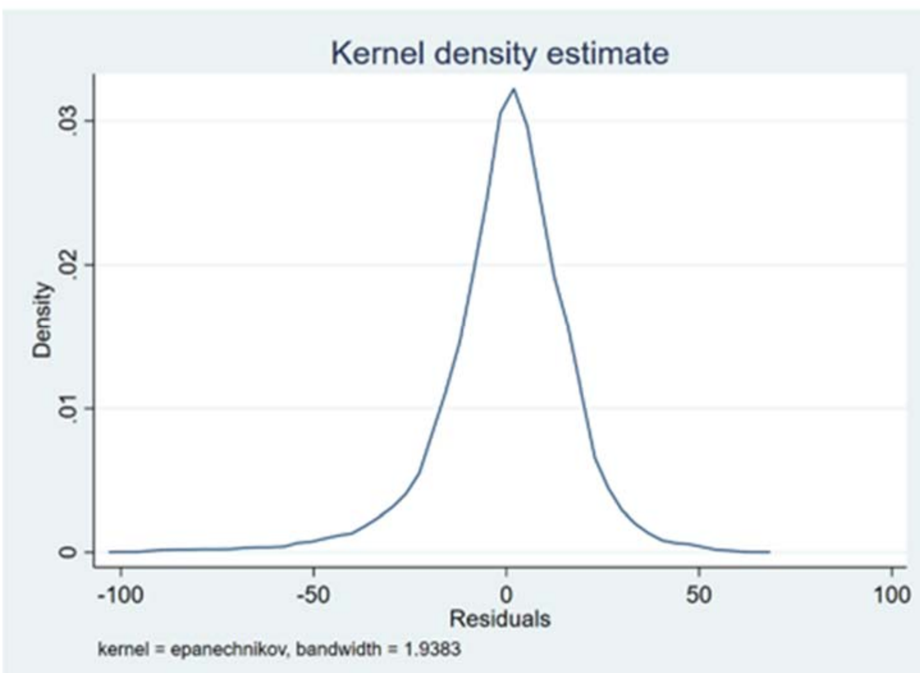
NC


Kernel density estimate
Density
.03
.02
.01
0
-50
0
50
Residuals
kernel = epanechnikov, bandwidth = 3.1297

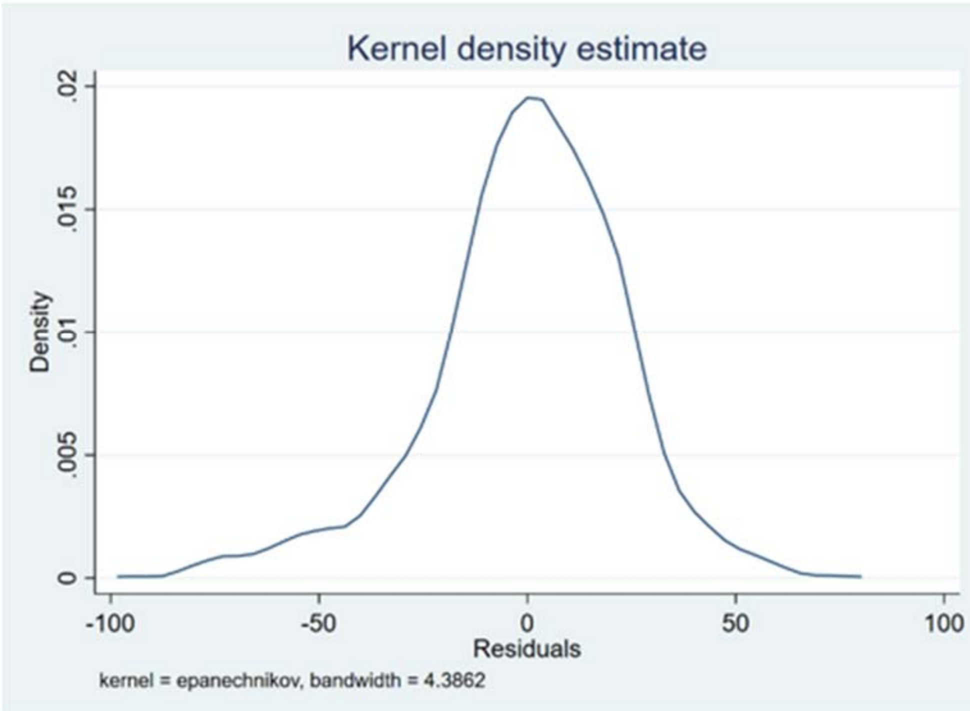
NH


Kernel density estimate
.03
.02
.01
0
Density
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.2934

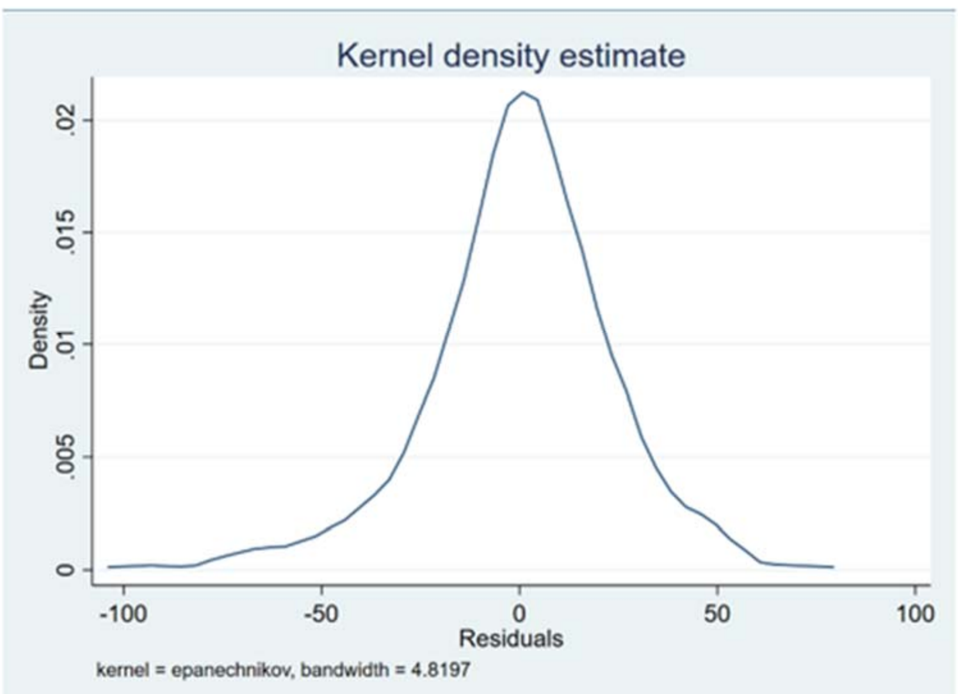
OH


Kernel density estimate
.03
.02
.01
0
Density
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 1.9383

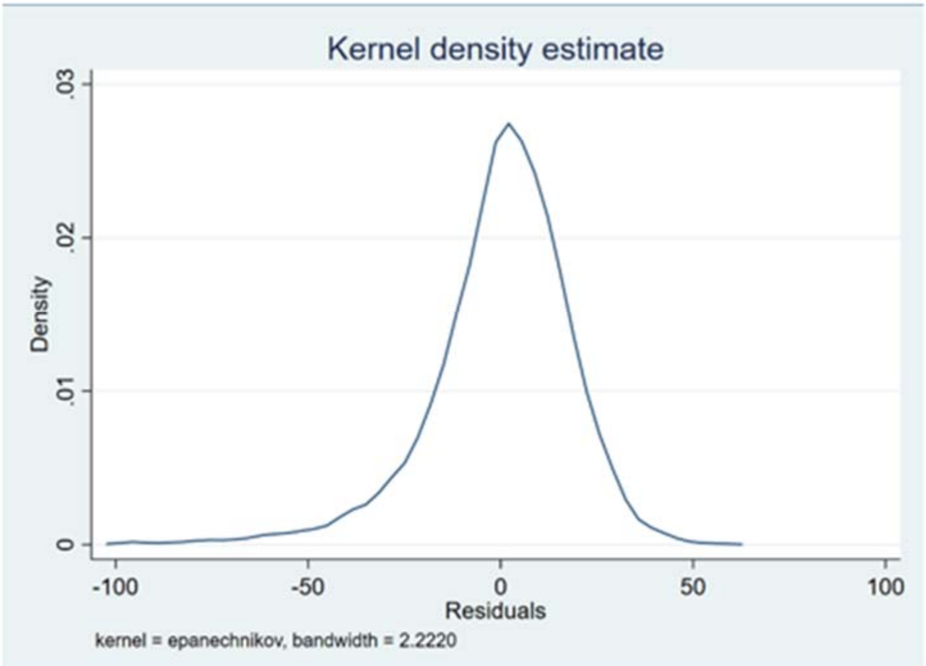
OR


Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 4.3862

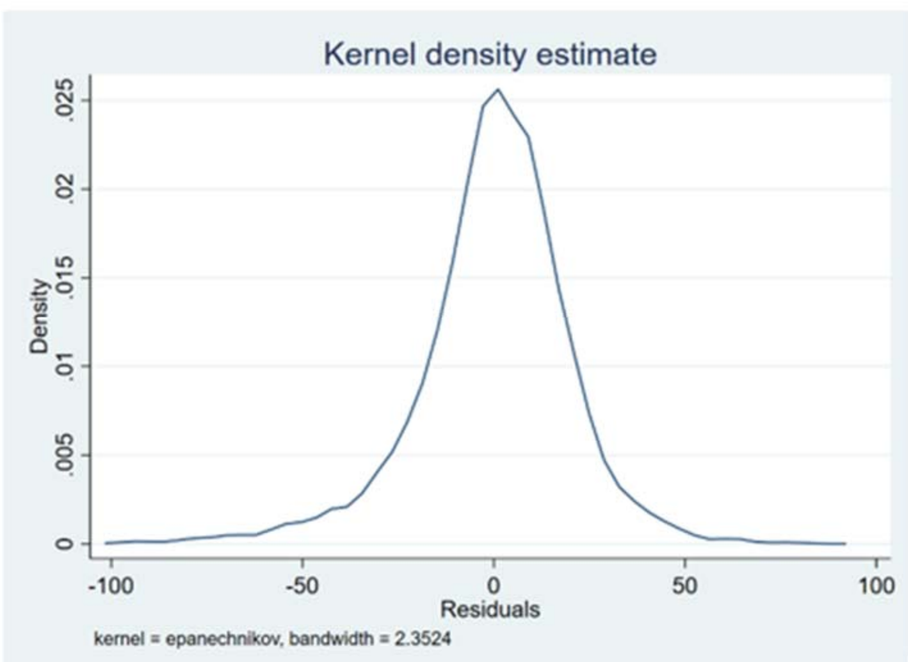
RI


Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 4.8197

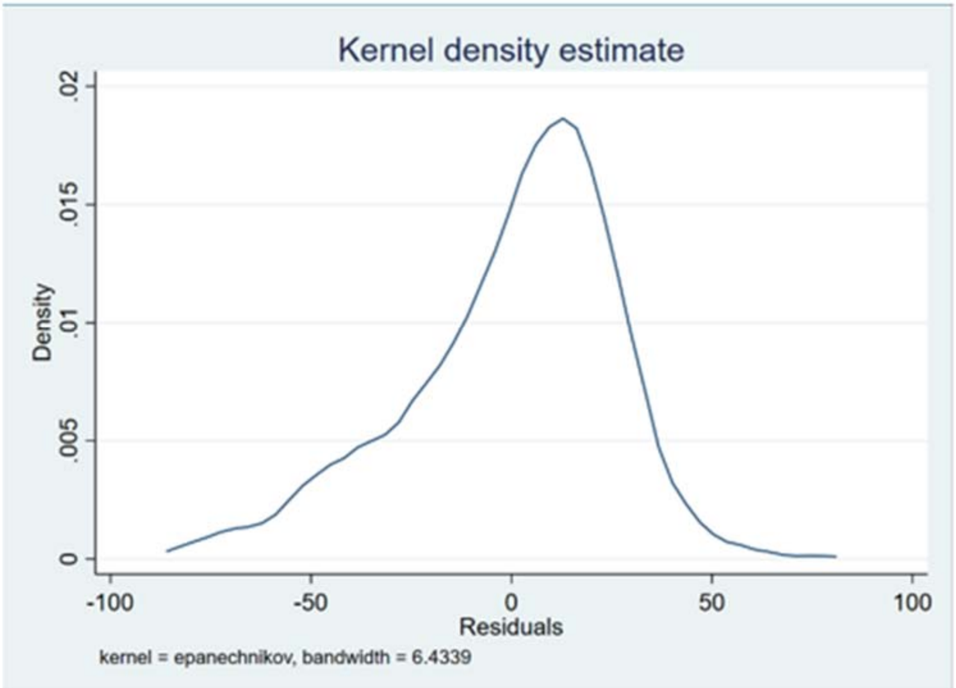
TX


Kernel density estimate
Density
0
.01
.02
.03
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 2.2220

