

To the Graduate Council:

I am submitting herewith a thesis written by Edward Lee Taylor entitled “The Shadow Cost of Disadvantaged Business Enterprise (DBE) Project Participation Goals in Tennessee Highway Construction.” I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Economics.

Matthew N. Murray, Major Professor

We have read this thesis
and recommend its acceptance:

Mark L. Burton

William S. Neilson

Accepted for the Council:

Carolyn R. Hodges, Vice Provost and
Dean of the Graduate School

(Original signatures are on file with official student records.)

The Shadow Cost of Disadvantaged Business Enterprise (DBE) Project
Participation Goals in Tennessee Highway Construction

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

Edward Lee Taylor
May 2009

Copyright © 2009 by Edward Lee Taylor

All rights reserved.

Acknowledgements

Many people contributed to this effort. I thank the Tennessee Department of Transportation Construction Division and the Tennessee Road Builders Association who provided the data. Thanks to Mr. Larry Eskew for providing the valuable insight of an industry veteran and to my committee for their guidance.

A special acknowledgement goes to the late Mr. John Tummins. As my former coworker, he helped me acquire an understanding of the intricacies of the highway construction industry and taught me valuable life lessons as well. His generous spirit and faith in God were without bound.

Abstract

Highway and bridge construction on interstate highways, U.S. highway routes, and state highways is partially funded by federal gasoline taxes and administered by the individual state departments of transportation. In 1983 the U.S. government instituted legislation that increased the opportunity for disadvantaged business enterprise (DBE) firms to participate in federally-funded highway construction. After subsequent evolution, this legislation remains the subject of debate due to its economic impact and social implications.

Some industry participants characterize the DBE program as inefficient because of the perception that DBE project participation goals create higher project costs and administrative burden. The price paid to achieve an equity objective is known as a shadow cost. This paper examines whether DBE participation goals imposed shadow costs to Tennessee highway projects during the years 2005 - 2008.

This question is considered against a backdrop of the political economics of the policies behind the goals. Measuring a shadow cost is relevant to efficiency and public policy. Since highway construction funding comes from federal and state gasoline tax revenue, nearly all Tennessee and U.S. motorists are affected.

Table of Contents

Chapter 1 Introduction, History, and Background.....	1
Introduction.....	1
National Legislative History and Court Challenges	3
Background-DBE Goals	5
Historical Standards and Goals.....	6
Current Standards and Goals - Tennessee	7
Background- Tennessee Highway Construction.....	8
Tennessee Department of Transportation (TDOT).....	9
Highway Contractors and Subcontractors	10
Chapter 2 Research Question.....	12
Economic Significance of Participation Goals	12
Perceptions of Participation Goals and Potential Goal Impacts	13
Chapter 3 Literature Review	15
Chapter 4 Theory and Analysis.....	18
Theoretical Framework.....	18
Elements of Analysis	19
Chapter 5 Econometrics.....	21
Regression Results – Full Data Set - 1085 observations	24
Regression Results with Atypical Observations eliminated – 1039 observations.....	24
Further Regression Results – 1039 Observations	25
Chapter 6 Conclusions and Recommendations.....	28

References.....	31
Appendices.....	34
Appendix A.....	35
Appendix B.....	45
Vita.....	48

List of Figures

Figure A1. TDOT Annual Participation Goals	36
Figure A2. TDOT Projected Participation Goal FFY 2009	36
Figure A3. TDOT Regional Organization	37
Figure A4. TDOT DBE Solicitation	37
Figure A5. Project Size Distribution (all projects)	38
Figure A6. Project Size Distribution (DBE projects only)	39

List of Tables

Table A1. Regression Variables	40
Table A2. Summary Statistics-All Observations	41
Table A3. Summary Statistics-Reduced Data Set.....	42
Table A4. Regression Results-Reduced Data Set	43
Table A5. Regression Results-Average Cost Effects	44
Table B1. Regression Results-Full Data Set (with all explanatory variables).....	46
Table B2. Regression Results-Full Data Set (with significant explanatory variables).....	47

Chapter 1

Introduction, History, and Background

Introduction

One definition of efficiency is achieving production at the lowest possible cost. Using this definition, the market for subcontractor services in Tennessee highway construction is suspected to be inefficient because of federal legislation mandating that disadvantaged business enterprise (DBE) firms receive a percentage of federal transportation contracting funds. By legislating that DBE firms be assured a portion of federally-funded highway construction, the government may have increased the cost of roads and bridges to the taxpayer in order to achieve equity in the contracting market. The price paid to achieve an equity objective is known as a shadow cost.

According to the United States Department of Transportation (USDOT), DBEs are for-profit small business concerns where socially and economically disadvantaged individuals own at least a 51 percent interest and control management and daily business operations. Mandated DBE participation represents a government directive and social policy intended to prevent discrimination and to provide equal opportunity. Rational thinking supports these goals but healthy debate exists on the efficiency of the current program. The efficiency question has significant economic interest and demands closer scrutiny. What increases in taxpayer costs might occur from mandating DBE participation? In other words, is a shadow cost incurred to achieve the societal goals?

Highway and bridge construction is a significant portion of federal transportation contracting exceeding \$35 billion per year. Highway and bridge construction as well as

maintenance on interstates, U.S. highway routes, and state routes is partially funded by federal gasoline taxes. The individual state departments of transportation administer the work.

Tennessee is a typical state in highway construction. The Tennessee Department of Transportation (TDOT) had a 2009 federal fiscal year (FFY 2009)¹ budget in excess of \$1.8 billion with more than \$700 million targeted for highway and bridge construction and established a FFY 2009 goal of 8.73² percent DBE participation. Tennessee's allocation of federal transportation funds comes from the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) as enacted August 10, 2005 as Public Law 109-59. SAFETEA-LU authorizes the federal surface transportation programs for 2005-2009.

In recent years, many of the industry's large contractors have scrutinized the DBE program as inefficient because of the perception that DBE firms raise project costs.³ Beyond this perception, definite effects on larger prime contractors include additional costs incurred in bidding and increased project management overhead owing to mandated DBE participation. TDOT, other state agencies, and the Federal Highway Administration (FHWA) also incur additional administrative expenses to maintain and manage these programs.⁴ These

¹ FFY 2009 spans from October 2008 thru September 2009.

² Goal furnished by the TDOT Civil Rights Division.

³ The author was previously employed in the Tennessee highway construction industry from 1993-2003. This observation comes from his interaction with many contractors during that period and from subsequent conversations in researching this topic.

⁴ A 2001 U.S. General Accounting Office (also known as the GAO and renamed in 2004 as the U.S. Government Accountability Office) report estimated \$6 million for the U.S. Department of Transportation in FFY 2000 and state averages exceeding \$1 million.

additional administrative costs, paid by taxpayers, could be explained by voter choice models where society chooses to trade the cost of a policy (e.g. affirmative action) in exchange for a desirable goal. Applying this model, voters have chosen to promote equal opportunity in an industry where statistical evidence indicates firms owned by minorities and women have historically not been proportionally represented. An alternate perspective is found in a self-interest model that explains governmental regulation as being sought by groups to restrict competition in their industry. Both models suggest mandated DBE participation may raise prices. However other literature indicates affirmative action can reduce costs and all these perspectives will be examined in more detail later.

Before beginning the analysis, I intend to review the history of the legislation and judicial decisions which formed the current program that might lead to production inefficiency. Most real-life questions are not considered within a single realm and this efficiency question is no exception. Normative and positive economics often provide different answers to policy questions. Whereas my analysis is in the positive realm, normative economics allows for an inefficient production outcome given the presence of social benefits in pursuing equity.

National Legislative History and Court Challenges

Recognizing past discrimination, the federal government intervened with legislation to provide better opportunities for these disadvantaged groups. Not only have DBE firms traditionally been denied participation opportunities, they continue to struggle with equal access to capital. A review of federal legislation and significant judicial decisions provides a starting point for understanding the possible existence of an inefficient production market

and ultimately weighing any inefficiency versus social benefits in accordance with a normative framework.

In 1982 the U.S. government first instituted legislation (to become effective in 1983) increasing the opportunity for minority businesses to participate in all federally-funded transportation contracting by enacting the Surface Transportation Assistance Act (STAA). This act provided the opportunity for qualified minority-owned businesses to participate in a USDOT program designated as the Disadvantaged Business Enterprise (DBE) Program. It was expanded in 1987 to include female-owned businesses and codified within Title 49 Code of Federal Regulations (C.F.R.) Part 23.

The program, administered by the FHWA, indicated that 10 percent of the funds authorized for federal and highway assistance should be channeled to DBE firms. Reauthorization of the program occurred under the George H.W. Bush administration in 1991-92. Although some revisions were periodically made in the finer details, the 10 percent provision remained constant and began to incur legal challenges. In spite of such challenges, the program was reinstituted by the 1998 Transportation Equity Act for the 21st Century (TEA-21) and expanded by the Surface Transportation Extension Act of 2005. Though I shall consider only that portion applicable to highways, similar federal programs currently exist for aviation and transit under the USDOT's Office of Small and Disadvantaged Business Utilization (OSDBU).

