Construction Solicitation Analysis for FAA Terminal Replace Projects

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The number of bids received on recent Federal Aviation Administration (FAA) Terminal Replacement Projects has been lower than anticipated. Given the knowledge that increased competition (i.e., more bidders) results in lower contract award costs, we have conducted an assessment to understand the relationships between: the number of bidders, the contract award price, and the national unemployment index. Using the data presented in this paper we propose a strategy for tailoring solicitations based on the unemployment index.

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Purpose

The number of bids received on recent Federal Aviation Administration (FAA) Terminal Replacement Projects has been lower than anticipated. Given the knowledge that increased competition (i.e., more bidders) results in lower contract award costs, we have conducted an assessment to understand the relationships between the number of bidders, the contract award price, and the national unemployment index. Using the data presented in this paper, we propose a strategy for tailoring solicitations based on the unemployment index.

Introduction

Research has shown increased competition (aka more bids) for construction projects results in a lower price for the owner. One study found that owners paid 15% more than their pre-bid estimate when only one bid was received [1], where others have shown the impact could be above 35% [2]. Given the large impact that bid participation can have on a project's cost, it is important that owners understand the factors affecting a contractor's decision to bid.

Contractors consider the following when deciding to bid and how to adjust their bid price: prequalification requirements, contract type, award basis, confidence in estimating ability, completeness and correctness of the design package, nature of the work, location, project duration, and assumed probability of winning. While many of these factors are worthy of individual consideration, they may be interrelated and/or driven by the overall economy. The relationship between the economy (via the unemployment rate) and bidding activity has been measured [2]: when unemployment is high, economic activity is low and construction projects are scarce, so owners can expect more bids. Conversely, when unemployment is low, construction projects are abundant, so owners can expect fewer bids. This suggests owners may want to tailor their solicitation documents to entice contractors to bid when the unemployment rate is low. The goal of any owner should be to generate maximum interest in a project, and ensure bidders are qualified to complete the work. Many government entities ensure this through pre-qualification.

Pre-qualification is a process that allows an owner to ensure potential bidders have the required experience and resources (i.e., human and financial) to complete the project they are bidding. While pre-qualification is generally viewed as a best practice, it is possible prequalification criteria can be overly restrictive and thereby reduce competition. Furthermore, an owner's prequalification criteria may be based on perceptions of what drives good performance rather than statically proven findings. For example, seeking contractors with prior experience in completing projects of a similar complexity is prudent, but restricting competition based on a particular project type with a particular owner may be overly restrictive and not related to project performance.

In this study, we use data from FAA projects that constructed a manned air traffic control (ATC) facility to look for statistical relationships between the unemployment rate, the number of bidders, and the project's cost. We compared how prequalification criteria in recent solicitation documents related to the number of bids received. Finally, we compared the performance outcomes between projects that did and did not use prime contractors who had prior FAA ATC construction experience. Our hope is this research will provide insight that improves the cost competitiveness and predictability of future projects.

Data Description

The FAA is responsible for the maintenance of over 300+ manned air traffic control facilities across the United States. As part of managing this infrastructure, it is periodically necessary to replace a facility. A replacement project typically involves the construction of Air Traffic Control Towers (ATCTs) and a base building that may or may not include a Terminal Radar Control (TRACON) facility. In addition, there are some projects that construct a standalone TRACON facility; typically these are 1- to 2-story buildings ranging in size from 20,000-65,000 square feet. These construction cost for replacing a manned ATC facility typically ranges from $10-$50 million.

Project Data

We have amassed a database that includes the construction award costs for 81 manned ATC facilities. The projects in the database were awarded between 1989 and 2018. Seventy-two of these projects are used in a regression model by the FAA to estimate the replacement cost for ATC facilities.