UID

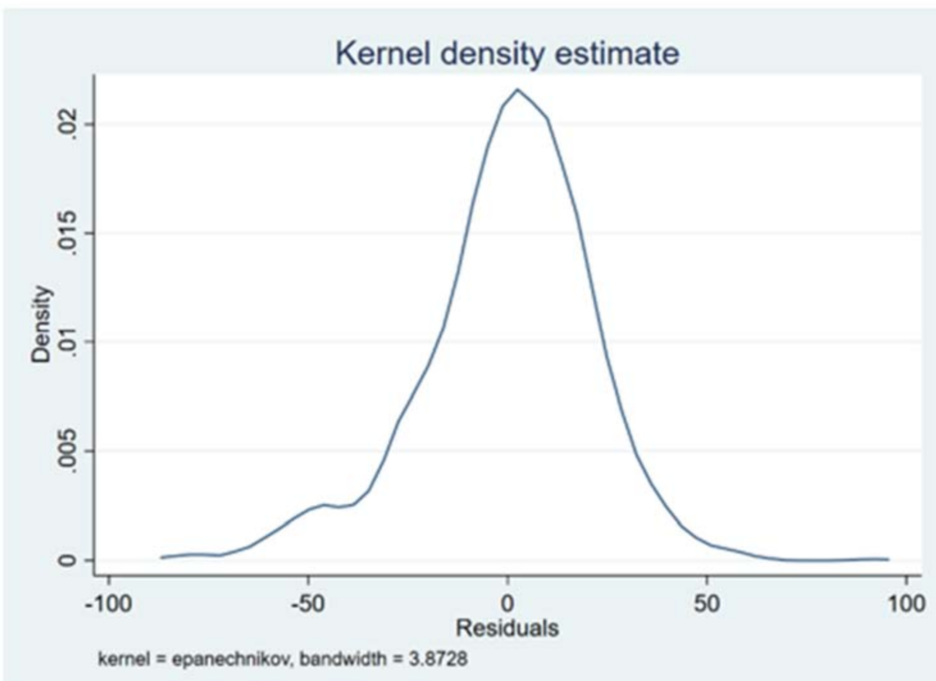

Kernel density estimate
Density
0
.005
.01
.015
.02
.025
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 2.3524

UT

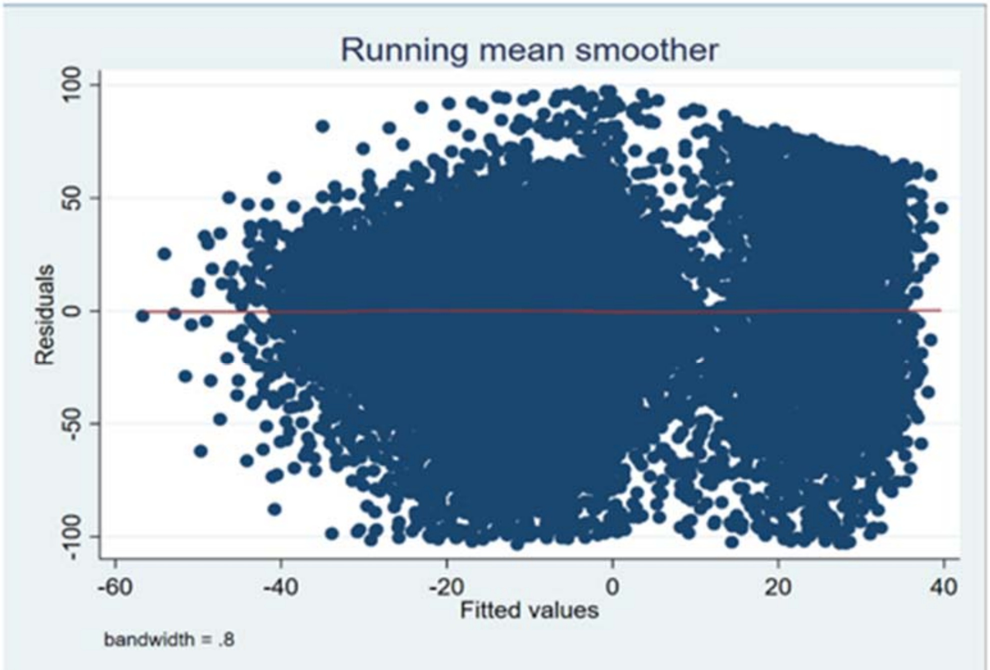


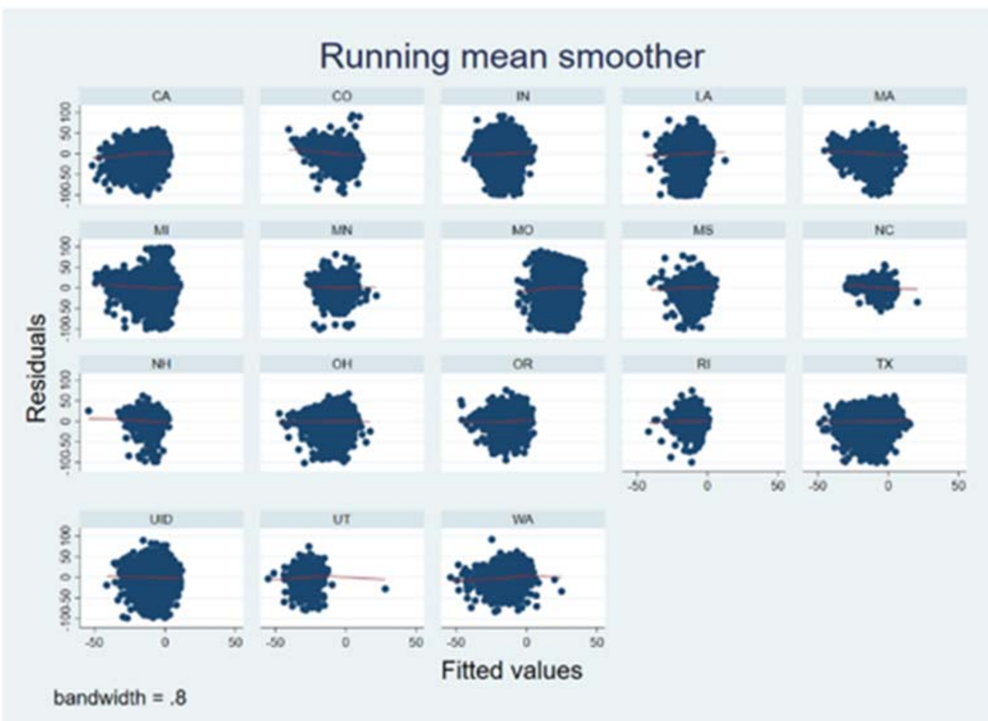
Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 6.4339

WA



Kernel density estimate
Density
0
.005
.01
.015
.02
-100
-50
0
50
100
Residuals
kernel = epanechnikov, bandwidth = 3.8728


Running mean smoother
Residuals
Fitted values
bandwidth = .8


Running mean smoother
CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Residuals
Fitted values
bandwidth = .8

APPENDIX D: STATE STATISTICAL RESULTS FOR TESTS IN SECTION 4.4

State = CA

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.3133*	1.0000					
Bidders	-0.4070*	-0.2432*	1.0000				
WBsize	0.0766*	-0.1144*	-0.0269	1.0000			
Duration	-0.0091	-0.0383	0.0629*	0.4950*	1.0000		
NatEmpl	-0.2884*	-0.6512*	0.2974*	-0.0301	-0.0282	1.0000	
Crude	-0.1375*	-0.4676*	0.1401*	0.0422*	0.0452*	0.4869*	1.0000
SP	0.3647*	0.6958*	-0.3230*	-0.0231	-0.0175	-0.8853*	-0.4691*
VIX	-0.3224*	-0.4469*	0.2681*	0.0581*	0.0534*	0.4211*	0.0679*

State = CO

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0684*	1.0000					
Bidders	-0.1666*	0.1250*	1.0000				
WBsize	0.1551*	0.2784*	0.0227	1.0000			
Duration	0.0050	0.1851*	0.1302*	0.3865*	1.0000		
NatEmpl	-0.0599*	0.0392	0.1764*	-0.0824*	-0.0018	1.0000	
Crude	0.0256	-0.0168	0.0505	-0.0214	-0.0149	0.3263*	1.0000
SP	0.0682*	-0.0342	-0.1916*	0.0865*	0.0198	-0.8493*	-0.4127*
VIX	-0.0886*	-0.0232	0.1742*	-0.0665*	-0.0115	0.4600*	-0.0435

State = IN

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0719*	1.0000					
Bidders	-0.1752*	-0.0009	1.0000				
WBsize	-0.0107	0.0261	0.0119	1.0000			
Duration	0.0418*	0.2019*	0.1463*	0.4760*	1.0000		
NatEmpl	-0.1945*	-0.3638*	0.1276*	-0.0050	-0.1411*	1.0000	
Crude	-0.0192	-0.1489*	0.0999*	0.0187	-0.0630*	0.3667*	1.0000
SP	0.1954*	0.3592*	-0.1123*	0.0139	0.1533*	-0.8843*	-0.3566*
VIX	-0.1481*	-0.2201*	0.0551*	-0.0150	-0.0894*	0.5118*	-0.0729*

State = LA

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0078	1.0000					
Bidders	-0.2778*	0.2071*	1.0000				
WBsize	0.0271	0.1086*	0.0159	1.0000			
Duration	0.0172	0.2301*	0.0885*	0.5252*	1.0000		
NatEmpl	-0.1138*	-0.0150	0.1057*	-0.0220	-0.0467*	1.0000	
Crude	0.0470*	-0.0728*	0.0080	0.0126	-0.0284	0.3073*	1.0000
SP	0.0960*	0.0525*	-0.0374*	-0.0076	0.0313	-0.8540*	-0.3250*
VIX	-0.1199*	-0.0340*	0.0088	0.0156	0.0047	0.4602*	-0.1356*

State = MA

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0966*	1.0000					
Bidders	-0.2215*	0.0831*	1.0000				
WBsize	0.0581*	0.0821*	-0.0022	1.0000			
Duration	-0.0551*	-0.0022	-0.0768*	0.3612*	1.0000		
NatEmpl	-0.2738*	-0.4857*	0.2155*	-0.0175	-0.0097	1.0000	
Crude	-0.0338	-0.4371*	-0.0083	0.0075	-0.0441*	0.3395*	1.0000
SP	0.1840*	0.5266*	-0.1728*	0.0309	0.0343	-0.8424*	-0.3742*
VIX	-0.1320*	-0.2466*	0.1305*	-0.0464*	-0.0024	0.4673*	-0.0872*

State = MI

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	-0.0651*	1.0000					
Bidders	-0.2059*	0.1589*	1.0000				
WBsize	0.0704*	0.1019*	-0.0373*	1.0000			
Duration	0.0730*	-0.0050	0.0292*	0.3482*	1.0000		
NatEmpl	-0.1466*	0.3882*	0.1802*	-0.0291*	-0.1630*	1.0000	
Crude	0.0272*	0.2625*	0.0538*	-0.0330*	-0.0477*	0.3332*	1.0000
SP	0.1519*	-0.4595*	-0.2179*	0.0198	0.1969*	-0.8746*	-0.3779*
VIX	-0.1386*	0.2966*	0.1942*	0.0049	-0.1698*	0.5019*	-0.0549*

State = MN

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0290	1.0000					
Bidders	-0.3052*	0.1374*	1.0000				
WBsize	0.0336	0.3057*	0.0118	1.0000			
Duration	-0.0179	0.1358*	0.0418	0.3710*	1.0000		
NatEmpl	-0.0370	-0.1120*	0.0134	-0.0602*	0.1420*	1.0000	
Crude	0.1005*	-0.2305*	-0.1314*	-0.0265	0.0937*	0.1774*	1.0000
SP	0.0991*	0.1521*	-0.0460	0.0659*	-0.1388*	-0.8751*	-0.2430*
VIX	-0.1140*	-0.0232	0.1111*	-0.0388	0.0123	0.5677*	-0.2598*

State = MO

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	-0.0543*	1.0000					
Bidders	-0.1842*	0.0327*	1.0000				
WBsize	0.1355*	0.1256*	0.0212	1.0000			
Duration	0.0962*	0.0537*	0.0033	0.5483*	1.0000		
NatEmpl	0.0120	-0.1574*	0.1397*	0.0099	-0.0502*	1.0000	
Crude	0.0859*	-0.2273*	0.0692*	0.0062	-0.0427*	0.3746*	1.0000
SP	0.0273	0.1524*	-0.1239*	-0.0222	0.0591*	-0.8778*	-0.3113*
VIX	-0.0296*	-0.0525*	0.0410*	0.0357*	-0.0193	0.4836*	-0.1388*