The legal challenges, examined in greater detail below, resulted in the replacement of Part 23 by a new regulation designated 49 C.F.R. Part 26. Part 26 eliminated the 10 percent mandate and provided the more narrowly tailored provision the courts demanded. The courts

acted because this controversial legislation prompted several challenges from affected contractors over the years. Two of these cases merit mention because they changed the nature of the program over time.

The first significant case, *City of Richmond v. J.A. Croson Co.*, 488 U.S. 469 (1989), was brought by the plaintiff contractor alleging that minority set-aside contracts were discriminatory against non-minority contractors. The Supreme Court's decision in support of the contractor resulted in the dissolution of numerous local set-aside programs and set the stage for a new era in affirmative action.

The landmark case, *Adarand Constructors Inc. v. Peña*, 515 U.S. 200 (1995), a 5 to 4 decision extended the strict scrutiny standard to federal programs. The Supreme Court decreed that government programs must have a compelling interest in remedying past discrimination, be narrowly tailored to avoid benefitting those not suffering from past discrimination, and bring no harm to innocent third parties. As a result of all the challenges, CFR Part 26 was enacted to 'mend not end the program' in 1999.

Background-DBE Goals

By eliminating the arbitrary 10 percent participation standard, Part 26 complies with the strict scrutiny of the Supreme Court's *Adarand* decision. States are allowed to establish individual participation goals based upon achieving DBE participation at its 'natural level'. This natural level is defined as that amount which would be present absent of any discrimination. In practice, states may establish annual goals based upon any reasonable methodology and it is common to use information from the Census Bureau County Business

Pattern database and other sources considering the number of ready, willing, and able firms in the market.

Historical Standards and Goals

Prior to 1999, recipients of federal aid were required to achieve the 10 percent goal or offer justification to the USDOT. The 1999 DBE regulations made significant changes. The new regulations overhauled the program's goal setting process, including the use of race-neutral measures and revised its eligibility requirements with a cap on owner's net worth.

The 1999 regulations resulting from *Adarand* also brought varying state goals. In a broad sense, note that minority participation rises and falls with the establishment of goals. A 1997 Urban Institute Study found that the termination of Michigan's state-funded program resulted in minority participation dropping to zero while the state's federal program achieved 12.7 percent participation.

Part 26 affected goals in other ways as well. While relaxing the 10 percent requirement, it instituted more rigorous standards in terms of both DBE qualification and revised definitions of what constitutes project participation. DBE certification requires that owners submit a Personal Net Worth (PNW) statement and the PNW of owners must be less than \$750,000 exclusive of their home or ownership in the business. More intrusive financial disclosure requirements seem to have resulted in a loss of certified DBE entities in Tennessee.⁵ In addition, Part 26 contained provisions which disallowed the previously acceptable practice of a DBE subcontracting to a second tier non-DBE and counting the subcontracted amount towards participation goals. So Part 26 modifications made it more

⁵ According to the TDOT Civil Rights Office.

difficult for firms to achieve certification and for states to achieve annual goals at previous levels. Tightened certification requirements certainly diminished the supply of available DBE firms. It is feasible that this reduced supply has an effect on project costs and the efficiency of this market. If this effect is significant, higher costs might result from reduced competition among DBE firms.

Obviously this legislation has evolved considerably since its 1983 inception. The changing nature highlights the controversy it has spawned and continues to generate. Given the historical perspective, we move to the current standards and Tennessee goals pertinent to the analysis herein.

Current Standards and Goals - Tennessee

Since Part 26 allows the individual states to establish their own annual goals using any reasonable methodology, recent Tennessee DBE participation goals have ranged between a high of 9.87 percent in FFY 2007 to a low of 8.00 percent in FFY 2005⁶ as shown in Figure A1 (refer to the appendices for this and all subsequent figures and tables). Noteworthy is the fact that goals can be met by a combination of race-conscious and race-neutral participation. Race-neutral is defined as that participation which occurs without the establishment of race or gender project goals. Tennessee, along with most other states, meets approximately one-third of its annual goal using race-neutral means. This is noteworthy because race-neutral participation occurs without mandate and can be assumed to occur in a competitive environment (see Figure A2).

⁶ Goals furnished by the TDOT Civil Rights Division.

In addition to its annual goal, TDOT establishes participation goals for approximately 20 percent of its individual projects based upon the local marketplace and subcontractor availability. In practice, these goals are actually minimum requirements for DBE firm participation and constitute a mandate. It is these project goals that are my focus.

In establishing these project participation goals, special weight is given to the availability of DBE subcontractors in conjunction with the specific types of work required. In-state DBE firms dominate the actual participation but approximately one hundred out-of-state firms have Tennessee certification.

Now that I have established the background for the current policy and its social goals, I need to establish background knowledge of the industry under consideration. My analysis is confined to the subcontracting market as it pertains to highway and road construction within the state of Tennessee from January 2005 until October 2008.

Background- Tennessee Highway Construction

In highway construction, Tennessee is believed to be a typical state in most respects. Sizeable projects include major work items of paving, grading, bridge construction, and several common minor elements. To understand the elements of my analysis, clarity of the contractual relationships between the parties and the roles of the parties is essential. This knowledge will facilitate the reader's understanding and acceptance of the key assumptions in the econometric analysis.

TDOT is headquartered in Nashville with several divisions including: Planning, Design, Structures, Construction, Civil Rights, and Maintenance. Size and geographic considerations dictate that daily operational functions are managed at the regional or district

level. Please refer to Figure A3 which shows the geographic delineation of state regions. My research question involves the state-level Construction and Civil Rights Divisions located in Nashville.

The Construction Division conducts the bid auctions and awards the contracts to the lowest qualified bidder in unit price contract (UPC) auctions. DBE participation goals are established by the Civil Rights and Construction Divisions on individual projects using various criteria such as project size, location, composition, and proximity to available DBE entities. The Civil Rights Division monitors DBE project goal compliance. Projects are awarded to the lowest qualified bidder in sealed bid UPC auctions that are held eight times per year. The two major participants in the auction process are TDOT and the bidding prime contractors. Seldom do DBE firms bid as prime contractors, instead they are typically involved in the auction process only indirectly. They participate by quoting prices on consulting services, project materials, or the subcontracting of selected work items. In practice, the overwhelming majority of DBE participation is through subcontracted work and hereafter I refer to the mechanism of participation as DBE subcontracting. The subcontractor's quoted prices are used by the prime contractors in formulating bids.

Tennessee Department of Transportation (TDOT)

In conducting the UPC auctions, TDOT receives sealed bids and then chooses to award the project to the lowest responsive bidder or reject all bids. In a UPC auction, a typical job is delineated into many bid items such as guardrail, pavement marking, asphalt paving, etc. which comprise the bid schedule. Each item on the bid schedule has a bid quantity thought to be a correct approximation of the actual project quantities. Bidding prime

contractors submit a unit price for each bid item. Item totals are then summed to get the total bid amount. The bidder with the lowest total bid is the auction winner. The winner chooses his subcontractors based upon their quoted prices and perceived reliability but must have sufficient DBE participation to meet the mandated project requirements even if lower cost or more reliable alternatives exist.

In addition to the auction mechanics, my analysis of shadow cost will incorporate relevant project specific characteristics. Among them are the general types of construction work performed. Large road building projects consist of three primary components. They include grading activities (earth moving), paving, and bridge construction. In addition to the major work areas, smaller work elements exist such as guardrail installation, pavement marking, signalization, signing, temporary traffic control, and landscaping. Often, medium size projects include only the resurfacing of existing roads to replace deteriorated pavement. TDOT provides project information to the bidding contractors in design drawings and specifications. An additional TDOT responsibility is to prepare the engineering cost estimate (ECE) prior to the auction. This estimate is fundamental to my analysis and discussed in more detail later.

Highway Contractors and Subcontractors

Generally a prime contractor will conduct one or more of the major work elements with his or her own forces and subcontract ancillary elements to other firms (sometimes known as the ‘make vs. buy’ decision).⁷ These generally smaller entities perform specific work segments under the management of the prime contractor. In compiling the bid prices,

⁷ Without mandated participation, prime contractors may choose to perform more work with their own forces or ‘make vs. buy’ decision.

the prime contractor solicits price quotes on the minor areas of work from DBE and non-DBE subcontractors.

Tennessee DBE subcontractors are generally concentrated in areas of work such as guardrail installation, pavement marking, trucking, and landscaping because these areas of work tend to have the lowest barriers for entry in both capital and industry experience. In fact, TDOT seems to encourage DBE entry in these areas (Figure A4).