To account for changes in inflation and the differences in construction costs across the U.S., each project in the model has been adjusted to 2016 dollars and a national average location[1] using RS Means. The variables in the model used to predict the construction cost are Air Traffic Control Tower Height (vertical linear feet to the cab floor) and the size of the base building (square feet). The model estimated cost is plotted against the observed construction award in Figure 1, demonstrating the goodness of fit. The blue line indicates when the prediction is equal to the award cost. The statistical measure of how well the model fits the data (how close the predictions are to the blue line) is known as R2. In this model, the R2 is 0.86, meaning that 86% of the variability in the construction cost of an ATC facility can be explained by the tower height and base building size.

[1] Location adjustments were made using RS Means.

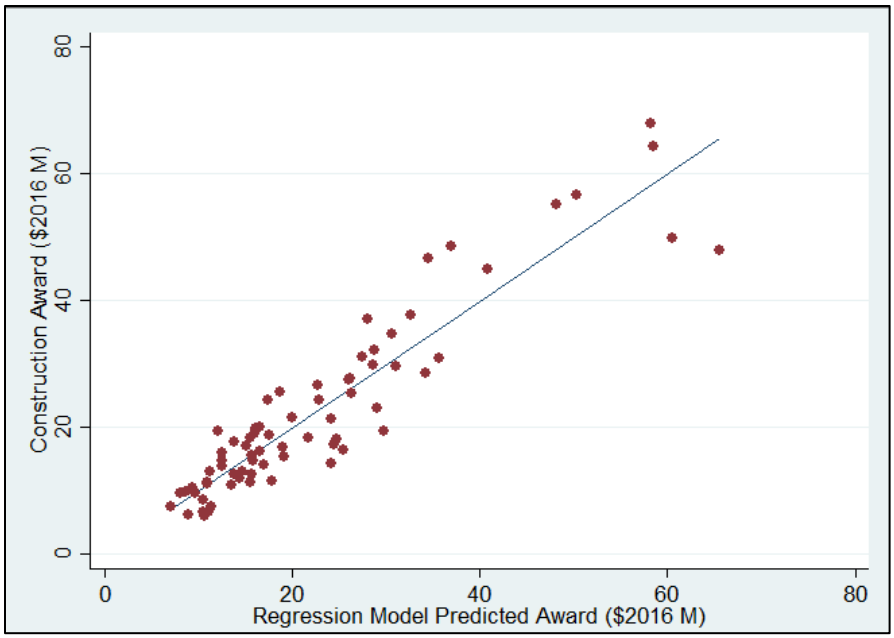

Figure 1: Modeled vs Observed Construction Award Cost

While the primary use for this regression model is to predict construction costs for future projects, the modeled cost can also be considered a benchmark cost (i.e., what historical data suggests the project should have cost) for completed projects. In this current study, we have used the model to determine the predicted cost for each project which we then compared to the actual award using a metric we call the Bid Factor. The Bid Factor represents the percent paid above or below what historical data suggests the project should have cost.

The equation for the Bid Factor is:

$$Bid\ Factor = \frac{Award\ Cost - Predicted\ Cost}{Predicted\ Cost} \times 100\% \quad (1)$$

The Bid Factor based on a benchmark cost provides us a unique advantage to study the impacts of the economy on project cost. Previous studies focused on a variety of project types, and compared the actual cost relative to the bids received or their estimates at the time. However, the owners cost estimate and contractor's bids would likely be higher or lower than a benchmark price depending on the economy. By using a benchmark model to develop a predicted cost and studying the accuracy of the model over a number of economic cycles, we can develop greater insight into how the economy affects the Bid Factor.

The database also contains the cost of change orders and schedule slip (actual construction duration divided by planned construction duration) data for 24 projects. The change orders, which are typically the result of scope or design changes during construction, are expressed as a percentage of the initial construction contract amount. This data only exists for 24 of the most recent projects because the records for older project were not readily retrievable.

Bid Data

When bidding the construction portion of the project[2], the FAA typically utilizes a 2-phase procurement procedure. The first phase is a Screening Information Request (SIR) invitation to pre-qualify the contractors. The contractors are provided a general scope of the project, given the pre-qualification requirements, and provided a synopsis of the project, typically including the following: project location and facility size, anticipated start date, a range for the estimated cost, evaluation criteria for prequalification, bonding, and insurance requirements. All contractors who successfully complete the phase 1 SIR are publicly announced via website and are invited to participate in Phase 2, the Request for Offer[3]. Contractors who successfully complete Phase 1 are individually sent the full design package, project requirements, and contract terms to enable bid development. Given that most of the Phase 2 documentation was not publicly posted, this information was not readily accessible.