State = MS

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0202	1.0000					
Bidders	-0.3357*	0.1521*	1.0000				
WBsize	0.0874*	0.4352*	0.1127*	1.0000			
Duration	-0.0478	0.4239*	0.4107*	0.5943*	1.0000		
NatEmpl	-0.0955*	0.1248*	0.1509*	0.0274	0.2110*	1.0000	
Crude	0.0703*	0.0213	0.0840*	-0.0090	0.1562*	0.3316*	1.0000
SP	0.0958*	-0.0581*	-0.1405*	-0.0086	-0.1533*	-0.8793*	-0.3422*
VIX	-0.1066*	-0.0003	0.0646*	-0.0267	0.0169	0.5496*	-0.0573*

State = NC

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.2333*	1.0000					
Bidders	-0.2295*	0.1839*	1.0000				
WBsize	-0.0195	0.2367*	-0.0475	1.0000			
Duration	-0.1329*	0.2538*	0.3172*	0.3839*	1.0000		
NatEmpl	-0.2610*	0.1779*	0.5185*	0.1106*	0.5626*	1.0000	
Crude	0.0413	0.2591*	0.2096*	0.1419*	0.5344*	0.4483*	1.0000
SP	0.2463*	-0.2113*	-0.4992*	-0.0976*	-0.6001*	-0.9305*	-0.6113*
VIX	-0.3045*	0.1045*	0.4375*	0.0175	0.2735*	0.7714*	0.0495

State = NH

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	.	.					
Bidders	-0.1292*	.	1.0000				
WBsize	0.0009	.	0.0567	1.0000			
Duration	0.0059	.	0.2627*	0.6988*	1.0000		
NatEmpl	-0.0758	.	0.1594*	-0.0049	-0.0096	1.0000	
Crude	0.1150*	.	0.0456	-0.0681	-0.0537	0.2732*	1.0000
SP	0.0703	.	-0.1504*	0.0046	0.0098	-0.8725*	-0.3419*
VIX	-0.0294	.	0.0985*	0.0088	0.0082	0.5246*	-0.1064*

State = OH

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0881*	1.0000					
Bidders	-0.3438*	0.0563*	1.0000				
WBsize	0.0266*	0.2202*	-0.0170	1.0000			
Duration	-0.0084	0.2725*	0.0914*	0.5190*	1.0000		
NatEmpl	-0.0929*	-0.0631*	0.0843*	-0.0002	-0.0455*	1.0000	
Crude	0.0046	-0.0863*	0.0031	-0.0015	-0.0390*	0.4212*	1.0000
SP	0.1371*	0.0971*	-0.0812*	0.0053	0.0403*	-0.8771*	-0.4330*
VIX	-0.1545*	-0.0787*	0.0892*	0.0042	-0.0100	0.4737*	-0.0108

State = OR

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.1940*	1.0000					
Bidders	-0.2222*	-0.0564	1.0000				
WBsize	0.0077	0.2809*	-0.0508	1.0000			
Duration	-0.0367	0.2233*	0.0977*	0.6510*	1.0000		
NatEmpl	-0.4089*	-0.3784*	0.2254*	-0.1418*	-0.0584*	1.0000	
Crude	-0.0889*	-0.2571*	0.1472*	-0.0420	-0.0687*	0.3146*	1.0000
SP	0.4152*	0.4218*	-0.2400*	0.1105*	0.0241	-0.8830*	-0.3006*
VIX	-0.3404*	-0.2753*	0.1521*	-0.0597*	0.0313	0.5000*	-0.1620*

State = RI

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.1080*	1.0000					
Bidders	-0.1679*	0.1931*	1.0000				
WBsize	-0.0129	0.1201*	-0.0022	1.0000			
Duration	0.0530	0.0759	-0.0318	0.4130*	1.0000		
NatEmpl	-0.1896*	-0.1100*	0.1550*	-0.0467	-0.0985*	1.0000	
Crude	-0.0109	-0.1856*	0.0166	-0.0217	0.0036	0.5749*	1.0000
SP	0.1880*	0.1243*	-0.1541*	0.0614	0.1109*	-0.9694*	-0.4491*
VIX	-0.1541*	0.0207	0.1575*	-0.0505	-0.0716	0.5760*	-0.0334

State = TX

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.0678*	1.0000					
Bidders	-0.3103*	0.0921*	1.0000				
WBsize	0.0548*	0.2825*	0.0394*	1.0000			
Duration	0.0682*	0.4796*	0.1214*	0.6885*	1.0000		
NatEmpl	-0.1301*	-0.0291*	0.1422*	-0.0769*	-0.0724*	1.0000	
Crude	0.1294*	-0.0197	-0.0348*	-0.0280*	-0.0260*	0.4036*	1.0000
SP	0.1642*	0.0028	-0.1401*	0.0841*	0.0728*	-0.8962*	-0.3856*
VIX	-0.2931*	0.0004	0.1898*	-0.0515*	-0.0460*	0.5317*	-0.0553*

State = UT

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	-0.0841	1.0000					
Bidders	-0.3404*	0.0597	1.0000				
WBsize	0.0471	0.0216	-0.0369	1.0000			
Duration	0.0159	0.2459*	0.0779	0.5745*	1.0000		
NatEmpl	-0.0596	-0.1410*	0.0398	0.0269	-0.0358	1.0000	
Crude	0.1650*	0.2512*	-0.1998*	0.0031	0.0105	-0.6773*	1.0000
SP	0.1546*	0.2875*	-0.1728*	0.0182	-0.0023	-0.5964*	0.9105*
VIX	-0.1805*	-0.2246*	0.1731*	0.0040	0.0472	0.1281*	-0.6832*

State = UT

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	-0.0841	1.0000					
Bidders	-0.3404*	0.0597	1.0000				
WBsize	0.0471	0.0216	-0.0369	1.0000			
Duration	0.0159	0.2459*	0.0779	0.5745*	1.0000		
NatEmpl	-0.0596	-0.1410*	0.0398	0.0269	-0.0358	1.0000	
Crude	0.1650*	0.2512*	-0.1998*	0.0031	0.0105	-0.6773*	1.0000
SP	0.1546*	0.2875*	-0.1728*	0.0182	-0.0023	-0.5964*	0.9105*
VIX	-0.1805*	-0.2246*	0.1731*	0.0040	0.0472	0.1281*	-0.6832*

State = WA

	BidDiff	DBE	Bidders	WBsize	Duration	NatEmpl	Crude
BidDiff	1.0000						
DBE	0.1478*	1.0000					
Bidders	-0.4096*	-0.0677*	1.0000				
WBsize	-0.0413	-0.0171	0.0305	1.0000			
Duration	-0.0813*	-0.0520*	0.1599*	0.7400*	1.0000		
NatEmpl	-0.3791*	-0.1039*	0.2400*	0.0144	0.0282	1.0000	
Crude	-0.0632*	-0.0781*	0.0562*	0.0154	0.0235	0.3476*	1.0000
SP	0.4018*	0.1320*	-0.2483*	-0.0050	-0.0312	-0.8681*	-0.3771*
VIX	-0.3450*	-0.1603*	0.2021*	-0.0137	0.0010	0.4691*	-0.1261*

APPENDIX E: STATE STATISTICAL RESULTS FOR TESTS IN SECTION 4.5

-> State = CA

Source	SS	df	MS			
				Number of obs	=	2,324
				F(21, 2302)	=	44.30
Model	453004.446	21	21571.6403	Prob > F	=	0.0000
Residual	1120984.36	2,302	486.96106	R-squared	=	0.2878
				Adj R-squared	=	0.2813
Total	1573988.81	2,323	677.567286	Root MSE	=	22.067

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.2965436	.1213179	2.44	0.015	.0586399	.5344473
Bidders	-2.61892	.1796922	-14.57	0.000	-2.971296	-2.266545
WBsize	.1751447	.0367156	4.77	0.000	.1031455	.2471439
Duration	-.0046286	.0022418	-2.06	0.039	-.0090248	-.0002324
NatEmpl	1.281898	1.802579	0.71	0.477	-2.252949	4.816746
Crude	.0606441	.0604458	1.00	0.316	-.0578897	.179178
SP	-.0062113	.0068287	-0.91	0.363	-.0196023	.0071798
VIX	-.1084289	.1208043	-0.90	0.370	-.3453256	.1284678
Q2	-2.026916	1.329302	-1.52	0.127	-4.633671	.5798389
Q3	-.2967337	1.576632	-0.19	0.851	-3.388501	2.795033
Q4	.5447	1.564211	0.35	0.728	-2.522709	3.612109
Y08	-26.76092	6.220827	-4.30	0.000	-38.95993	-14.56191
Y09	-32.03786	7.11639	-4.50	0.000	-45.99307	-18.08265
Y10	-22.6378	6.557379	-3.45	0.001	-35.49678	-9.778808
Y11	-1.304813	6.107209	-0.21	0.831	-13.28102	10.67139
Y12	-9.118697	4.74095	-1.92	0.055	-18.41568	.1782821
Y13	-2.108343	3.237723	-0.65	0.515	-8.4575	4.240815
Y15	2.264449	3.408986	0.66	0.507	-4.420556	8.949454
Y16	4.029427	3.997217	1.01	0.314	-3.809096	11.86795
Y17	7.709094	5.289687	1.46	0.145	-2.663956	18.08214
Y18	11.44632	6.170278	1.86	0.064	-.6535609	23.54621
_cons	3.579425	19.22739	0.19	0.852	-34.1254	41.28425

-> State = CO

Source	SS	df	MS
Model	37837.1399	21	1801.76857
Residual	445871.93	1,447	308.135405
Total	483709.07	1,468	329.502092

Number of obs	=	1,469
F(21, 1447)	=	5.85
Prob > F	=	0.0000
R-squared	=	0.0782
Adj R-squared	=	0.0648
Root MSE	=	17.554

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.1975633	.10202	1.94	0.053	-.0025596	.3976862
Bidders	-.9748931	.1801986	-5.41	0.000	-1.328371	-.6214147
WBsize	.4704062	.0860718	5.47	0.000	.3015672	.6392451
Duration	-.0064878	.0039941	-1.62	0.105	-.0143227	.001347
NatEmpl	-2.475518	1.586617	-1.56	0.119	-5.587833	.6367965
Crude	.0533721	.0575419	0.93	0.354	-.0595023	.1662464
SP	-.0053356	.007074	-0.75	0.451	-.0192121	.0085408
VIX	-.0902156	.103852	-0.87	0.385	-.2939321	.1135009
Q2	2.439397	1.27079	1.92	0.055	-.0533907	4.932184
Q3	3.580928	1.347045	2.66	0.008	.9385583	6.223298
Q4	.8782669	1.511184	0.58	0.561	-2.086078	3.842612
Y08	-6.92897	5.773384	-1.20	0.230	-18.25407	4.396128
Y09	1.665625	6.475694	0.26	0.797	-11.03713	14.36838
Y10	3.784372	6.135023	0.62	0.537	-8.250119	15.81886
Y11	2.020633	5.304496	0.38	0.703	-8.384692	12.42596
Y12	1.005994	4.377775	0.23	0.818	-7.581469	9.593458
Y13	-.657241	3.191767	-0.21	0.837	-6.918227	5.603745
Y15	2.437097	3.667422	0.66	0.506	-4.756936	9.631129
Y16	-1.102495	4.215494	-0.26	0.794	-9.371628	7.166638
Y17	-6.320153	5.447117	-1.16	0.246	-17.00524	4.364938
Y18	1.003774	6.402144	0.16	0.875	-11.5547	13.56225
_cons	19.95487	19.12504	1.04	0.297	-17.56089	57.47063

-> State = IN

Source	SS	df	MS			
Model	415815.374	21	19800.7321	Number of obs	=	4,729
Residual	2896710.15	4,707	615.404748	F(21, 4707)	=	32.18
				Prob > F	=	0.0000
				R-squared	=	0.1255
				Adj R-squared	=	0.1216
Total	3312525.52	4,728	700.618765	Root MSE	=	24.807