Bidding prime contractors are prequalified and the job (if awarded) goes to the lowest bidder. Since only the low bidder can receive the award, prime contractors have a strong incentive to choose subcontractors having the lowest unit prices. A notable exception occurs if a contractor fails to meet the minimum requirement for DBE participation when utilizing the lowest prices available. In this instance, a contractor may be compelled to utilize a higher price quote from a DBE subcontractor to meet a project DBE participation goal.

Chapter 2

Research Question

As of the year 2000, 99 percent of the states and transit authorities surveyed by the GAO had not conducted studies to determine whether the DBE program affected their contracting cost. With annual spending currently in the billions, federal transportation contracting is an economic engine and significant funds are being received by Tennessee DBE highway subcontractors. During the study period, DBE firms received almost \$50 million annually.⁸ Given similar goals in all states, the national flow to DBE firms exceeds \$2 billion annually in highway construction alone. Measuring the DBE program's effect on contracting costs will determine if the program is costly to taxpayers.

Economic Significance of Participation Goals

The rigid qualification process for DBE subcontractors limits entry and restricts competition while project participation goals are a constraint on the prime contractor's choice of subcontractors. Assuming DBE firms exhibit higher costs and this constraint binds, DBE project goals impose a shadow cost on taxpayers. However it is possible that there are offsetting influences such as non-DBE firms bidding more aggressively that might counter this effect. Investigating the cost effects of the DBE program is relevant to public policy and can assist policy makers in directing the program's future.

Since funding comes from federal and state gasoline tax revenue, nearly all Tennessee motorists are affected. This topic becomes timelier as the federal government has

⁸ Based on an 8 percent minimum annual goal with \$600 million average annual expenditures.

recently instituted a two-year economic stimulus package giving Tennessee \$572 million for highway construction in addition to its annual allocation under SAFETEA-LU.

Perceptions of Participation Goals and Potential Goal Impacts

Evidence exists supporting the highway community's perception that DBE firms command higher prices because of their certification status. Marion (2006) states that it is commonly accepted that 'front' companies exist. These fronts are white and male-controlled but DBE certified. Since their existence constitutes fraud, the incentive to form these companies logically lends credence to the perception that mandated participation goals affect prices. Higher prices might occur because of lack of scale, lack of access to capital, and the lower productivity of newer, less-experienced firms.

Goal impacts potentially include positive and negative effects both direct and those somewhat more subtle. Potential negative effects include not only increased project costs but less obvious effects such as the elimination of opportunities for non-DBE white males. The costs of positive impacts are the shadow costs. Positive benefits, though difficult to quantify in monetary terms, are the social benefits achieved through diversity and equal opportunity for the disadvantaged. Even opponents of the current program acknowledge that past discrimination existed. Leveling the playing field could create positive externalities that provide justification for potentially increasing taxpayer costs. This normative perspective fits perfectly with median voter choice models.

If mandated DBE participation raises total project costs, the normative policy debate will continue among factions. If this perception is false, then project costs are impacted only indirectly by increasing administrative burden on government and the industry. Since costs

of the burden are minimal, all factions would likely accept them. I intend to analyze costs enabling these factions to evaluate the trade-off.

Chapter 3

Literature Review

Relevant literature falls into two broad categories. In the general literature, we see theories explaining the origins of regulatory policy and we find specific literature on the effect of affirmative action on highway costs in other states. A brief discussion of both types will be helpful in framing the principal questions of this paper and understanding the implications of its findings.

Public choice models like the median voter model represent one possible path for policy development. Congleton (2008) discusses the rational view that market failures may be corrected by voter demands. His Moral Voter Hypothesis asserts that normative theories can predict outcomes that depart from self-interest. We see the parallels to the DBE program where the federal government corrected a market failure with legislation demanded by a voting public. However Congleton (2002) explains that just because the median voter gets his wishes, the outcome is not necessarily Pareto efficient. As I explore the possibility that a shadow cost exists and there is production inefficiency, Congleton's work provides a plausible explanation for this combination.

An alternate explanation of policy adoption is found in a self-interest model by Stigler (1971). His writing on the economic theory of regulation explores how government regulation may actually be sought by an industry. By achieving legislation which reduces available supply and limits substitutes, an industry can affect an increase in prices. Though his work extends further, Stigler points out how some regulations create costs as a trade for some social goal. He concludes that industries receiving protection from the state will

achieve benefits less than the damage to the rest of the community and that regulation creates higher prices.

Both the median voter and self-interest models support the possibility of higher costs but do not assure them since other literature (discussed below) explains that affirmative action programs can decrease prices. However we have evidence of programs increasing costs in other highway-specific literature. Despite the narrow nature of this topic, the effect of governmental regulation on highway costs has previously been explored in other states. Some of the parallel work by Marion (2007) deals with bid preferences in California highway contracting where small businesses are given a 5 percent preference on state road construction projects but not federal projects. Marion explores the effect of these preferences and finds that though winning firm's profits are reduced, overall costs increase 3.8 percent because of reduced participation in the preference auctions by larger firms. Larger low cost firms merely substitute the non-preference federal auctions and the resultant efficiency loss is 3.6 percent or 27 cents of each dollar awarded to small firms in preference auctions. It is noteworthy that a fundamental difference between the bid preference auctions and DBE subcontracting goals is that bid preferences facilitate participation but do not mandate it when the cost differential exceeds a threshold value. It is reasonable to assume low cost firms are more likely to forego auctions when participation is mandated.

Marion's (2006) most relevant work considers the costs of affirmative action after California adopted legislation to eliminate preferential treatment to minority and female businesses on state (but not federal) road projects. This natural experiment provided a ready control group to facilitate analysis of the costs of affirmative action. He determined that the

elimination of affirmative action goals caused prices to fall by 5.6 percent on state projects relative to federal projects. Marion's results indicate that an increase of 10 percent in DBE participation increased the winning bid by 3.1 percent and the elimination of preferential treatment lowered prices because of the fewer subcontractors utilized (make vs. buy decision) and the mix of subcontractors chosen.⁹

Other work by Corns and Schotter (1999) and McAfee and McMillan (1989) suggest that an affirmative action program that uses bid preferences for disadvantaged firms could, in fact, lower the equilibrium winning bid if it forces non-disadvantaged firms to bid more aggressively. Therefore affirmative action does not necessarily increase costs. McAfee and McMillan also show that even cases where bid preferences have adverse cost effects are not necessarily suboptimal if the favored group's profits enter positively into the social welfare function. Hence we see the theoretical possibility that regulations can both enhance competition and produce positive externalities.

⁹Marion found DBE subcontractors tend to be concentrated in urban areas. Their urban locations tend to create higher average costs though not necessarily higher than non-DBE firms in the same locale. With the flexibility to choose a different mix (including lower cost subs in non-urban areas), overall project costs were lowered.

Chapter 4

Theory and Analysis

Theoretical Framework

The literature review gave two theories explaining the possible existence of higher prices from regulation. Congleton's Moral Voter Hypothesis indicates politicians will take policy positions in accordance with the preferences of their constituents even if costs are increased and Stigler's seminal paper on the economic theory of regulation posits that industries seek regulation that controls entry and limits substitutes for the purpose of increasing prices.

While these theories offer an explanation for the origin of the DBE program, microeconomic theory and econometric analysis is required to examine the cost effects. I begin with a fundamental assumption regarding the cost structure of DBE firms. It is entirely reasonable that DBEs have higher average and marginal cost structures because of their generally smaller size, lack of capital, and relative inexperience so any mandate raising their level of participation raises costs *ceteris paribus*.

It is also possible that DBE firms have higher, lower, or the same average costs but are able to earn economic rent because their participation is mandated. At least two possibilities exist that might enable DBE subcontractors to command higher prices from a lessening of competition. The DBE certification might act as a 'license' similar to those held by importers where import quotas exist or DBE firms may have crowded out non-DBE,

lower cost firms in certain sectors and specific geographic areas.¹⁰ On the other hand, it is possible that their participation causes non-DBE subcontractors to price more aggressively and that overall project costs decrease in accordance with the literature discussed earlier.

A way to understand and frame the analysis is found in the microeconomic concept of constrained optimization. The project participation requirement can be considered a constraint on the lowest cost objective function. If this constraint binds, the lowest bid price increases and the effect of the constraint can be measured as a shadow cost. Do limited entry, restriction of substitutes, and mandated participation goals create a shadow cost? Using the auction mechanics and industry characteristics, I intend to formulate an econometric model to answer these questions.

Elements of Analysis

Before receiving bids, TDOT compiles an engineering cost estimate (ECE) of the expected project cost. This carefully prepared estimate is used for budgeting and also subsequently used as a basis to insure that the received bids are a true representation of the fair value of the auction. The preparation of this estimate involves an extension of expected unit prices and quantities for project work items. The TDOT Construction Division indicated that estimates are prepared in advance of the establishment of project participation goals and

¹⁰ TDOT states that there are no indications that any overconcentration exists and discounts the latter possibility. TDOT Civil Rights Office, Small Business Development Program, Disadvantaged Business Enterprise Goals FFY 2007/2008.

are in theory not explicitly biased.¹¹ In other words, TDOT estimators do not try to account for the effect of any goals when deriving their estimates.