Fortunately, the FAA does maintain an archive of some of the information that was posted during Phase 1 on the FAA Contract Opportunities website [3]. For many of the projects since 2007, we were able to obtain the Phase 1 SIR documentation and the qualified vendor list that resulted from Phase 1. In total, we were able to identify much of this documentation and data for 14 projects. While we don't know how many of the vendors submitted bids, we know the number of invited bidders.

Other data taken from the Phase 1 documentation that we will analyze the effects of are the allowed construction duration, the bid evaluation criteria/key performance indicators, and the award basis (e.g., low bid, best value, etc.).

Analysis

All of the findings discussed from this point forward are based on FAA data that have a statistical significance of 95% or higher. With this level of significance, we have high confidence in each of the trends and findings discussed.

[2] The vast majority of FAA ATC manned facilities replacement projects follow a Design-Bid-Build delivery method. The focus of this analysis is on the construction portion of the project.

[3] Bolded for emphasis as this will be discussed later.

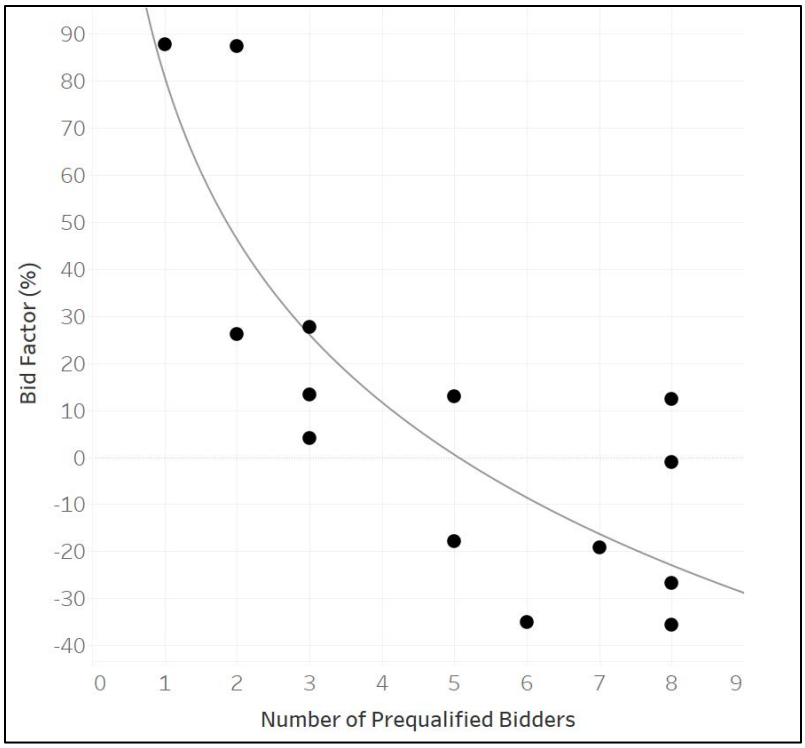

Figure 2: Relationship between Bid Factor and Number of Prequalified Bidders

Figure 2 shows the relationship between the Bid Factor and the number of bidders prequalified and invited to bid on the project. The correlation coefficient between these 2 variables is -0.76. The negative correlation coefficient indicates an inverse relationship: fewer bids results in a higher bid factor. The negative correlation between the number of bidders and its impact on the awarded bid is consistent with previous studies. Based on this data, the benefits of attracting more competition is significant; projects with less than 4 prequalified bidders paid an average of 41% more than their benchmark cost while projects with 4 or more bidders paid an average of 14% less than their benchmark cost. Finally, the shape of the trend line[4] supports previous findings that there is an optimal number of bidders, beyond which there is a diminishing benefit for receiving more bids [1].