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	-.0390265	.0801666	-0.49	0.626	-.1961906	.1181375
Bidders	-2.242446	.1790041	-12.53	0.000	-2.593378	-1.891514
WBsize	-.1723133	.0632966	-2.72	0.007	-.2964044	-.0482223
Duration	.0069947	.0021668	3.23	0.001	.0027468	.0112427
NatEmpl	-2.947681	1.107714	-2.66	0.008	-5.119319	-.776043
Crude	-.0300392	.048343	-0.62	0.534	-.1248142	.0647357
SP	-.0067884	.0057469	-1.18	0.238	-.018055	.0044782
VIX	.3251189	.0821828	3.96	0.000	.1640021	.4862356
Q2	1.660143	1.053734	1.58	0.115	-.4056689	3.725954
Q3	4.424883	1.055196	4.19	0.000	2.356206	6.49356
Q4	1.66025	1.14578	1.45	0.147	-.5860147	3.906515
Y08	-24.78529	4.567735	-5.43	0.000	-33.74019	-15.83039
Y09	-29.07058	4.918702	-5.91	0.000	-38.71353	-19.42762
Y10	-15.1344	4.665989	-3.24	0.001	-24.28192	-5.986872
Y11	-7.779613	4.111044	-1.89	0.059	-15.83918	.2799586
Y12	-5.837987	3.495278	-1.67	0.095	-12.69037	1.014394
Y13	-4.733369	2.435961	-1.94	0.052	-9.508992	.0422542
Y15	-5.998343	2.919001	-2.05	0.040	-11.72095	-.2757342
Y16	-14.16031	3.323533	-4.26	0.000	-20.67599	-7.644626
Y17	-11.89644	4.28719	-2.77	0.006	-20.30133	-3.491537
Y18	-10.33335	5.146369	-2.01	0.045	-20.42264	-.2440599
_cons	31.40444	14.26678	2.20	0.028	3.434879	59.374

-> State = LA

Source	SS	df	MS			
				Number of obs	=	3,846
				F(21, 3824)	=	23.00
Model	305163.941	21	14531.6162	Prob > F	=	0.0000
Residual	2415847.77	3,824	631.759354	R-squared	=	0.1122
				Adj R-squared	=	0.1073
Total	2721011.71	3,845	707.675347	Root MSE	=	25.135

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.3960329	.0976868	4.05	0.000	.2045098	.5875561
Bidders	-3.800213	.2173993	-17.48	0.000	-4.226443	-3.373983
WBsize	.0384347	.0554712	0.69	0.488	-.0703212	.1471906
Duration	.0037535	.0034661	1.08	0.279	-.0030422	.0105491
NatEmpl	-2.200859	1.168382	-1.88	0.060	-4.491571	.0898536
Crude	-.0275591	.0474326	-0.58	0.561	-.1205548	.0654367
SP	.0121895	.0062412	1.95	0.051	-.0000469	.0244258
VIX	-.1178255	.0879484	-1.34	0.180	-.2902558	.0546049
Q2	1.425257	1.117463	1.28	0.202	-.7656226	3.616137
Q3	1.696412	1.241966	1.37	0.172	-.7385676	4.131392
Q4	.660948	1.351587	0.49	0.625	-1.988952	3.310848
Y08	4.212336	5.059424	0.83	0.405	-5.707093	14.13176
Y09	6.481827	5.214956	1.24	0.214	-3.742536	16.70619
Y10	7.036851	4.939189	1.42	0.154	-2.646847	16.72055
Y11	9.600261	4.393033	2.19	0.029	.987348	18.21317
Y12	8.171308	3.724175	2.19	0.028	.8697478	15.47287
Y13	2.122568	2.677373	0.79	0.428	-3.126647	7.371784
Y15	-4.949337	3.215562	-1.54	0.124	-11.25372	1.355046
Y16	-11.28184	3.669835	-3.07	0.002	-18.47686	-4.086819
Y17	-18.50647	4.879037	-3.79	0.000	-28.07223	-8.940704
Y18	-23.34497	5.831896	-4.00	0.000	-34.77889	-11.91105
_cons	.5371609	15.588	0.03	0.973	-30.02443	31.09876

-> State = MA

Source	SS	df	MS			
				Number of obs	=	2,338
				F(21, 2316)	=	21.28
Model	185775.056	21	8846.43124	Prob > F	=	0.0000
Residual	962843.106	2,316	415.735365	R-squared	=	0.1617
				Adj R-squared	=	0.1541
Total	1148618.16	2,337	491.492581	Root MSE	=	20.39

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.169333	.1655976	1.02	0.307	-.1554021	.494068
Bidders	-1.185615	.1472469	-8.05	0.000	-1.474364	-.8968651
WBsize	.1390329	.0344233	4.04	0.000	.0715293	.2065366
Duration	-.0085692	.0018487	-4.64	0.000	-.0121944	-.0049439
NatEmpl	-3.137866	1.238006	-2.53	0.011	-5.565582	-.7101493
Crude	.0573193	.0485254	1.18	0.238	-.0378384	.152477
SP	-.0080703	.0065093	-1.24	0.215	-.020835	.0046944
VIX	-.1144212	.088966	-1.29	0.199	-.2888825	.0600401
Q2	-2.280645	1.237075	-1.84	0.065	-4.706535	.1452446
Q3	.6292113	1.250263	0.50	0.615	-1.82254	3.080963
Q4	-.0014266	1.363472	-0.00	0.999	-2.67518	2.672327
Y08	-6.317659	5.224996	-1.21	0.227	-16.56382	3.9285
Y09	-2.861123	5.327262	-0.54	0.591	-13.30782	7.585578
Y10	-14.98666	5.076807	-2.95	0.003	-24.94222	-5.031094
Y11	-6.844586	4.554675	-1.50	0.133	-15.77625	2.087079
Y12	-6.981758	3.850572	-1.81	0.070	-14.53269	.569171
Y13	-2.906856	2.829769	-1.03	0.304	-8.456002	2.64229
Y15	5.718987	3.217779	1.78	0.076	-.591041	12.02902
Y16	-1.19409	3.780883	-0.32	0.752	-8.608359	6.22018
Y17	-5.551969	4.787619	-1.16	0.246	-14.94044	3.836498
Y18	-4.321044	5.863395	-0.74	0.461	-15.8191	7.177008
_cons	38.04253	16.73109	2.27	0.023	5.233042	70.85201

-> State = MI

Source	SS	df	MS			
Model	320643.421	21	15268.7344	Number of obs	=	8,692
Residual	3214575.68	8,670	370.769975	F(21, 8670)	=	41.18
				Prob > F	=	0.0000
				R-squared	=	0.0907
				Adj R-squared	=	0.0885
Total	3535219.1	8,691	406.767818	Root MSE	=	19.255

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.0937912	.0746684	1.26	0.209	-.0525767	.2401591
Bidders	-1.128013	.0728249	-15.49	0.000	-1.270767	-.9852591
WBsize	.2606118	.0526155	4.95	0.000	.157473	.3637506
Duration	.0013718	.0012077	1.14	0.256	-.0009956	.0037391
NatEmpl	-1.588604	.7273067	-2.18	0.029	-3.014298	-.1629101
Crude	.0365369	.0280597	1.30	0.193	-.0184668	.0915407
SP	-.00871	.0034641	-2.51	0.012	-.0155004	-.0019195
VIX	-.0468882	.0515906	-0.91	0.363	-.1480182	.0542417
Q2	-.9500139	.568673	-1.67	0.095	-2.064748	.1647202
Q3	3.035308	.6020677	5.04	0.000	1.855112	4.215504
Q4	2.238782	.7552756	2.96	0.003	.7582626	3.719302
Y08	-13.19951	2.7624	-4.78	0.000	-18.61447	-7.784553
Y09	-14.52584	3.060899	-4.75	0.000	-20.52593	-8.525755
Y10	-12.48084	2.885694	-4.33	0.000	-18.13749	-6.824192
Y11	-7.652319	2.495227	-3.07	0.002	-12.54356	-2.761082
Y12	-6.53352	2.039982	-3.20	0.001	-10.53237	-2.534671
Y13	-6.099907	1.397364	-4.37	0.000	-8.839073	-3.360741
Y15	-.257055	1.778182	-0.14	0.885	-3.742714	3.228604
Y16	-5.548726	2.045271	-2.71	0.007	-9.557944	-1.539508
Y17	-5.991545	2.664393	-2.25	0.025	-11.21439	-.7687017
Y18	2.87953	3.165942	0.91	0.363	-3.326468	9.085528
_cons	26.56976	9.016925	2.95	0.003	8.89444	44.24507

-> State = MN
note: Y10 omitted because of collinearity
note: Y11 omitted because of collinearity

Source	SS	df	MS
Model	84022.4195	19	4422.23261
Residual	512701.572	1,448	354.075672
Total	596723.992	1,467	406.764821

Number of obs	=	1,468
F(19, 1448)	=	12.49
Prob > F	=	0.0000
R-squared	=	0.1408
Adj R-squared	=	0.1295
Root MSE	=	18.817

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.3560385	.1424575	2.50	0.013	.0765935	.6354836
Bidders	-3.273902	.2814746	-11.63	0.000	-3.826044	-2.721761
WBsize	.0182999	.0377146	0.49	0.628	-.0556813	.092281
Duration	-.0010193	.0038142	-0.27	0.789	-.0085013	.0064626
NatEmpl	4.424286	1.606824	2.75	0.006	1.272335	7.576237
Crude	.0978164	.0712527	1.37	0.170	-.0419532	.2375859
SP	.0201758	.0087485	2.31	0.021	.0030147	.037337
VIX	.3114438	.1399652	2.23	0.026	.0368875	.5860001
Q2	2.371595	1.262508	1.88	0.061	-.1049455	4.848135
Q3	3.574559	1.873753	1.91	0.057	-.1010024	7.250119
Q4	4.688357	1.943974	2.41	0.016	.8750513	8.501663
Y08	7.698119	6.648905	1.16	0.247	-5.344396	20.74063
Y09	-1.173046	7.161904	-0.16	0.870	-15.22186	12.87577
Y10	0	(omitted)				
Y11	0	(omitted)				
Y12	1.957254	4.566233	0.43	0.668	-6.999886	10.91439
Y13	-1.209522	2.993306	-0.40	0.686	-7.081203	4.662158
Y15	-8.155629	7.422882	-1.10	0.272	-22.71638	6.405123
Y16	2.425899	5.436051	0.45	0.655	-8.237479	13.08928
Y17	-1.743885	6.702033	-0.26	0.795	-14.89062	11.40285
Y18	-.3554626	7.763324	-0.05	0.963	-15.58403	14.8731
_cons	-73.75101	21.58402	-3.42	0.001	-116.0903	-31.41172

-> State = MO

Source	SS	df	MS			
				Number of obs	=	4,584
				F(21, 4562)	=	25.39
Model	896597.856	21	42695.136	Prob > F	=	0.0000
Residual	7670305.43	4,562	1681.34709	R-squared	=	0.1047
				Adj R-squared	=	0.1005
Total	8566903.29	4,583	1869.27848	Root MSE	=	41.004

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	-.4182626	.1304116	-3.21	0.001	-.6739325	-.1625927
Bidders	-4.034218	.2851425	-14.15	0.000	-4.593236	-3.475201
WBsize	.9591422	.1179585	8.13	0.000	.7278864	1.190398
Duration	.0050761	.0052815	0.96	0.337	-.0052783	.0154304
NatEmpl	-3.009279	1.714457	-1.76	0.079	-6.370445	.3518861
Crude	.3827996	.0833169	4.59	0.000	.2194582	.5461411
SP	-.0199966	.0095729	-2.09	0.037	-.0387642	-.001229
VIX	.3637947	.1343497	2.71	0.007	.1004042	.6271853
Q2	-10.72081	1.628182	-6.58	0.000	-13.91284	-7.528786
Q3	-1.144775	2.150234	-0.53	0.594	-5.360274	3.070723
Q4	5.804176	1.868084	3.11	0.002	2.141828	9.466524
Y08	-42.76162	7.368799	-5.80	0.000	-57.20803	-28.3152
Y09	-20.73928	7.746516	-2.68	0.007	-35.92621	-5.552361
Y10	-11.9355	7.562819	-1.58	0.115	-26.76229	2.891284
Y11	-15.36608	6.580402	-2.34	0.020	-28.26686	-2.465309
Y12	-6.927152	5.700839	-1.22	0.224	-18.10356	4.249251
Y13	-7.373601	4.013124	-1.84	0.066	-15.24127	.4940649
Y15	1.580753	5.412563	0.29	0.770	-9.030492	12.192
Y16	-2.647194	6.083812	-0.44	0.663	-14.57441	9.280023
Y17	12.38339	7.832303	1.58	0.114	-2.971718	27.73849
Y18	10.79753	9.02616	1.20	0.232	-6.898116	28.49317
_cons	65.77538	22.67706	2.90	0.004	21.31735	110.2334

-> State = MS

Source	SS	df	MS			
				Number of obs	=	1,360
				F(21, 1338)	=	13.33
Model	99205.4649	21	4724.06976	Prob > F	=	0.0000
Residual	474200.503	1,338	354.409942	R-squared	=	0.1730
				Adj R-squared	=	0.1600
Total	573405.967	1,359	421.932279	Root MSE	=	18.826