If the estimates do not assume higher DBE average costs, my analysis should be unbiased. The other possibility is that the ECE implicitly incorporates some effect based on historical cost data and creates a bias. However if the analysis indicates a shadow cost, such a bias only enhances the conclusion.

A shadow cost will result if DBE participation goals and higher costs create a binding constraint that prevents achieving the lowest auction price. I test the following null hypothesis:

H₀: DBE project participation goals affect the winning bid of Tennessee highway projects.

With an alternate hypothesis of:

H₁: DBE project participation goals have no effect on the winning bid of Tennessee highway projects.

¹¹ TDOT Construction Division provided this specific information in response to my inquiry.

Chapter 5

Econometrics

The qualitative benefits from DBE participation such as industry diversity and equal opportunity are noble goals but not subject to quantitative evaluation and are highly subjective. Other quantitative measurements as to the success and progress of program participants would require firm and owner financial data currently protected by federal law, but I can examine the existence and magnitude of a shadow cost with available data. To quantify how changes in DBE participation goals across projects affect project costs, consider the following model used by Marion:

$$\ln (\text{Bid}_i) = \alpha G_i + \beta X_i + \gamma_t + u_i \quad (1)$$

where $\ln (\text{Bid}_i)$ is the log of the winning bid, G_i is the project participation goal, X_i is a vector of project specific characteristics, and γ_t represents unobserved time shocks.

Using observations of Tennessee highway bid data from the period January 2005 thru October 2008, the econometric analysis controls for project characteristics (the number of bids received, the type and character of work, geographic location, etc.) and time sensitive factors (price shocks, change in state annual goals, etc.). The analysis variables are found in Table A1.

1085 observations were obtained with 207 observations having a DBE project participation goal ranging from 3 to 10 percent. Please refer to Tables A2 and A3 for summary statistics. The former pertains to the entire data set and the latter references a

reduced set of projects (see discussion below). Figures A5 and A6 indicate the distribution of the two groups into size categories.

Stata 10 provided a multiple regression package utilized in the analysis. An OLS robust regression was performed by regressing the variable of interest, *dbegoal*, and project controls on the log of the winning auction bid. In accordance with Marion's model, the logarithmic forms of the independent variables were typically utilized for quantity variables. Logarithmic forms reduce the effect of outlying observations and coefficient estimates reflect elasticities.

A key decision regarding the OLS choice concerns the potential endogeneity of *dbegoal*. Should this variable be endogenous, OLS results would be biased. After careful consideration, I argue *dbegoal* is not endogenous because of the assumption on another key explanatory variable. The variable *lestamt* is the log of the ECE. Note that this estimate is made by TDOT with essentially the same information available to the bidding contractors. The differences in information include the *dbegoal* value, the actual completion time allotted, general time shocks that might occur subsequent to the TDOT estimate but before the bidding, and the winning bidder's competitive position (firm backlog, backlog of major competitors, distance to the project, etc.). My analytical framework controls for all of the above information differences except certain aspects of the competitive position which remain in the error term. Logically, *dbegoal* cannot be correlated with these competitive aspects and is not endogenous. Therefore the OLS estimator is BLUE. As noted earlier, if *lestamt* implicitly incorporates higher historical prices, a positive slope coefficient on

dbegoal contains attenuation (toward zero) bias but this bias would strengthen a rejection of the null hypothesis.

Other analytical decisions warrant mention. Preliminary results indicated that the winning bidder's distance from the project and a proxy variable for project completion time were insignificant with no explanatory power. Both were dropped from the final analysis to avoid over-specifying the model.¹² However, the most debatable decision was to estimate the model without certain observations determined to be from a different population.

In compiling the data, I noted observations where winning bids were below \$100,000. Based upon personal experience with the auctions, I questioned the nature of these observations. Upon further review, it appears these observations come from a different population. The population of interest is Tennessee highway construction subcontracting as it pertains the construction of roads and bridges. These 46 observations included highly atypical projects such as the construction of salt bins and the cleaning of tunnels while only a single observation in the questionable group contained paving or grading. These small projects do not represent opportunities for DBE construction subcontracting borne out by the fact that eliminating these observations did not eliminate a single DBE project goal job. In addition, these jobs have minimal economic impact. In the study period, the 1085 observations totaled approximately \$2.4 billion of value. While these 46 observations constituted almost 5 percent of total observations, they represent less than 0.2 percent of value. I conclude these observations come from a different population and are irrelevant to

¹² Introductory Econometrics, Woolridge, p. 211.

my analysis. The results including them are meaningless but I report them in Appendix B to be consistent with recognized econometric practices.¹³

Regression Results – Full Data Set - 1085 observations

I performed a preliminary regression on the variables listed in Table A1. Summary statistics for the full data set are found in Table A2. The regression results show little of interest but can be found in Table B1. The coefficient on the variable of interest, *dbegoal*, has the expected sign but is insignificant. As expected, *lestamt* and *qtybids* are highly significant. Other explanatory variables related to the allowable completion time and the winner's geographic proximity to the project, *ltime* and *biddist*, both lack significance. I dropped the latter two explanatory variables and repeated the regression. These results remain uninteresting but are given in Table B2. Both regressions yielded similar results confirming my decision to eliminate *ltime* and *biddist*. In both regressions, the coefficient on *dbegoal* remains insignificant.

Regression Results with Atypical Observations eliminated – 1039 observations

Eliminating the smallest 46 observations (projects less than \$100,000) increased the average winning bid slightly from \$2.11 million to \$2.20 million with minimal effects on other numerical variables. However this modification yielded substantially different regression results for *dbegoal*. These results, shown in Table A4, show a slope coefficient of 0.380 for *dbegoal*. This coefficient indicates an increase in the winning bid price of 3.80

¹³ Ibid, p.328.

percent for an increase of 0.1 in *dbegoal* (10 percent in the project DBE goal). Since *dbegoal* has a t-statistic of 1.87 and a p-value equal to 0.06, I fail to reject the null hypothesis that DBE subcontractor participation project goals affect project costs at the 10 percent significance level but I reject the null at the 5 percent significance level.

Coefficients on the other two previously significant explanatory variables, *lestamt* and *qtybids* remain highly significant with p-values less than 0.01. The overall R-squared value of 0.979 reflects the highly significant t-statistics of 145.0 and -6.81 for these two significant variables. The standard error of the regression is 0.163 and the Breusch-Pagan test confirmed the choice for robust regression with a chi-squared value of 29.1 and I reject the null hypothesis of homoskedasticity at a significance level less than 1 percent.

It is interesting to note that the dummy variable coefficient for TDOT Region 4 is -0.048 and highly significant with a t-statistic of -3.26 indicating a geographic cost difference. Though not statistically significant, Regions 2 and 3 also had coefficients of negative signs. All coefficients were with respect to Region 1 which was omitted in the analysis to avoid the dummy variable trap.

Further Regression Results – 1039 Observations

The above results on *dbegoal* narrowly missed being significant at the 5 percent level and included a likely attenuation bias. To obtain more information, an alternate regression was considered. Whereas the previous regression considered marginal effects, it did not provide information on the average effect of DBE participation goals. In order to consider these average effects, I used the following model:

$$\ln(\text{Bid}_i) = \alpha D_i + \beta X_i + \gamma_t + u_i \quad (2)$$

where D_i is a dummy variable having a value of one for projects with DBE participation goals and zero otherwise. Other variables are as in Equation (1). Results are listed in Table A5 where the coefficient on the dummy participation goal variable, *dbepart*, is 0.041 (an average price increase of 4.1 percent) with a t-statistic of 2.85 ($p < 0.01$) and highly significant. Coefficients on the other significant explanatory variables remain significant at their previous levels.

As a final experiment to validate the analysis, I considered an alternate specification for the marginal effect which removed *lestamt* as an explanatory variable. With such strong predictive power, this variable has the potential to overshadow the variable of interest. The alternate specification considered a new dependent variable created by subtracting *lestamt* from *laward* (or dividing the award amount by the ECE and taking the log of the result). Results of this regression closely corresponded with the original model. Using the same data set of 1039 observations and retaining the other variables, the coefficient on *dbegoal* was 0.420 at a confidence level exceeding 95 percent. Taking this robustness experiment an additional step, I eliminated the 104 smallest observations for *laward* (award amounts less than \$250,000) because they do not represent any DBE participation projects. This regression yielded a *dbegoal* slope coefficient of 0.335 with a t-statistic of 1.96 (and a p-value = 0.05).

Removing *lestamt* as an explanatory variable definitely reflected its explanatory power as the removal caused the overall R-squared value to fall sharply to a value less than 0.2 and the remaining explanatory variables to be measured in a different context. The

experimental results do nothing to cast doubt on the results of the original model. Since they were used only for verification, they are not reported in tabular form.