Knowing this trend can help organizations understand why bids have come in higher than estimated, but it does not directly assist budget planning. In fact, the number of prequalified bidders on FAA projects is generally not known until a few months before the award is planned. Therefore, if we can estimate the bid activity based on a known economic indicator, like the national unemployment index, this would improve an organizations ability to more accurately estimate a project's cost.

In Figure 3, we compare the national unemployment index at the time of construction award to the number of prequalified bidders. The correlation coefficient between these 2 variables is 0.91. Given that a coefficient of 1.0 suggests a statistically certain relationship, while a coefficient above 0.50 is considered a "strong" correlation. A coefficient of 0.91 suggests the number of vendors

[4] A logarithmic function was a better fit than linear: R^2 of 0.70 vs 0.58, respectively.

that will bid on a project can mostly be explained by the unemployment index. While we would expect there would be more bidders on projects when there is less work available (higher unemployment index), the strength of the correlation is much higher than we anticipated. Additional factors that may be affecting this trend will be discussed later.

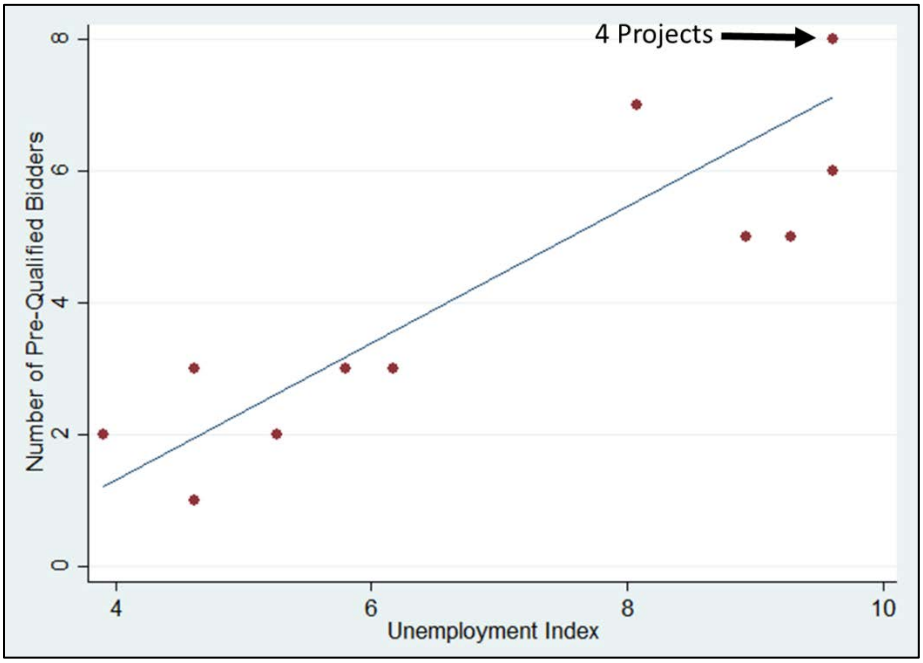

Figure 3: Number of Prequalified Bidders vs Unemployment Index

We have now shown the number of bidders affects the bid premium, and the number of bidders is correlated with the unemployment index. This naturally leads us to believe the bid factor is related to the unemployment index. Their relationship is shown below in Figure 4. The correlation coefficient between these two variables is -0.79; as the unemployment index decreases, the Bid Factor increases. The data is best fit with a logarithmic function (R2=0.66).