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.1944915	.2175694	0.89	0.372	-.2323228	.6213058
Bidders	-3.354211	.2717653	-12.34	0.000	-3.887344	-2.821079
WBsize	.2533049	.0757833	3.34	0.001	.1046378	.401972
Duration	.0004544	.0037279	0.12	0.903	-.0068588	.0077676
NatEmpl	-.6250608	1.833252	-0.34	0.733	-4.221421	2.9713
Crude	.097909	.0787417	1.24	0.214	-.0565616	.2523796
SP	-.0070344	.0089309	-0.79	0.431	-.0245544	.0104856
VIX	.1440842	.1264534	1.14	0.255	-.1039844	.3921528
Q2	.9713015	1.407073	0.69	0.490	-1.789007	3.73161
Q3	-.0664695	1.540524	-0.04	0.966	-3.088574	2.955635
Q4	4.282484	1.974853	2.17	0.030	.4083392	8.156628
Y08	-11.72561	6.914448	-1.70	0.090	-25.28995	1.838731
Y09	-18.4121	8.305707	-2.22	0.027	-34.70573	-2.118479
Y10	-12.48163	7.577707	-1.65	0.100	-27.34711	2.383847
Y11	-5.026886	6.26442	-0.80	0.422	-17.31604	7.262269
Y12	-5.945446	5.185937	-1.15	0.252	-16.1189	4.228007
Y13	-5.918278	3.71526	-1.59	0.111	-13.20665	1.370091
Y15	1.163704	4.764114	0.24	0.807	-8.182243	10.50965
Y16	.0391353	5.430308	0.01	0.994	-10.61371	10.69198
Y17	-3.482436	7.082026	-0.49	0.623	-17.37552	10.41065
Y18	1.584255	8.461467	0.19	0.852	-15.01493	18.18344
_cons	13.23854	21.9429	0.60	0.546	-29.80769	56.28478

```
-> State = NC
note: Y09 omitted because of collinearity
note: Y10 omitted because of collinearity
note: Y11 omitted because of collinearity
note: Y12 omitted because of collinearity
note: Y13 omitted because of collinearity
note: Y15 omitted because of collinearity
note: Y16 omitted because of collinearity
note: Y17 omitted because of collinearity
note: Y18 omitted because of collinearity
```

Source	SS	df	MS
Model	25342.6025	12	2111.88354
Residual	87896.7592	500	175.793518
Total	113239.362	512	221.170628

Number of obs	=	513
F(12, 500)	=	12.01
Prob > F	=	0.0000
R-squared	=	0.2238
Adj R-squared	=	0.2052
Root MSE	=	13.259

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	1.71072	.2275799	7.52	0.000	1.263589	2.15785
Bidders	-.9125936	.2829106	-3.23	0.001	-1.468434	-.3567535
WBsize	-.0495459	.0306035	-1.62	0.106	-.1096733	.0105814
Duration	-.0046897	.0029693	-1.58	0.115	-.0105234	.0011441
NatEmpl	5.66944	2.514976	2.25	0.025	.7282173	10.61066
Crude	.2022567	.0762011	2.65	0.008	.0525429	.3519706
SP	.0128893	.009558	1.35	0.178	-.0058896	.0316681
VIX	-.1259753	.1611945	-0.78	0.435	-.4426774	.1907268
Q2	-3.082265	2.322861	-1.33	0.185	-7.646036	1.481506
Q3	-6.197824	2.517174	-2.46	0.014	-11.14337	-1.252282
Q4	-2.400973	1.92886	-1.24	0.214	-6.190642	1.388696
Y08	-1.212742	12.79589	-0.09	0.925	-26.35308	23.9276
Y09	0	(omitted)				
Y10	0	(omitted)				
Y11	0	(omitted)				
Y12	0	(omitted)				
Y13	0	(omitted)				
Y15	0	(omitted)				
Y16	0	(omitted)				
Y17	0	(omitted)				
Y18	0	(omitted)				
_cons	-72.73911	33.61074	-2.16	0.031	-138.7748	-6.703422

-> State = NH
note: DBE omitted because of collinearity

Source	SS	df	MS			
				Number of obs	=	644
				F(20, 623)	=	8.37
Model	71780.16	20	3589.008	Prob > F	=	0.0000
Residual	267077.762	623	428.696247	R-squared	=	0.2118
				Adj R-squared	=	0.1865
Total	338857.922	643	526.995213	Root MSE	=	20.705

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	0	(omitted)				
Bidders	-1.597961	.393359	-4.06	0.000	-2.370431	-.8254904
WBsize	.0251218	.1586787	0.16	0.874	-.2864881	.3367317
Duration	.0056268	.0049161	1.14	0.253	-.0040274	.015281
NatEmpl	-3.298933	3.277772	-1.01	0.315	-9.735754	3.137888
Crude	.0952436	.1079987	0.88	0.378	-.116842	.3073291
SP	-.0096429	.0139514	-0.69	0.490	-.0370403	.0177546
VIX	.185234	.1884855	0.98	0.326	-.1849098	.5553778
Q2	-5.36807	2.580958	-2.08	0.038	-10.4365	-.2996383
Q3	1.541757	2.781274	0.55	0.580	-3.920051	7.003564
Q4	-1.350101	2.813168	-0.48	0.631	-6.874541	4.174339
Y08	-10.61187	11.24641	-0.94	0.346	-32.69734	11.4736
Y09	-6.986102	12.58291	-0.56	0.579	-31.69615	17.72395
Y10	-2.628125	12.07464	-0.22	0.828	-26.34005	21.0838
Y11	-6.233672	10.38721	-0.60	0.549	-26.63185	14.16451
Y12	-4.678456	8.066034	-0.58	0.562	-20.51836	11.16145
Y13	-2.710111	5.760506	-0.47	0.638	-14.02247	8.602251
Y15	6.197581	7.448759	0.83	0.406	-8.430136	20.8253
Y16	-31.26162	8.440404	-3.70	0.000	-47.83671	-14.68653
Y17	8.667162	11.46768	0.76	0.450	-13.85282	31.18715
Y18	7.012431	12.61123	0.56	0.578	-17.75323	31.77809
_cons	27.40516	38.33171	0.71	0.475	-47.86985	102.6802

-> State = OH

Source	SS	df	MS			
				Number of obs	=	8,131
				F(21, 8109)	=	77.85
Model	452994.208	21	21571.1528	Prob > F	=	0.0000
Residual	2247009.15	8,109	277.100648	R-squared	=	0.1678
				Adj R-squared	=	0.1656
Total	2700003.36	8,130	332.103734	Root MSE	=	16.646

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.5425525	.0557603	9.73	0.000	.433248	.651857
Bidders	-2.530182	.0807039	-31.35	0.000	-2.688382	-2.371982
WBsize	.0036726	.0256558	0.14	0.886	-.0466192	.0539645
Duration	-.0007552	.0012911	-0.58	0.559	-.0032861	.0017756
NatEmpl	-.3885584	.6452542	-0.60	0.547	-1.653422	.8763055
Crude	.082891	.024867	3.33	0.001	.0341454	.1316366
SP	-.0114551	.0030649	-3.74	0.000	-.0174631	-.0054471
VIX	-.0368136	.0445722	-0.83	0.409	-.1241866	.0505594
Q2	1.925371	.4820193	3.99	0.000	.9804898	2.870253
Q3	4.157926	.5802399	7.17	0.000	3.020507	5.295345
Q4	3.045181	.6348722	4.80	0.000	1.800669	4.289693
Y08	-15.3152	2.387129	-6.42	0.000	-19.99459	-10.63582
Y09	-15.2298	2.713508	-5.61	0.000	-20.54897	-9.910628
Y10	-12.45068	2.559646	-4.86	0.000	-17.46824	-7.433115
Y11	-5.208668	2.173108	-2.40	0.017	-9.468518	-.9488184
Y12	-4.417839	1.788469	-2.47	0.014	-7.923698	-.9119805
Y13	-3.946369	1.263472	-3.12	0.002	-6.423099	-1.469639
Y15	2.752643	1.597132	1.72	0.085	-.3781461	5.883431
Y16	5.21502	1.818929	2.87	0.004	1.649452	8.780587
Y17	8.104311	2.351776	3.45	0.001	3.494227	12.7144
Y18	11.43058	2.844254	4.02	0.000	5.855114	17.00605
_cons	19.01477	7.924537	2.40	0.016	3.480646	34.5489

-> State = OR

Source	SS	df	MS			
				Number of obs	=	1,184
				F(21, 1162)	=	16.56
Model	170851.399	21	8135.78088	Prob > F	=	0.0000
Residual	570940.714	1,162	491.343127	R-squared	=	0.2303
				Adj R-squared	=	0.2164
Total	741792.112	1,183	627.043206	Root MSE	=	22.166

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.3175478	.3275307	0.97	0.332	-.32507	.9601655
Bidders	-1.142059	.237671	-4.81	0.000	-1.608371	-.6757465
WBsize	-.1946064	.1548457	-1.26	0.209	-.4984148	.1092021
Duration	-.0012096	.0033858	-0.36	0.721	-.0078525	.0054333
NatEmpl	-2.925522	2.21656	-1.32	0.187	-7.27443	1.423385
Crude	.0275034	.0930604	0.30	0.768	-.1550818	.2100885
SP	-.0041154	.0114953	-0.36	0.720	-.0266691	.0184384
VIX	-.2198361	.1596365	-1.38	0.169	-.533044	.0933719
Q2	-1.792841	1.791481	-1.00	0.317	-5.30774	1.722059
Q3	3.581943	2.180343	1.64	0.101	-.6959064	7.859793
Q4	.8939109	2.091638	0.43	0.669	-3.209898	4.99772
Y08	-7.359102	8.955084	-0.82	0.411	-24.92904	10.21084
Y09	-9.498929	9.62007	-0.99	0.324	-28.37358	9.375722
Y10	-9.247726	8.979976	-1.03	0.303	-26.86651	8.371055
Y11	-5.606019	7.826967	-0.72	0.474	-20.96259	9.750551
Y12	1.006497	6.511742	0.15	0.877	-11.76959	13.78258
Y13	2.455218	4.490955	0.55	0.585	-6.356069	11.2665
Y15	2.373085	5.573892	0.43	0.670	-8.562934	13.3091
Y16	1.744518	6.3239	0.28	0.783	-10.66302	14.15206
Y17	10.8156	8.736894	1.24	0.216	-6.326252	27.95745
Y18	3.088038	9.8987	0.31	0.755	-16.33329	22.50936
_cons	26.24041	28.89533	0.91	0.364	-30.45245	82.93327

-> State = RI
note: Y08 omitted because of collinearity

Source	SS	df	MS			
				Number of obs	=	453
				F(20, 432)	=	3.40
Model	36937.1098	20	1846.85549	Prob > F	=	0.0000
Residual	234407.322	432	542.609541	R-squared	=	0.1361
				Adj R-squared	=	0.0961
Total	271344.432	452	600.319539	Root MSE	=	23.294

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.6084753	.1737156	3.50	0.001	.2670424	.9499081
Bidders	-1.711152	.5560953	-3.08	0.002	-2.804141	-.6181633
WBsize	-.1939445	.2072789	-0.94	0.350	-.6013451	.2134561
Duration	.0020313	.0044933	0.45	0.651	-.0068002	.0108628
NatEmpl	7.391992	8.01461	0.92	0.357	-8.360489	23.14447
Crude	-.2033456	.1877712	-1.08	0.279	-.5724043	.1657131
SP	.0359497	.0219357	1.64	0.102	-.0071642	.0790636
VIX	.6797003	.3191801	2.13	0.034	.0523612	1.307039
Q2	-1.495134	4.100735	-0.36	0.716	-9.555008	6.564739
Q3	-1.46081	4.558417	-0.32	0.749	-10.42024	7.498624
Q4	-.5824024	6.094838	-0.10	0.924	-12.56163	11.39682
Y08	0	(omitted)				
Y09	-34.42698	32.30143	-1.07	0.287	-97.91448	29.06052
Y10	-20.87275	30.56853	-0.68	0.495	-80.9543	39.2088
Y11	-11.78438	24.83895	-0.47	0.635	-60.6046	37.03584
Y12	-5.261752	17.94452	-0.29	0.769	-40.53118	30.00768
Y13	-3.625121	11.41029	-0.32	0.751	-26.05171	18.80147
Y15	-9.267061	10.54213	-0.88	0.380	-29.9873	11.45318
Y16	-15.12991	12.4178	-1.22	0.224	-39.53672	9.276898
Y17	-23.0387	18.37642	-1.25	0.211	-59.15701	13.0796
Y18	-26.38291	24.11572	-1.09	0.275	-73.78165	21.01583
_cons	-106.1106	67.896	-1.56	0.119	-239.5582	27.33698

-> State = TX

Source	SS	df	MS
Model	748387.887	21	35637.5184
Residual	2753744.67	8,557	321.811928
Total	3502132.56	8,578	408.269125

Number of obs	=	8,579
F(21, 8557)	=	110.74
Prob > F	=	0.0000
R-squared	=	0.2137
Adj R-squared	=	0.2118
Root MSE	=	17.939