Chapter 6

Conclusions and Recommendations

The feasible set of available subcontractors on goal projects is reduced by participation requirements which serve to eliminate some non-DBE firms from consideration. In addition, there are fewer DBE subcontractors available in recent years because of more stringent qualification procedures. In 2008, there were 156 Tennessee firms listed as having certified DBE status and fewer still were active.¹⁴

Logically it could be expected that the population centers of the state, with their higher minority populations, would have a greater number of DBE subcontracting participants in a more competitive environment. Note that Region 4 (Memphis region) has significantly larger total and minority populations than Region 1 (Knoxville and Tri-Cities region). Though not conclusive evidence of increased competition, we do observe Region 4 having statistically significant lower prices than Region 1.

However we do get a strong result from the regression on *dbgoal*. Recall the null hypothesis stated that participation goals affect project costs. I initially rejected this null hypothesis at the 5 percent significance level ($p=0.06$) but had a possible attenuation bias created by the use of historical pricing in formulating the ECE. Though I was unable to determine a marginal effect at the 5 percent level of significance, more conclusive results were obtained on average effects of project goals. The model represented by Equation (2) gave a stronger and conclusive result indicating an average cost increase for goal projects exceeding 4 percent. The confidence level for this result exceeded 99 percent.

¹⁴ The number of firms was taken from a July 25, 2008 listing of the Tennessee Uniform Certification Program. A large percentage of these were not active participants. According to information from TDOT's Civil Rights Division, less than half of the Tennessee firms received a subcontract during the study period.

In this study period, my model indicates that DBE subcontracting goals have an effect on costs in Tennessee highway construction. I conclude that shadow costs occur because participation goal requirements create a binding constraint on the selection of subcontracting firms. Though there is a strong inference that DBE subcontractors command higher prices than their displaced competitors, it is possible that increased prices result from the mandate merely adding additional subcontractors to a project or other factors. Any factor increasing project complexity or introducing additional uncertainty would increase costs. However the magnitude of the shadow cost coefficient and the existence of ‘front’ companies imply that DBE firms can command higher prices. My findings seem consistent with the earlier referenced work of Marion in California highway contracting.¹⁵

I recommend that TDOT carefully establish annual participation goals at levels such that disadvantaged firms can achieve participation at its ‘natural level’ as defined by the Supreme Court’s *Adarand* decision. We can determine just how costly small increases in annual goals might be. From Figure A1, we note the variation in annual goals in FFY 2006 – 2008. In FFY 2007 the annual goal increased to 9.87 percent versus 8.48 percent in the previous year only to fall to 8.38 percent in FFY 2008. These differences translate to a year-to-year taxpayer cost difference of over \$2 million.¹⁶ Clearly TDOT must define these annual goals carefully and not specify goals in excess of those justified.

Various factors limit the supply of available DBE subcontracting services. They include barriers to entry and limited access to capital. The current cap on personal net worth

¹⁵ He concluded that affirmative action increased prices because prime contractors lacked flexibility to choose a different mix of subcontractors or perform more work with their own forces.

¹⁶ DBE goal projects were approximately \$400 million annually during the study period. Using the slope coefficient of 0.380, $\$400 \text{ million} \times 0.38 \times 1.4 \text{ percent} > \2 million

for eligible individuals is \$750,000 and has not been revised since 1999. Assuming this 1999 standard was valid at that time, federal policy makers should raise this cap consistent with the increases in inflation and open up the market to more persons. Also, TDOT must increase its efforts in recruiting and training potential DBE owners. Any efforts resulting in increasing the number and quality of these firms will enhance competition in this market and reduce the current shadow cost.

The analysis considers only short-run cost effects with all factors fixed. The program accrues long-run benefits by positively influencing social welfare. The cost of these benefits is the shadow cost. Further work is needed to ascertain the magnitude of the benefits to social welfare.

References

- [1]Anderson, John A., Behney, and Lubart. "The Disadvantaged Business Enterprise Program and Transportation Policy". *Handbook of Transportation Policy and Administration*, pp.431-443, Plant, Jeremy F., ed. (2007).
- [2]Becker, Gary S. (1983). "A Theory of Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics* 98: 371-400.
- [3]Corns, Allen and Andrew Schotter (1999). "Can Affirmative Action Be Cost Effective? An Experimental Examination of Price-Preference Auctions," *The American Economic Review* 89:1, p. 291-305.
- [4]Congleton, Roger D. (2008). "The Moral Voter Hypothesis: Economic and Normative Aspects of Public Policy and Law within Democracies," *Journal of Public Finance and Public Choice* (forthcoming).
- [5]_____(2002). "The Median Voter Model," Charles K. Rowley and Friedrich Schneide eds., *The Encyclopedia of Public Choice* 2: 382-386.
- [6]Krugman, Paul R. and Maurice Obstfeld. *International Economics: Theory & Policy*, Seventh Edition, Pearson Education 2006.
- [7]Gorman, Allison. *Cross Roads*, February 2008.
<http://www.businessstn.com/content/200801/cross-roads>
- [8]La Noue, et al. "The Road's End for Racial Preferences in Public Contracting?" *Constructor*, January 2001, pp.14-19.
- [9]Marion, Justin (2007a). "Are Bid Preferences Benign? The Effect of Small Business Subsidies in Highway Procurement Auctions," *Journal of Public Economics* 91:7-8, pp. 1591-1624.
- [10]_____(2007b). "The Effectiveness of Affirmative Action in Highway Procurement," Working Paper, Department of Economics, UC- Santa Cruz.
- [11]_____(2006). "How Costly is Affirmative Action? Government Contracting and California's Proposition 209," Working Paper, Department of Economics, UC-Santa Cruz.
- [12]_____(2008). "Affirmative Action and the Utilization of Minority- and Women-Owned Businesses in Highway Procurement," Working Paper, Department of Economics, UC-Santa Cruz.
- [13]McAfee, R. Preston and John McMillan (1989). "Government Procurement and International Trade," *Journal of International Economics* 26:3-4, pp. 291-308.

[14]McChesney, Fred (1998). “Rent from Regulation,” *New Palgrave Dictionary of Economics and the Law*, pp. 310-315, Newman, Peter, ed. (2007).

[15]Stigler, George J. (1971). “The Theory of Economic Regulation,” *Bell Journal of Economics and Management Science* 2:3-21.

[16]Tennessee Department of Transportation, Small Business Development PowerPoint Presentation, 2008.

[17]United States General Accounting Office, “Disadvantaged Business Enterprises: Critical Information Is Needed to Understand Program Impact,” June 2001.

[18]Urban Institute, “Do Minorities Get a Fair Share of Government Contracts,” (1997).

[19]Woolridge, Jeffrey M., *Introductory Econometrics*, Third Edition, Southwestern Publishers, 2006.