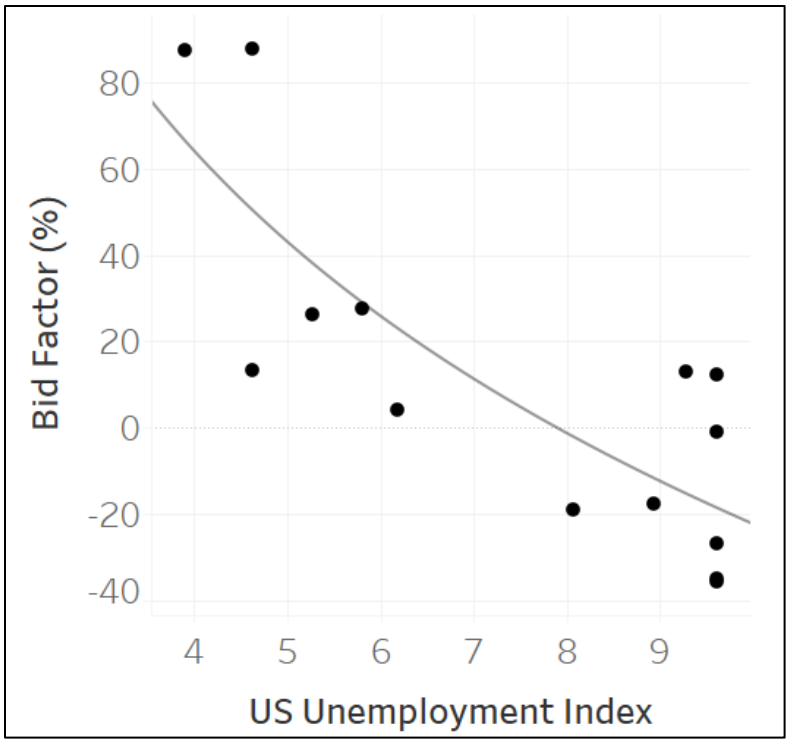

Figure 4: Bid Factor vs Unemployment Index (Recent Projects)

Until this point, we focused our analysis on recent projects where we were able to review the solicitation documents. Given that we found such a strong correlation between the Unemployment Index and the Bid Factor, we analyzed the correlation after adding in all of the projects in the linear regression cost model.

The combined data for 75 projects are shown in Figure 5. The Figure shows both the logarithmic best fit curve (R^2=0.20) and the uncertainty bands show the 95% confidence interval. Given this data dates back to 1989, and given how procurement practices both on the FAA side and construction contractors have changed, it is not surprising to see significant scatter in the data. However, using all 75 projects, the correlation coefficient between these 2 variables is -0.42 and is still statistically significant.

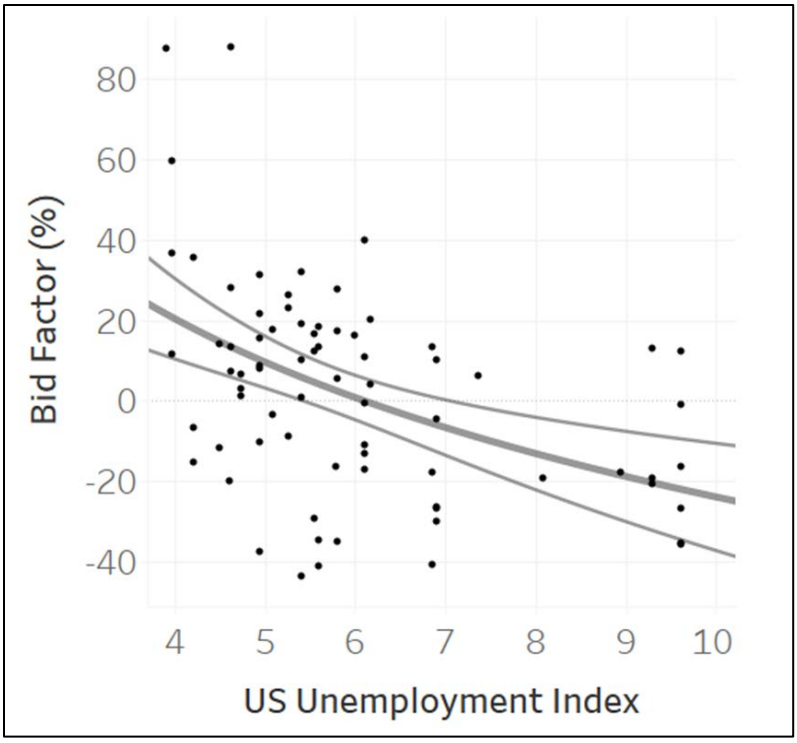

Figure 5: Bid Factor vs Unemployment Index (All Projects)

Solicitation Review

While the statistical analysis presented herein provides a methodology for better predicting/anticipating the future costs of projects, it also provides an opportunity to improve owner acquisition practices. For example:

- How might information in solicitation documents be impacting a contractor's decision to bid?
- Should the solicitation documents be tailored based on the unemployment index?
- Should an owner publicly announce the names of prequalified vendors?