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.6555169	.0886332	7.40	0.000	.4817744	.8292594
Bidders	-1.882197	.0821674	-22.91	0.000	-2.043265	-1.721129
WBsize	-.0224355	.0191109	-1.17	0.240	-.0598974	.0150264
Duration	.0071969	.0018638	3.86	0.000	.0035434	.0108503
NatEmpl	3.517001	.6822408	5.16	0.000	2.179644	4.854357
Crude	.0807348	.0265969	3.04	0.002	.0285985	.132871
SP	-.003145	.0031289	-1.01	0.315	-.0092783	.0029883
VIX	-.2714523	.0456311	-5.95	0.000	-.3609004	-.1820043
Q2	2.512794	.5628655	4.46	0.000	1.409442	3.616146
Q3	4.308511	.5606052	7.69	0.000	3.20959	5.407433
Q4	4.100551	.667976	6.14	0.000	2.791157	5.409945
Y08	-.4630961	2.507452	-0.18	0.853	-5.378308	4.452116
Y09	-25.93274	2.911296	-8.91	0.000	-31.63958	-20.2259
Y10	-14.59203	2.762885	-5.28	0.000	-20.00795	-9.176105
Y11	-9.583577	2.369769	-4.04	0.000	-14.2289	-4.938258
Y12	-4.75205	1.931328	-2.46	0.014	-8.537919	-.9661806
Y13	-5.57583	1.359175	-4.10	0.000	-8.240141	-2.91152
Y15	8.582872	1.610133	5.33	0.000	5.426624	11.73912
Y16	6.686717	1.882444	3.55	0.000	2.996673	10.37676
Y17	6.521223	2.41393	2.70	0.007	1.789338	11.25311
Y18	12.51014	2.902467	4.31	0.000	6.820601	18.19967
_cons	-19.64261	8.151925	-2.41	0.016	-35.62235	-3.662868

-> State = UID

Source	SS	df	MS
Model	315067.66	21	15003.2219
Residual	3116811.37	7,914	393.83515
Total	3431879.03	7,935	432.498933

Number of obs	=	7,936
F(21, 7914)	=	38.10
Prob > F	=	0.0000
R-squared	=	0.0918
Adj R-squared	=	0.0894
Root MSE	=	19.845

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.8401691	.0988118	8.50	0.000	.6464718	1.033866
Bidders	-1.825485	.0937077	-19.48	0.000	-2.009177	-1.641793
WBsize	.0093689	.0529769	0.18	0.860	-.0944797	.1132176
Duration	.0029139	.0009165	3.18	0.001	.0011173	.0047105
NatEmpl	.8441529	.7260067	1.16	0.245	-.5790117	2.267318
Crude	.0105658	.0297911	0.35	0.723	-.0478327	.0689643
SP	-.0022899	.0039261	-0.58	0.560	-.0099861	.0054063
VIX	-.0201498	.0511253	-0.39	0.693	-.1203689	.0800693
Q2	-1.078177	.5918723	-1.82	0.069	-2.238403	.082049
Q3	1.568441	.6958821	2.25	0.024	.204329	2.932554
Q4	1.798317	.8058606	2.23	0.026	.2186176	3.378016
Y08	-8.295895	2.942959	-2.82	0.005	-14.06487	-2.52692
Y09	-13.67194	3.187812	-4.29	0.000	-19.9209	-7.422992
Y10	-9.094018	3.005337	-3.03	0.002	-14.98527	-3.202764
Y11	-4.84735	2.628002	-1.84	0.065	-9.998928	.304227
Y12	-6.365878	2.199646	-2.89	0.004	-10.67776	-2.053993
Y13	-7.763621	1.601965	-4.85	0.000	-10.9039	-4.623347
Y15	6.429624	1.980426	3.25	0.001	2.547468	10.31178
Y16	1.280152	2.240298	0.57	0.568	-3.111423	5.671727
Y17	.9639595	2.977061	0.32	0.746	-4.871865	6.799784
Y18	4.186775	3.72188	1.12	0.261	-3.109092	11.48264
_cons	.735295	9.779134	0.08	0.940	-18.43439	19.90498

```
-> State = UT
note: Y08 omitted because of collinearity
note: Y11 omitted because of collinearity
note: Y12 omitted because of collinearity
note: Y13 omitted because of collinearity
note: Y15 omitted because of collinearity
note: Y16 omitted because of collinearity
note: Y17 omitted because of collinearity
note: Y18 omitted because of collinearity
```

Source	SS	df	MS			
				Number of obs	=	404
				F(13, 390)	=	5.49
Model	46126.3999	13	3548.18461	Prob > F	=	0.0000
Residual	251829.585	390	645.716886	R-squared	=	0.1548
				Adj R-squared	=	0.1266
Total	297955.985	403	739.344877	Root MSE	=	25.411

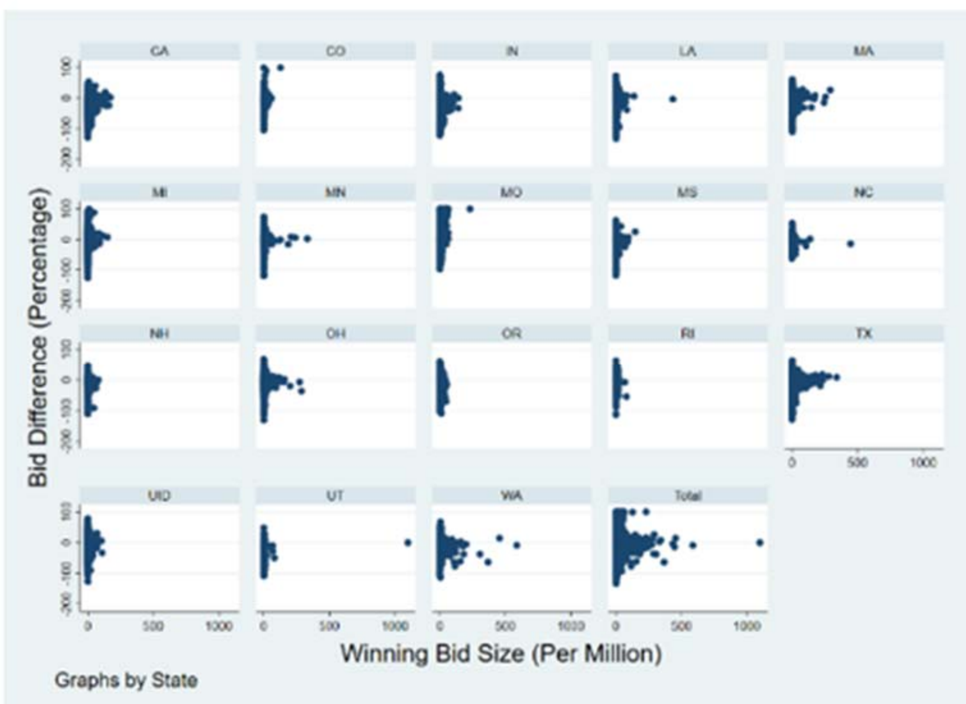
BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	-1.372353	.5455303	-2.52	0.012	-2.444901	-.2998048
Bidders	-3.604562	.5551933	-6.49	0.000	-4.696108	-2.513016
WBsize	-.004855	.0290931	-0.17	0.868	-.062054	.0523439
Duration	.0201419	.0147586	1.36	0.173	-.0088744	.0491581
NatEmpl	-.3503907	3.633057	-0.10	0.923	-7.493219	6.792437
Crude	.0102387	.1846723	0.06	0.956	-.3528391	.3733164
SP	-.0088092	.0230593	-0.38	0.703	-.0541453	.0365268
VIX	-.3477238	.2876337	-1.21	0.227	-.9132304	.2177828
Q2	.8863491	3.959991	0.22	0.823	-6.899252	8.67195
Q3	4.105196	4.59097	0.89	0.372	-4.920951	13.13134
Q4	5.685822	5.376749	1.06	0.291	-4.885217	16.25686
Y08	0	(omitted)				
Y09	-6.096993	13.91301	-0.44	0.661	-33.45088	21.25689
Y10	-2.754466	14.59381	-0.19	0.850	-31.44686	25.93793
Y11	0	(omitted)				
Y12	0	(omitted)				
Y13	0	(omitted)				
Y15	0	(omitted)				
Y16	0	(omitted)				
Y17	0	(omitted)				
Y18	0	(omitted)				
_cons	15.82709	40.4444	0.39	0.696	-63.68924	95.34343

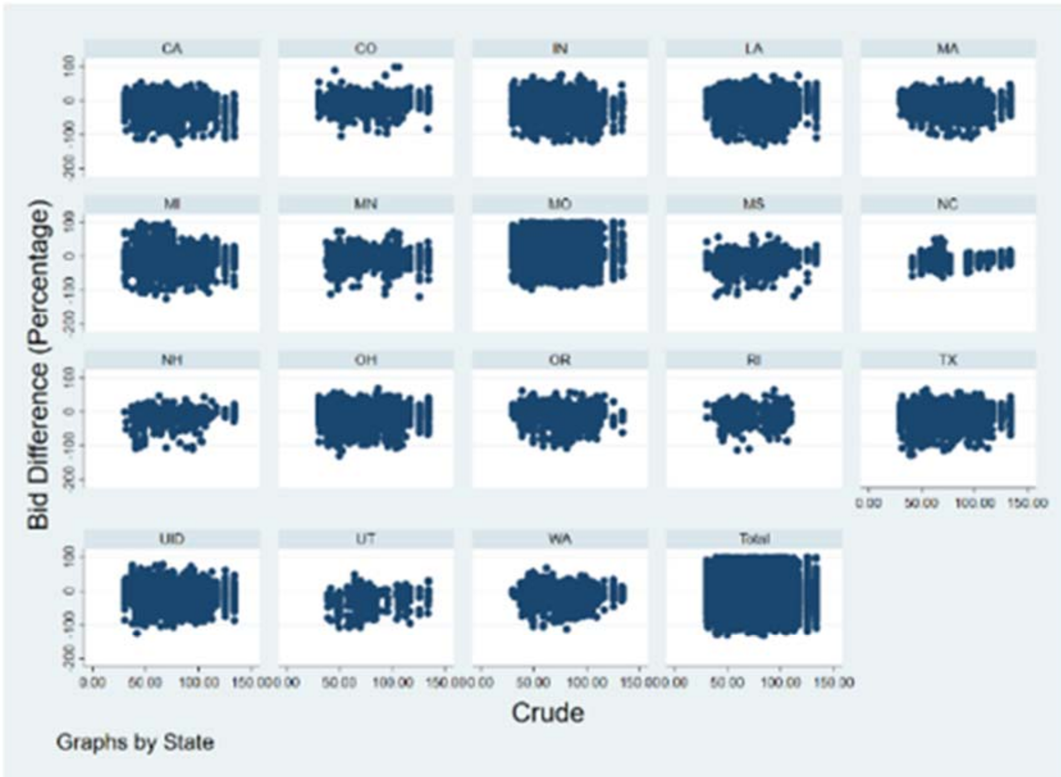
-> State = WA

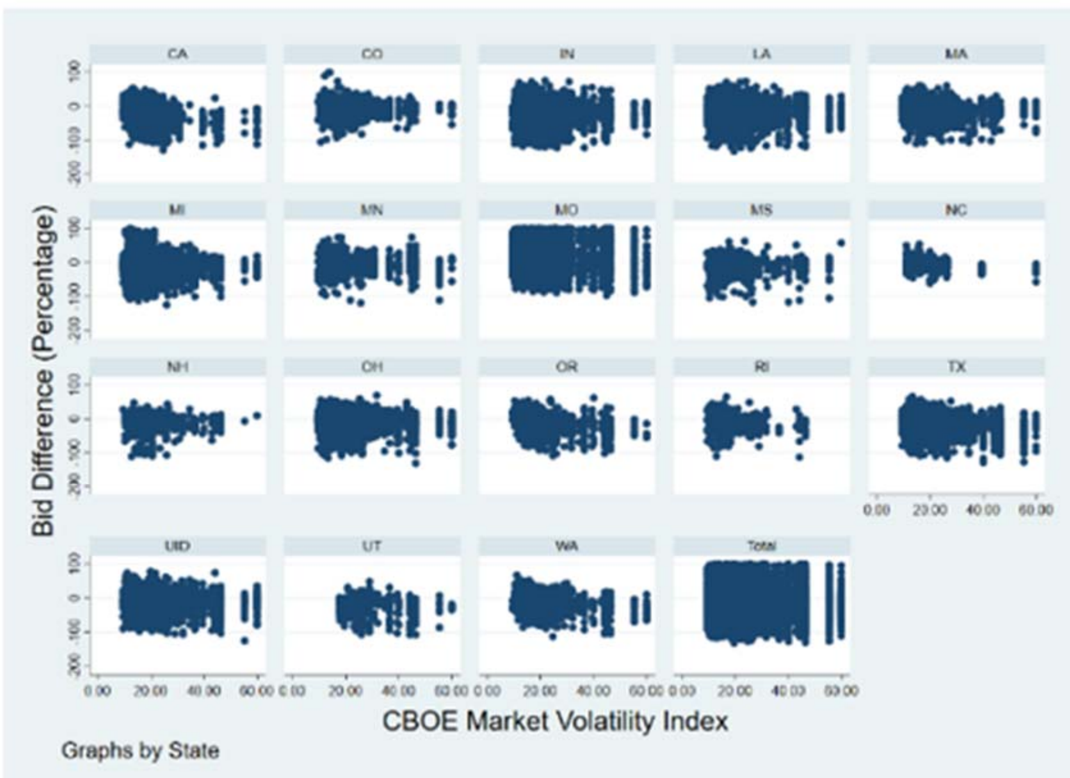
Source	SS	df	MS			
				Number of obs	=	1,534
				F(21, 1512)	=	31.37
Model	271144.977	21	12911.6656	Prob > F	=	0.0000
Residual	622245.767	1,512	411.538206	R-squared	=	0.3035
				Adj R-squared	=	0.2938
Total	893390.744	1,533	582.772827	Root MSE	=	20.286