Appendices

Appendix A

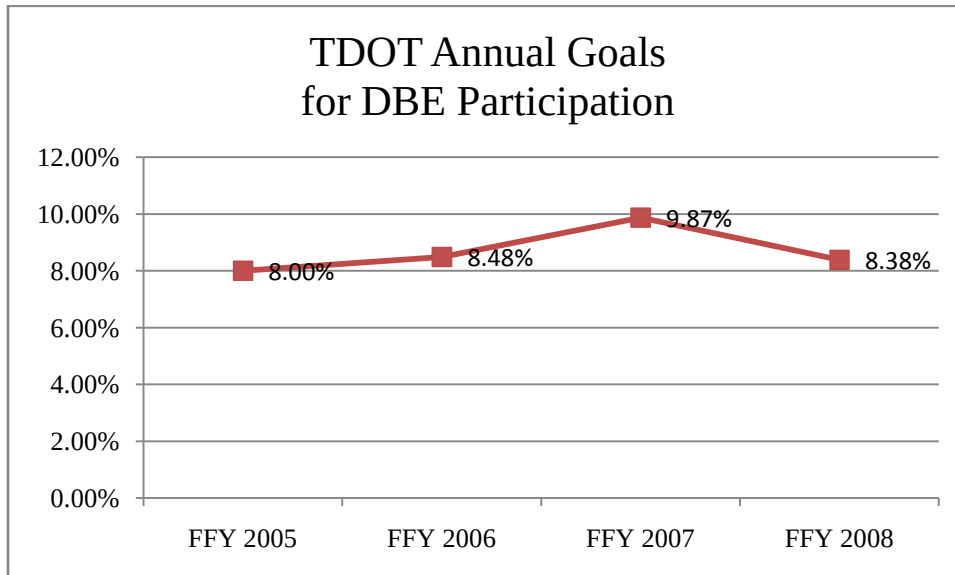


Figure A1. TDOT Annual Participation Goals

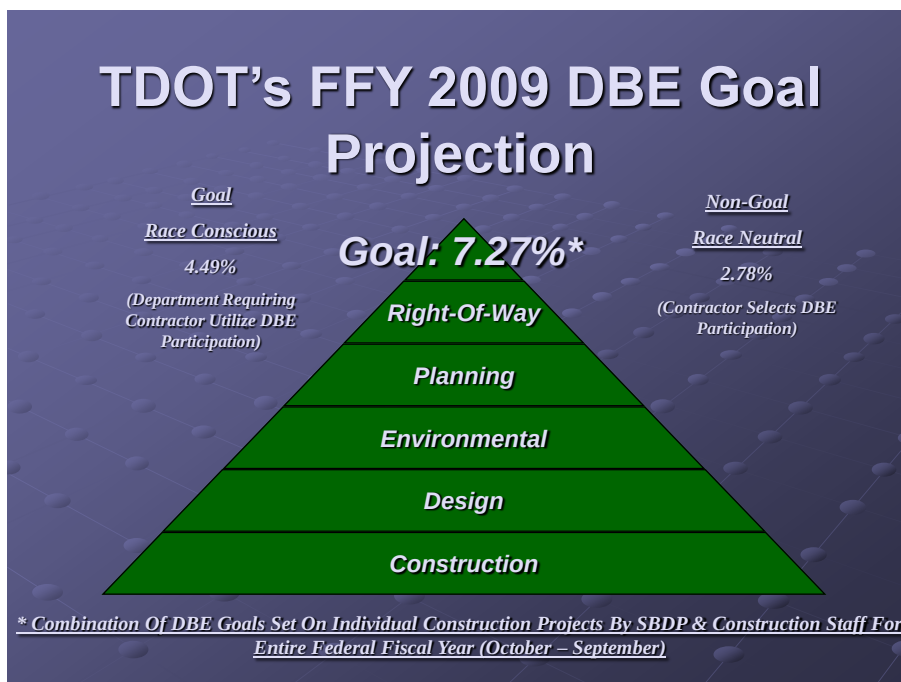


Figure A2. TDOT Projected Participation Goal FFY 2009

Taken from Reference [16]

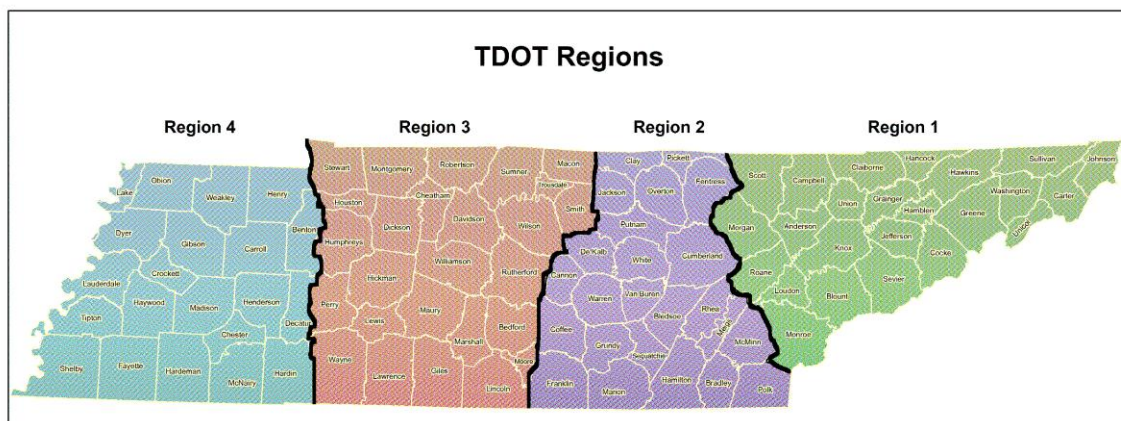


Figure A3. TDOT Regional Organization

Modified TDOT GIS Map

DBE Highway & Bridge Construction Work Areas

- Paving
- Concrete Construction:
- Reinforcement Steel
- Specialty Items:
- Guardrail & Fence Placement
- Pavement Scoring
- Earthwork Services
- Drainage:
- Placement of Lateral Underdrains & Catchbasins
- Consultants
- Suppliers
- Professional Services



Figure A4. TDOT DBE Solicitation

Taken from Reference [16]

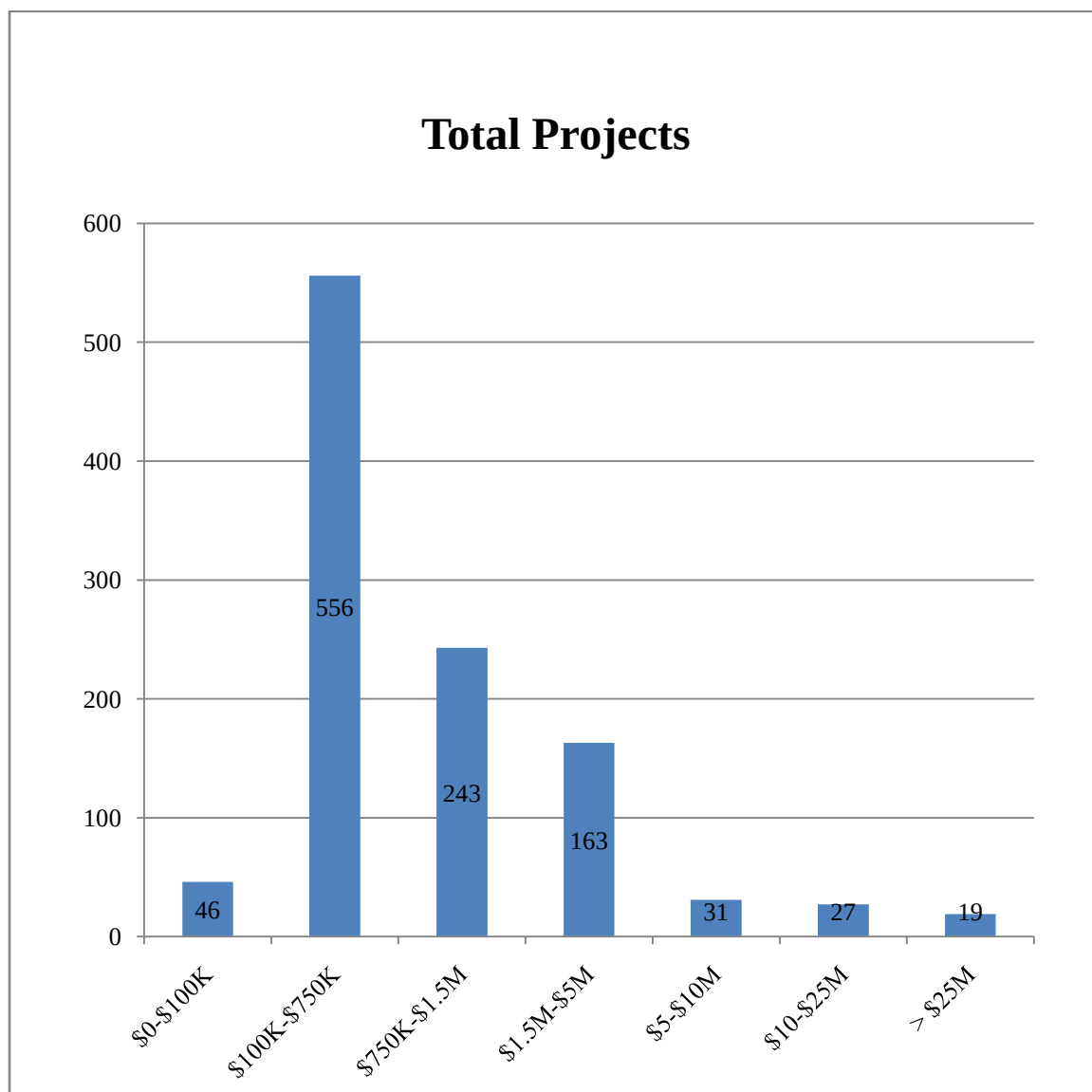


Figure A5. Project Size Distribution (all projects)

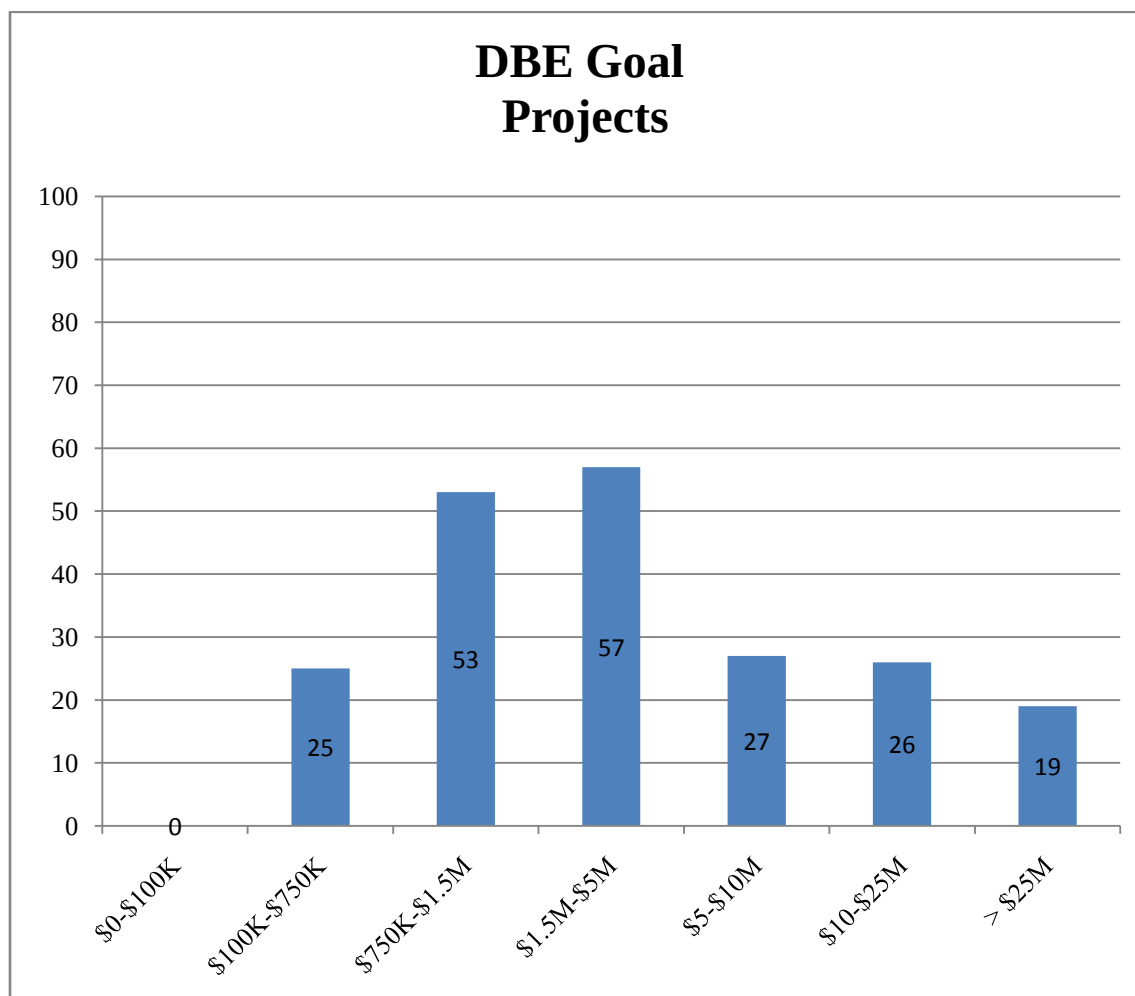


Figure A6. Project Size Distribution (DBE projects only)

Table A1. Regression Variables

Regression Variable	Description
<i>laward</i>	Dependent Variable – Log Winning Bid
<i>dbegoal</i>	Project Participation Goal
<i>dbepart</i>	Dummy Variable – Participation Goal
<i>lestamt</i>	Log of TDOT Cost Estimate (ECE)
<i>qtybids</i>	Number of Bids Received
<i>biddist</i>	Contractor's Proximity to Project (miles)
<i>ltime</i>	Log Time (days from bid to completion)
<i>major</i>	Indicator Variable – Major* Work Item
<i>landscape</i>	Indicator Variable – Landscaping
<i>resurface</i>	Indicator Variable – Resurfacing
<i>other</i>	Indicator Variable – Other Work
<i>regX</i>	Geographic Dummy Variable
<i>inshwy</i>	Dummy Variable – Interstate Highway
<i>ushwy</i>	Dummy Variable – US Highway Route
<i>srhwy</i>	Dummy Variable – State Route Highway
<i>city</i>	Dummy Variable – City Street
<i>ctyroad</i>	Dummy Variable- County Road
<i>misc</i>	Dummy Variable – Other Location
<i>ffyyXX</i>	Dummy Variable – Federal Fiscal Year

*A major work item is defined as any combination of bridge work, paving, and grading.

Table A2. Summary Statistics-All Observations

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>laward</i>	1085	13.51204	1.221522	9.349145	18.46632
<i>awardamt*</i>	1085	2106874	6389294	11489	1.05E+08
<i>dbegoal</i>	1085	0.013005	0.029193	0	0.1
<i>dbepart</i>	1085	0.190783	0.393100	0	1
<i>lestamt</i>	1085	13.58661	1.186630	9.9711	18.37954
<i>estimatedamt*</i>	1085	2187744	6277549	21399	9.60E+07
<i>qtybids</i>	1085	2.740092	1.509718	1	9
<i>biddist</i>	1085	80.74747	110.0358	0	783
<i>ltime</i>	1085	5.463661	0.532734	4.110874	7.25982
<i>projtime*</i>	1085	278.3871	200.2123	61	1422
<i>major</i>	1085	0.358525	0.479789	0	1
<i>landscape</i>	1085	0.001843	0.042914	0	1
<i>resurface</i>	1085	0.392627	0.488560	0	1
<i>other</i>	1085	0.303226	0.459864	0	1
<i>reg1</i>	1085	0.269124	0.443709	0	1
<i>reg2</i>	1085	0.221198	0.415245	0	1
<i>reg3</i>	1085	0.262673	0.440289	0	1
<i>reg4</i>	1085	0.247005	0.431468	0	1
<i>inshwy</i>	1085	0.125346	0.331263	0	1
<i>ushwy</i>	1085	0.200000	0.400185	0	1
<i>srhwy</i>	1085	0.398157	0.489744	0	1
<i>city</i>	1085	0.076498	0.265915	0	1
<i>ctyroad</i>	1085	0.073733	0.261456	0	1
<i>misc</i>	1085	0.119816	0.324896	0	1
<i>ffy05</i>	1085	0.247005	0.431468	0	1
<i>ffy06</i>	1085	0.266359	0.442258	0	1
<i>ffy07</i>	1085	0.224885	0.417699	0	1
<i>ffy08</i>	1085	0.246083	0.430926	0	1
<i>ffy09</i>	1085	0.015668	0.124246	0	1

*Corresponding level values of the logarithmic forms

Table A3. Summary Statistics-Reduced Data Set

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>laward</i>	1039	13.62164	1.124726	11.53084	18.46632
<i>awardamt*</i>	1039	2197167	6514575	101807.8	1.05E+08
<i>dbegoal</i>	1039	0.013580	0.029701	0	0.1
<i>dbepart</i>	1039	0.199230	0.399614	0	1
<i>lestamt</i>	1039	13.68575	1.108338	11.49137	18.37954
<i>estimatedamt*</i>	1039	2280418	6399308	97868	9.60E+07
<i>qtybids</i>	1039	2.748797	1.518491	1	9
<i>biddist</i>	1039	78.88065	107.7139	0	783
<i>ltime</i>	1039	5.467898	0.534755	4.110874	7.25982
<i>projtime*</i>	1039	280.1059	203.0152	61	1422
<i>major</i>	1039	0.369586	0.482925	0	1
<i>landscape</i>	1039	0.001925	0.043853	0	1
<i>resurface</i>	1039	0.410010	0.492072	0	1
<i>other</i>	1039	0.277190	0.447827	0	1
<i>reg1</i>	1039	0.267565	0.442903	0	1
<i>reg2</i>	1039	0.225217	0.417926	0	1
<i>reg3</i>	1039	0.254091	0.435558	0	1
<i>reg4</i>	1039	0.253128	0.435013	0	1
<i>inshwy</i>	1039	0.124158	0.329920	0	1
<i>ushwy</i>	1039	0.200193	0.400337	0	1
<i>srhwy</i>	1039	0.406160	0.491352	0	1
<i>city</i>	1039	0.069297	0.254082	0	1
<i>ctyroad</i>	1039	0.075072	0.263635	0	1
<i>misc</i>	1039	0.118383	0.323217	0	1
<i>ffy05</i>	1039	0.248316	0.432244	0	1
<i>ffy06</i>	1039	0.267565	0.442903	0	1
<i>ffy07</i>	1039	0.223292	0.416653	0	1
<i>ffy08</i>	1039	0.245428	0.430548	0	1
<i>ffy09</i>	1039	0.015399	0.123195	0	1

*Corresponding level values of the logarithmic forms

Table A4. Regression Results-Reduced Data Set

Number of obs	=	1039				
F(18, 1020)	=	2943.36				
Prob > F	=	0.0000				
R-squared	=	0.9793				
Root MSE	=	0.16332				