BidDiff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DBE	.3481441	.0922073	3.78	0.000	.1672763	.5290118
Bidders	-2.68959	.2056452	-13.08	0.000	-3.09297	-2.28621
WBsize	-.036037	.0290694	-1.24	0.215	-.0930576	.0209835
Duration	.0010302	.0049125	0.21	0.834	-.008606	.0106663
NatEmpl	-5.556246	1.626238	-3.42	0.001	-8.746169	-2.366324
Crude	.1176137	.0678615	1.73	0.083	-.015499	.2507264
SP	-.0183988	.00863	-2.13	0.033	-.0353269	-.0014707
VIX	-.2852308	.1264206	-2.26	0.024	-.533209	-.0372525
Q2	1.907716	1.409785	1.35	0.176	-.8576246	4.673057
Q3	5.68597	1.694549	3.36	0.001	2.362053	9.009886
Q4	5.688815	1.824501	3.12	0.002	2.109994	9.267635
Y08	-22.68464	6.880298	-3.30	0.001	-36.18058	-9.188699
Y09	-10.88388	7.269645	-1.50	0.135	-25.14354	3.375772
Y10	-11.65457	6.881105	-1.69	0.091	-25.1521	1.842949
Y11	-3.258494	6.013014	-0.54	0.588	-15.05323	8.536239
Y12	-4.888292	5.190524	-0.94	0.346	-15.06968	5.293099
Y13	-6.057876	3.721405	-1.63	0.104	-13.35754	1.241787
Y15	1.571768	4.538888	0.35	0.729	-7.331415	10.47495
Y16	-1.656062	5.035034	-0.33	0.742	-11.53245	8.220329
Y17	7.683465	6.424729	1.20	0.232	-4.91886	20.28579
Y18	9.321467	7.67046	1.22	0.224	-5.724403	24.36734
_cons	65.90543	22.12807	2.98	0.003	22.50046	109.3104

APPENDIX F: TWO-WAY CHARTS FOR BID DIFFERENCE AND CONTINIOUS VARIABLES




CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Total
Bid Difference (Percentage)
Crude
Graphs by State


CA
CO
IN
LA
MA
MI
MN
MO
MS
NC
NH
OH
OR
RI
TX
UID
UT
WA
Total
Bid Difference (Percentage)
CBOE Market Volatility Index
Graphs by State

APPENDIX G: COST VECTOR CROSS TABLE

Sample Name	Bid Difference	Variable Average							
		DBE	Wbsize	Duration	NatEmpl	Crude	SP	VIX	Bidders
California	($1,560,209,033.60)	7.76	6.88	202.25	2.35	39.59	1180.71	7.97	5.87
Colorado	$16,606,927.48	4.82	3.17	129.17	3.14	47.26	927.83	10.72	4.78
Indiana	($1,664,839,721.00)	5.14	2.29	308.39	3.18	43.71	942.75	11.22	4.21
Louisiana	($667,158,312.60)	3.29	2.06	112.17	3.27	47.36	900.33	11.26	3.78
Massachusetts	($505,004,259.20)	1.49	3.77	584.32	3.13	46.76	928.43	11.14	5.28
Michigan	($395,825,857.20)	4.1	1.45	150.01	3.25	46.69	923.02	10.38	4.66
Minnesota	($95,239,920.44)	3.11	3.69	99.03	2.79	48.23	1006.33	11.24	3.8
Missouri	$4,725,187,200.00	6.08	2.74	312	3.16	45.1	951.73	11.72	4.1
Mississippi	($217,398,992.00)	2.25	4.15	220.34	3	43.16	978.11	10.83	3.43
North Carolina	($188,314,245.90)	4.05	4.31	197.57	1	50.34	1318.29	10.73	4.13
New Hampshire	($247,889,896.80)	0	3.48	294.49	3.26	46.96	909.15	11.62	3.79
Ohio	($732,388,360.29)	4.4	2.11	253.11	2.93	45.19	1009.28	9.71	4.07
Oregon	($485,390,390.40)	1.03	3.3	365.98	3.42	46.07	885.82	11.48	5.58
Rhode Island	($161,275,021.50)	7.82	2.85	366.36	2.95	44.2	1087.76	8.47	4.06
Texas	($1,911,264,793.90)	2.07	4.95	156.91	3.09	44.66	982.45	10.37	5.04
Unidentified State	($844,584,832.00)	2.35	2.24	351.17	3.34	46.33	871.89	11.67	4.88
Utah	($272,791,061.60)	2.57	5.31	84.57	4.82	47.54	341.91	20.83	4.53
Washington	($1,419,749,674.20)	5.01	5.72	99.78	3.13	45.24	941.93	11.13	4.31
The National Aggregate Sample	($6,627,529,394.40)	3.73	3.03	238.64	3.12	45.51	952.55	10.77	4.54

Sample Name	Net Explainable Difference (Millions)							
	DBE	Bidders	WBsize	Duration	NatEmpl	Crude	SP	VIX
California	$35.96	($199.00)	$18.78	($15.78)				
Colorado		($0.61)	$0.25					
Indiana		($119.82)	($6.56)	$35.94	($156.07)			$60.71
Louisiana	$8.69	($70.48)						
Massachusetts		($25.63)	$2.65	($26.56)	($49.60)			
Michigan		($16.34)	$1.50		($20.44)		($32.88)	
Minnesota	$1.05	($8.73)			$11.76		$19.17	$3.33
Missouri	($120.09)	($590.90)	$124.16			$816.20	($899.42)	$201.58
Mississippi		($17.72)	$2.28					
North Carolina	$13.05	($5.38)			$10.68	$19.15		
New Hampshire		($11.05)						
Ohio	$17.50	($56.89)				$27.47	($81.31)	
Oregon		($25.39)						
Rhode Island	$7.67	($8.44)						$9.29
Texas	$25.95	($145.32)		$20.99	$207.71	$69.14		($53.71)
Unidentified State	$16.67	($59.81)		$8.90				
Utah	($9.62)	($34.71)						
Washington	$24.75	($126.41)			($246.90)		($240.71)	($45.04)
The National Aggregate Sample	$79.19	($493.84)	$9.21	$37.88	($227.70)	$260.87	($420.31)	

Sample Name	Cost Vector ("Blank" cells are greater than p=0.05)							
	DBE	Bidders	Wbsize	Duration	NatEmpl	Crude	SP	VIX
California	2.305	-12.755	1.204	-1.011				
Colorado		-3.686	1.49					
Indiana		-7.197	-0.394	2.159	-9.375			3.647
Louisiana	1.303	-10.564						
Massachusetts		-5.076	0.524	-5.259	-9.822			
Michigan		-4.128	0.378		-5.164		-8.307	
Minnesota	1.107	-9.167			12.343		20.127	3.496
Missouri	-2.541	-12.505	2.628			17.273	-19.035	4.266
Mississippi		-8.15	1.05					
North Carolina	6.93	-2.858			5.669	10.169		
New Hampshire		-4.458						
Ohio	2.389	-7.767				3.751	-11.102	
Oregon		-5.23						
Rhode Island	4.755	-5.236						5.76
Texas	1.358	-7.603		1.098	10.868	3.617		-2.81
Unidentified State	1.974	-7.081		1.054				
Utah	-3.526	-12.726						
Washington	1.743	-8.904			-17.39		-16.955	-3.172
The National Aggregate Sample	1.195	-7.451	0.139	0.571	-3.436	3.936	-6.342	

REFERENCES

Adarand Constructors, Inc. v. Pena (United States Supreme Court, June 12, 1995).

Alroomi, A. (2012). Analysis of cost-estimating competencies using criticality matrix and factor analysis. Journal of Construction Engineering & Management, 138(11), 1270-1281. doi:10.1061/(ASCE)CO.1943-7862.0000351

Alemu, D. S. (2016). Dissertation Completion Guide: a Chapter-by-Chapter Nontechnical Guide for Graduate Research Projects. Proficient Professionals Group, LLC, 2016.

Association for the Advancement of Cost Engineering International (ACCE), Cost Estimate Classification System 17R-97, Recommended Practices, AACE International, 2019, web.aacei.org/resources/publications/recommended-practices.

Associated General Contractors of America, San Diego Chapter v. Kempton (United States Court of Appeals, Ninth Circuit. August 19, 2015).

Barreto, H., & Howland, F.M. (2013). *Introductory econometrics: using monte carlo simulation with Microsoft Excel*. Cambridge Univ. Press.

Berry, William D., and Stanley Feldman. Multiple Regression in Practice. Sage Publ., 2006.

Bohrnstedt, George W., and David Knoke. Statistics for Social Data Analysis. F.E. Peacock Publishers, 1982.

Buck, Steven. “Statistical Inference with Regression Analysis.” Introductory Applied Econometrics, 2015, are.berkeley.edu/courses/EEP118/current/handouts/Lecture13_ notes_EEP118_Sp15.pdf.

Bureau of Labor Statistics. (2018, January 19). Labor Force Statistics from the Current Population Survey. Retrieved from https://www.bls.gov/cps/cpsaat18.htm

Carr, R. (1989). Cost-estimating principles. Journal Of Construction Engineering And Management-Asce, 115(4), 545-551.

Chang, L. (1989). Method to Deal with DBE Issues. Journal of Professional Issues in Engineering, 115(3), 305-319. doi:10.1061/(ASCE)1052-3928(1989)115:3(305)

Chiang, I-Chant, and Paul Price. “Research Methods in Psychology.” Research Methods in Psychology , edited by Rajiv Jhangiani, Simple Book Publishing.

Chicago Board of Options Exchange (CBOE), VIX Price Charts, 2020, www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-price-charts.

Choi, Y. (2014). Chapter 23 - Estimating prices. In Principles of applied civil engineering design (pp. 279-294). Reston

Danforth, E., Weidman, J., & Farnsworth, C. (2017). Strategies employed and lessons learned by commercial construction companies during economic recession and recovery. Journal Of Construction Engineering And Management, 143(7). doi:10.1061/(ASCE)CO.1943-7862.0001310

Dawson, Graham. Economics and Economic Change. Prentice-Hall Financial Times, 2006.

Durkin, E. (2015, November 26). Activist Slams De Blasio's Choosing Controversial Company To Study Minority Contracting. Retrieved from https://www.nydailynews.com/news/politics/ activist-slams-de-blasio-choice-minority-contract-study-article-1.2447449

Dunnet Bay Construction Company v. Borggren (United States Court of Appeals, Seventh Circuit. August 19, 2015).

Exec. Order No. 12291, 3 C.F.R. (1981).

Exec. Order No. 12866, 3 C.F.R. (1993).

Exec. Order No. 13563, 3 C.F.R. (2011).

Fairlie, R., & Marion, J. (2012). Affirmative action programs and business ownership among minorities and women. Small Business Economics, 39(2), 319-339. doi: 10.1007/s11187-010-9305-4

Farrell, Chris. (2013) Why Not Target a 3% Unemployment Rate? Bloomberg, 2013, Retrieved from www.bloomberg.com/news/articles/2013-05-02 /why-not-target-a-3-percent-unemployment-rate.

FHWA. (2018). Bridge Condition by Functional Classification Count 2018. Retrieved from www.fhwa.dot.gov/bridge/nbi/no10/fccount18.cfm#d.

FHWA. (2012, August). Civil Rights Disadvantaged Business Enterprise DBE Contract Goals. Retrieved from https://www.fhwa.dot.gov/federal-aidessentials/companionresources/84contractgoals.pdf

FHWA. (2009, August). DBE Participation Goal Setting Methodology. Retrieved from https://www.fhwa.dot.gov/resourcecenter/teams/civilrights/cr_ppp3.pp+

FHWA. (2015, February 05). DBE Laws, Policy and Guidance. Retrieved from https://cms.dot.gov/civil-rights/disadvantaged-business-enterprise/dbe-laws-policy-and-guidance

FHWA. (n.d.). Disadvantaged Business Enterprise Program (DBE) - Civil Rights | Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/civilrights/programs/dbess.cfm

FHWA. (2014, December 2014). Disadvantaged Business Enterprise Program Final (Full). Retrieved from https://www.transportation.gov/osdbu/disadvantaged-business-enterprise/disadvantaged-business-enterprise-program-final

FHWA. (n.d.) "Disadvantaged Business Enterprise/ Supportive Services Program." U.S. Department of Transportation/Federal Highway Administration, FHWA, www.fhwa.dot.gov/resourcecenter/teams/civilrights/dbessfactsheet.cfm.