Variable	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
<i>dbegoal*</i>	0.379987	0.202769	1.87	0.061	-0.017906	0.777879
<i>lestamt***</i>	1.002061	0.006910	145.01	0.000	0.988501	1.015621
<i>qtybids***</i>	-0.027530	0.004044	-6.81	0.000	-0.035464	-0.019600
<i>major</i>	0.012538	0.025265	0.50	0.620	-0.037040	0.062116
<i>resurface</i>	-0.003828	0.027618	-0.14	0.890	-0.058024	0.050367
<i>landscape</i>	0.089694	0.220235	0.41	0.684	-0.342471	0.521859
<i>other</i>	-0.015150	0.021911	-0.69	0.489	-0.058147	0.027847
<i>ffyo5</i>	-0.003069	0.016919	-0.18	0.856	-0.036268	0.030131
<i>ffyo6</i>	-0.010209	0.014674	-0.70	0.487	-0.039004	0.018587
<i>ffyo7</i>	-0.013267	0.013963	-0.95	0.342	-0.040665	0.014133
<i>reg2</i>	-0.025764	0.015806	-1.63	0.103	-0.056780	0.005252
<i>reg3</i>	-0.012415	0.014099	-0.88	0.379	-0.040081	0.015250
<i>reg4***</i>	-0.047990	0.014702	-3.26	0.001	-0.076839	-0.019142
<i>inshwy</i>	-0.007955	0.025430	-0.31	0.754	-0.057856	0.041946
<i>ushwy</i>	0.027597	0.022861	1.21	0.228	-0.017262	0.072456
<i>srhwy**</i>	0.046576	0.023097	2.02	0.044	0.001253	0.091899
<i>city</i>	0.021864	0.033738	0.65	0.517	-0.044340	0.088067
<i>ctyroad</i>	0.031357	0.029452	1.06	0.287	-0.026436	0.089150
<i>_cons</i>	-0.020604	0.097822	-0.21	0.833	-0.212559	0.171352

***, **, * Indicates confidence levels of 99%, 95%, and 90% respectively

Table A5. Regression Results-Average Cost Effects

Number of obs	=	1039				
F(18, 1020)	=	2957.53				
Prob > F	=	0.0000				
R-squared	=	0.9794				
Root MSE	=	0.16304				

Variable	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
<i>dbepart</i> ***	0.041291	0.014507	2.85	0.005	0.012824	0.069757
<i>lestamt</i> ***	0.999249	0.006979	143.18	0.000	0.985554	1.012943
<i>qtybids</i> ***	-0.027514	0.004032	-6.82	0.000	-0.035425	-0.019603
<i>major</i>	0.010708	0.025230	0.42	0.671	-0.038801	0.060218
<i>resurface</i>	-0.007176	0.027239	-0.26	0.792	-0.060627	0.046275
<i>landscape</i>	0.092260	0.216342	0.43	0.670	-0.332266	0.516786
<i>other</i>	-0.016202	0.021860	-0.74	0.459	-0.059098	0.026693
<i>ffly05</i>	-0.006355	0.017076	-0.37	0.710	-0.039863	0.027153
<i>ffly06</i>	-0.011877	0.014762	-0.80	0.421	-0.040844	0.017090
<i>ffly07</i>	-0.014838	0.014065	-1.05	0.292	-0.042437	0.012761
<i>reg2</i>	-0.025131	0.015632	-1.61	0.108	-0.055805	0.005543
<i>reg3</i>	-0.011899	0.014020	-0.85	0.396	-0.039411	0.015612
<i>reg4</i> ***	-0.048027	0.014668	-3.27	0.001	-0.076811	-0.019243
<i>inshwy</i>	-0.011169	0.025408	-0.44	0.660	-0.061026	0.038688
<i>ushwy</i>	0.027471	0.022774	1.21	0.228	-0.017218	0.072159
<i>srhwy</i> **	0.046533	0.022965	2.03	0.043	0.001469	0.091597
<i>city</i>	0.021254	0.033532	0.63	0.526	-0.044546	0.087054
<i>ctyroad</i>	0.029369	0.029522	0.99	0.320	-0.028561	0.087299
<i>_cons</i>	0.019096	0.099095	0.19	0.847	-0.175357	0.213549

***, **, * Indicates confidence levels of 99%, 95%, and 90% respectively

Appendix B

Table B1. Regression Results-Full Data Set (with all explanatory variables)

Number of obs	=	1085				
F(20, 1064)	=	2507.95				
Prob > F	=	0.0000				
R-squared	=	0.9794				
Root MSE	=	0.17692				

Variable	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
<i>dbegoal</i>	0.136901	0.222051	0.62	0.538	-0.298807	0.572609
<i>lestamt***</i>	1.016655	0.008059	126.15	0.000	1.000841	1.032469
<i>qtybids***</i>	-0.027400	0.004217	-6.50	0.000	-0.035675	-0.019125
<i>ltime</i>	0.002059	0.018497	0.11	0.911	-0.034236	0.038354
<i>biddist</i>	0.000049	0.000056	0.87	0.382	-0.000061	0.000159
<i>major*</i>	0.044917	0.026689	1.68	0.093	-0.007453	0.097287
<i>resurface</i>	0.029312	0.031132	0.94	0.347	-0.031775	0.090398
<i>landscape</i>	0.120302	0.268891	0.45	0.655	-0.407314	0.647918
<i>other</i>	-0.016370	0.023399	-0.70	0.484	-0.062288	0.029540
<i>ffly05</i>	-0.000727	0.017479	-0.04	0.967	-0.035024	0.033571
<i>ffly06</i>	-0.012711	0.014877	-0.85	0.393	-0.041904	0.016480
<i>ffly07</i>	-0.014080	0.015304	-0.92	0.358	-0.044109	0.015950
<i>reg2</i>	-0.008329	0.016854	-0.49	0.621	-0.041399	0.024742
<i>reg3</i>	-0.009442	0.015450	-0.61	0.541	-0.039759	0.020874
<i>reg4**</i>	-0.039770	0.016247	-2.45	0.015	-0.071649	-0.007891
<i>inshwy</i>	-0.032342	0.026696	-1.21	0.226	-0.084724	0.020040
<i>ushwy</i>	0.002086	0.023830	0.09	0.930	-0.044673	0.048846
<i>srhwy</i>	0.033031	0.023083	1.43	0.153	-0.012261	0.078324
<i>city</i>	-0.027124	0.038082	-0.71	0.476	-0.101847	0.047600
<i>ctyroad</i>	0.018029	0.029877	0.60	0.546	-0.040596	0.076653
<i>_cons**</i>	-0.253534	0.116321	-2.18	0.030	-0.481780	-0.025290

***, **, * Indicates confidence levels of 99%, 95%, and 90% respectively

Table B2. Regression Results-Full Data Set (with significant explanatory variables)

Number of obs	=	1085				
F(18, 1066)	=	2749.74				
Prob > F	=	0.0000				
R-squared	=	0.9794				
Root MSE	=	0.17683				

Variable	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
<i>dbegoal</i>	0.136316	0.212847	0.64	0.522	-0.281330	0.553961
<i>lestamt***</i>	1.017364	0.007238	140.56	0.000	1.003162	1.031566
<i>qtybids***</i>	-0.027137	0.004210	-6.45	0.000	-0.035398	-0.018876
<i>major</i>	0.042334	0.026457	1.60	0.110	-0.009580	0.094247
<i>resurface</i>	0.025600	0.029227	0.88	0.381	-0.031750	0.082949
<i>landscape</i>	0.116035	0.269084	0.43	0.666	-0.411958	0.644028
<i>other</i>	-0.016530	0.023051	-0.72	0.474	-0.061757	0.028702
<i>ffly05</i>	-0.000531	0.017465	-0.03	0.976	-0.034803	0.033736
<i>ffly06</i>	-0.013085	0.014870	-0.88	0.379	-0.042263	0.016093
<i>ffly07</i>	-0.014023	0.015292	-0.92	0.359	-0.044029	0.015984
<i>reg2</i>	-0.007228	0.016765	-0.43	0.666	-0.040123	0.025668
<i>reg3</i>	-0.009355	0.015418	-0.61	0.544	-0.039608	0.020898
<i>reg4**</i>	-0.040466	0.015903	-2.54	0.011	-0.071671	-0.009260
<i>inshwy</i>	-0.031582	0.026340	-1.20	0.231	-0.083266	0.020102
<i>ushwy</i>	0.001700	0.023963	0.07	0.943	-0.045320	0.048720
<i>srhwy</i>	0.032090	0.023337	1.38	0.169	-0.013702	0.077882
<i>city</i>	-0.026728	0.038072	-0.70	0.483	-0.101433	0.047977
<i>ctyroad</i>	0.017315	0.029860	0.58	0.562	-0.041277	0.075907
<i>_cons**</i>	-0.245894	0.102517	-2.40	0.017	-0.447052	-0.044740

***, **, * Indicates confidence levels of 99%, 95%, and 90% respectively

Vita

Edward Lee Taylor was born in Jackson, Tennessee. He graduated from Huntingdon High School in 1976 and served in the U.S. Army. Upon discharge, he entered the University of Tennessee and earned a Bachelor of Science in Civil Engineering in 1983. After being employed in consulting and manufacturing as a registered professional engineer, he entered the University of Georgia and received a Master of Business Administration degree in 1993. Subsequent work included ten years in project management within the bridge construction industry and self-employment. This thesis completes the requirements for a Master of Arts in Economics at the University of Tennessee in 2009.