FHWA. (2015, January 20). Do You Qualify as a DBE? Retrieved October 13, 2018, from https://www.transportation.gov/civil-rights/disadvantaged-business-enterprise/do-you-qualify-dbe

FHWA- National Review of State Cost Estimation Practice | Office of Inspector General. (2012, November 14). Report Number: MH-2013-012

FHWA. (2017, March 28). Obligation of Funding - Policy | Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/policy/olsp/fundingfederalaid/04.cfm

FHWA. (2013, June 24). Tips for Goal-Setting in the Disadvantaged Business Enterprise (DBE) Program. Retrieved from https://www.transportation.gov/osdbu/disadvantaged-business-enterprise/tips-goal-setting-disadvantaged-business-enterprise

FHWA- Weaknesses in the Department's Disadvantaged Business Enterprise Program Limit Achievement of Its Objectives | Office of Inspector General. (2013, April 23). Retrieved May 05, 2013, from http://www.oig.dot.gov/node/6101

FHWA. (2013, June 10). Section 26.53 What Are the Good Faith Efforts Procedures Recipients Follow in Situations Where There Are Contract Goals? Retrieved from https://www.transportation.gov/osdbu/disadvantaged-business-enterprise/final-rule- section-26-53

FHWA. (2013, June 07). What's New In The New DOT DBE Rule? Retrieved from https://www.transportation.gov/civil-rights/disadvantaged-business-enterprise/whats-new-new-dot-dbe-rule

Fowler, F. J. (2014). Survey research methods. London: Sage Publication.

Government Accountability Office, U. G. (1989, January 05). Highway Contracting: Assessing Fraud and Abuse in FHWA's Disadvantaged Business Enterprise Program. Retrieved from https://www.gao.gov/products/RCED-89-26

Government Accountability Office. (2008, June 12). Federal-Aid Highways: Federal Requirements for Highways May Influence Funding Decisions and Create Challenges, but Benefits and Costs Are Not Tracked. Retrieved from https://digital.library.unt.edu/ark:/67531/metadc303007/

Gransberg, D., & Riemer, C. (2009). Impact of inaccurate engineer's estimated quantities on unit price contracts. Journal Of Construction Engineering And Management-Asce, 135(11), 1138-1145. doi:10.1061/(ASCE)CO.1943-7862.0000084

Hegazy, T, & Ayed, A. (1998). Neural Network Model for Parametric Cost Estimation of Highway Projects. Journal of Construction Engineering and Management, vol. 124, no. 3, 1998, pp. 210–218., doi:10.1061/(asce)0733-9364(1998)124:3(210).

Holt, C., & Lubart, J. (2018). U.S. DOT's Disadvantaged Business Enterprise Program: Key Components and Issues. National Academies of Sciences, Engineering, and Medicine / R News 318, 318.

Ichniowski, T. (1998, September 21). FEDERAL HIGHWAY DBE PROGRAM STRUCK DOWN IN MINNESOTA. Engineering News-Record, Retrieved from https://trid.trb.org/view.aspx?id=541227

INDOT. “DBE Database.” INDOT: Economic Opportunity Contact Information, 2018, www.in.gov/indot/2752.htm

INDOT. “INDOT Department of Economic Opportunity.” INDOT: Economic Opportunity Contact Information, 2018, www.in.gov/indot/2752.htm.

Ingraham, Christopher. “Mapping America's Most Dangerous Bridges.” The Washington Post, WP Company, 26 Apr. 2019

Kasarda, R. (2017, December 21). Will Cincinnati award contracts based on race? Retrieved from https://pacificlegal.org/will-cincinnati-award-contracts-based-on-race

Kasarda, R. (2013, March 03). Oops! Cleveland Taxpayers Billed $758,000 For Cut-and-paste Disparity Study Retrieved from https://pacificlegal.org/oops-cleveland-taxpayers-billed-758000-for-cut-and-paste-disparity-study/

Kasarda, R. (2014, October 15). Is the denial of preferential treatment discrimination? Retrieved from https://pacificlegal.org/denial-preferential-treatment-discrimination/

Kasarda, R. (2015, December 01). Disparity Studies Get No Respect Retrieved from https://pacificlegal.org/disparity-studies-get-no-respect/

Koehn, E. (1993). Infrastructure Construction: Effect of Social and Environmental Regulations. Journal of Professional Issues in Engineering Education and Practice, 119(3), 284-296. doi:10.1061/(ASCE)1052-3928(1993)119:3(284)

Lepenies, Philipp. The Power of a Single Number: a Political History of GDP. Columbia University Press, 2016.

Marion, J. (2007). Are bid preferences benign? The effect of small business subsidies in highway procurement auctions. Journal of Public Economics, 91(7-8), 1591-1624. doi: 10.1016/j.jpubeco.2006.12.005

Marion, J. (2009). Firm racial segregation and affirmative action in the highway construction industry. Small Business Economics, 33(4), 441-453. doi: 10.1007/s11187-009-9204-8

Marion, J. (2009). How Costly Is Affirmative Action? Government Contracting and California's Proposition 209. Review of Economics and Statistics, 91(3), 503-522. doi: 10.1162/rest.91.3.503

Marion, J. (2011). Affirmative Action And The Utilization Of Minority- And Women-Owned Businesses In Highway Procurement. Economic Inquiry, 49(3), 899-915. doi: 10.1111/j.1465-7295.2009.00259.x

McVicker, M. (2016). The Real Cost of DBE Fraud. doi:https://cms.dot.gov/sites/dot.gov/files/docs/S3TheRealCostofDBEFraud.pdf

Midwest Fence Corporation v. United States Department of Transportation (United States Court of Appeals, Seventh Circuit. November 4, 2016).

National Academies of Sciences, Engineering, and Medicine 2019. Compendium of Successful Practices, Strategies, and Resources in the U.S. DOT Disadvantaged Business Enterprise Program. Washington, DC: The National Academies Press.https://doi.org/10.17226/25538.

National Academies of Sciences, Engineering, and Medicine. 2010. Guidelines for Conducting a Disparity and Availability Study for the Federal DBE Program. Washington, DC: The National Academies Press. https://doi.org/10.17226/14346.

National Academies of Sciences, Engineering, and Medicine. 2005. Management of Disadvantaged Business Enterprise Issues in Construction Contracting. Washington, DC: The National Academies Press. https://doi.org/10.17226/13817.

Northern Contracting, Inc. v. Brown (United States Court of Appeals, Seventh Circuit. January 8, 2007).

Orndoff, C., Papkov, G., Behney, M., & Lubart, J. (2011). Defining the Problem: Disadvantaged Business Enterprise Program Impediments Identified by Survey of Program Administrators. Public Works Management & Policy, 16(2), 132-156. doi: 10.1177/1087724X11398937

Parvin, C. (1999, March). The Contractor's Side: DBE Program Unconstitutional. Roads and Bridges Magazine. Retrieved from https://www.roadsbridges.com/contractors-side-dbe-program-unconstitutional

Picker, S. (2007). Using Transportation Construction Contracts to Create Social Equity. Constructability Concepts and Practice, 75-81. doi:10.1061/9780784408957.ch05

Pindyck, Robert S., and Daniel L. Rubinfeld. Microeconomics. Pearson, 2018.

Porter, M. E. (2008). Competitive forces (Porter's five forces). Harvard Business Review. doi:10.4135/9781452229805.n131

Ryan, R., Rapp R., Shaurette, M., & Hubbard, S. (2018). Examining the Microeconomics of Bid Difference of Engineer & Contractor Bids in Highway Construction.

Sanchez, Thomas & Stolz, R & S Ma, J & Community Change, Center. (2003). Moving to equity: Addressing inequiTable effects of transportation policies on minorities.

Saint, I., & Bawa, S. (n.d.). 2017 Illinois Department of Transportation Disparity Study (Illinois, Department of Transportation).

“Sample Size Calculator: Understanding Sample Sizes.” SurveyMonkey

Shane, J. S., et al. (2009) Construction Project Cost Escalation Factors. Journal of Management in Engineering, vol. 25, no. 4, 2009, pp. 221–229., doi:10.1061/(asce)0742-597x(2009)25:4(221).

Skosey, Peter. (2016, April 1) Illinois Has a $43 Billion Transportation Deficit, Metropolitan Planning Council, Retrieved from https://www.metroplanning.org/uploads/cms/documents/mpc_tranportation_crisis_fact_sheet_2016_04_01.pdf

Slowey, K. (2017, March 20). Chicago subcontractor sentenced to 1-year prison term for DBE fraud scheme. Retrieved from https://www.constructiondive.com/news/chicago-subcontractor-sentenced-to-1-year-prison-term-for-dbe-fraud-scheme/438441/

“STATA FAQ.” IDRE Stats, University of California, Los Angeles: Institute for Digital Research & Education, stats.idre.ucla.edu/stata/faq/why-dont-my-anova-and-regression-results-agree-stata-11/.

STATA “Heywood Cases and Other Anomalies about Communality Estimates.” SAS/STATA(R) 9.2 User's Guide, Second Edition, 30 Apr. 2010, support.sas.com/documentation/cdl/en/statug/63033/HTML/default/viewer.htm#statug_factor_sect022.htm.

Taylor, E. L. (2009). The Shadow Cost of Disadvantaged Business Enterprise (DBE) Project Participation Goals in Tennessee Highway Construction (Unpublished master's thesis). University of Tennessee, Knoxville.

Title 49, Subtitle A, Part 26: PART 26— Participation by Disadvantaged Business Enterprise in Department of Transportation Financial Assistance Programs. (n.d.). Retrieved from https://www.ecfr.gov/cgi-bin/text-idx?region=DIV1%3Btype#ap49.1.26_1109.a

Thorndike, J. (2013, October 24). The Gas Tax Doesn't Work Because Politicians Broke It. Retrieved from http://www.forbes.com/sites/taxanalysts/2013/10/24/the-gas-tax-doesnt-work-because-politicians-broke-it/ +

Wilmot, C. G., and G. Cheng. Estimating Future Highway Construction Costs. Journal of Construction Engineering and Management, vol. 129, no. 3, 2003, pp. 272–279., doi:10.1061/(asce)0733-9364(2003)129:3(272).

Wooldridge, Jeffrey M. Introductory Econometrics: a Modern Approach. Cengage Learning, 2018.

Yisela, J., Jr. (2012, May 14). As contractors bend the rules, Public Building Commission stands pat. Retrieved April 10, 2014, from http://www.chicagobusiness.com/article/20120512/ISSUE01/305129975/as-contractors-bend-the-rules-public-building-commission-stands-pat

United States Department of Justice. (1999). Adarand Constructors, Inc. v. Slater - Opposition. Retrieved from https://www.justice.gov/osg/brief/adarand-constructors-inc-v-slater-opposition

U.S. Attorney's Office (Ed.). (2012, February 14). Two Area Contractors Charged with Fraud Involving Minority and Women Set-Asides for Government Construction Contracts. Retrieved from https://archives.fbi.gov/archives/chicago/press-releases/2012/two-area-contractors-charged-with-fraud-involving-minority-and-women-set-asides-for-government- construction-contracts

U.S. Bureau of Labor Statistics Overview of BLS Statistics on Unemployment. U.S. Bureau of Labor Statistics, 16 Dec. 2013, www.bls.gov/bls/unemployment.htm

U.S. Bureau of Economic Analysis Gross Domestic Product. U.S. Bureau of Economic Analysis (BEA), www.bea.gov/data/gdp/gross-dsomestic-product.

U.S. Energy Information Administration Independent Statistics and Analysis. Energy & Financial Markets – Crude oil - U.S. Energy Information Administration (EIA), www.eia.gov/finance/markets/crudeoil/demand-nonoecd.php.

U.S. House of Representatives, Surface Transportation Assistance Act of 1982 (Rep. No. 97-987).

Washington Department of Transportation (Ed.). (2008). Cost estimating manual for WSDOT projects.

Wisconsin Department of Transportation. “Estimating Tools”. (2020) wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/tools/estimating/est-tools.aspx.

Wilmot, C., & Cheng, G. (2003). Estimating future highway construction costs.(Author Abstract). Journal of Construction Engineering and Management, 129(3), 272. doi:10.1061/(ASCE)0733-9364(2003)129:3(272)

Wooldridge, Jeffrey M. Introductory Econometrics: a Modern Approach. Cengage Learning, 2018.