Additionally, by analyzing the cost and schedule performance of projects, we can also help inform project professionals about what criteria may or may not be tied to outcomes. In particular, does contractor experience on FAA projects result in better cost or schedule performance?

Bid Evaluation/Prequalification Criteria

The vast majority of solicitation documents we reviewed cited Best Value as the award basis. On average, there were 4 evaluation criteria categories with a range of 1-5. Past Performance was the most often used criteria. We noticed, however, that in some instances, the solicitation indicated a strong preference of FAA ATCT/TRACON experience, while others did not specifically mention FAA experience and instead chose phrasing such as experience with placing pre-cast panels on structures over 200 feet tall. We separated the solicitations into two groups based on whether or not they indicated a preference for FAA experience.

Knowing contractors will review the evaluation criteria to determine if they have a good chance of winning the work, we were not surprised to find that when FAA experience was a positive evaluation factor, there were fewer bidders. Interestingly, FAA experience was more likely to be preferred when the unemployment rate was low. This seemed counterintuitive: why when the unemployment index is low does the prequalification criteria seem more restrictive? If FAA experience is believed to be beneficial, why would the preference for it change over time? While this seems counterintuitive, the reason for the difference is likely due to government spending priorities during the Great Recession.

The projects we have solicitation packages for range from the years 2007-2018, with an average year of 2011. During the period after the passage of the stimulus package, Federal Agencies were provided funds and directed to prioritize shovel ready projects. It seems possible that to ensure contractors bid on the projects, and the funds were awarded quickly, Acquisition Officials may have reduced/loosened pre-qualification requirements.

If you recall, the correlation between the number of bidders and the unemployment index (Figure 3) was much higher than observed in prior studies. It is likely the impact of writing more restrictive evaluation/prequalification criteria is influencing the trend. This represents an opportunity for owners: you should relax pre-qualification criteria when the unemployment index is low to increase the number of bids you receive.

In the next section, we seek to understand if there are quantifiable benefits for limiting competition to contractors with significant prior experience.

The Value of Past Performance

By combining project cost and schedule data with information obtained from www.usaspending.gov, we sought to link experience with prior FAA ATCT/TRACON projects to outcomes. We identified projects where the contractor had been awarded and previously constructed one or more ATC facilities, and compared their outcomes to projects where it was the contractor's first ATC facility project. Table 1 shows how the bid factor, schedule slip (planned vs actual duration), and percentage of change orders compared between the two groups.

Performance Indicator	Finding
Bid Factor	No difference
Schedule Slip	No difference
Change orders	No difference

Table 1: Comparing Outcomes between Contractors with and without Prior ATC Experience

The belief that prior FAA manned facility construction experience should be sought because it results in better performance is not supported by the data in this study.

Other Notable Contract Clauses

Some recent contracts have identified liquidated damages assessed on a $/day basis for taking longer than the number of days specified in the contract. What makes this notable is recently

completed projects have taken 21% longer to complete construction, on average, than what was listed in the original contract. While contract modification (change orders) likely provided an extension to these durations, the fact that no project completed faster than what was listed in the contract indicates the contract durations are not "soft." If these durations are considered by the contractors as aggressive (particularly for those who have prior FAA experience), it is very likely contractors will price this risk into their bids.

Finally, we did notice a few projects did list the requirement for small business subcontracting goals. These goals were listed at either 25% or 45%. The goal to achieve 45% subcontracting goals could significantly affect a contractor's execution strategy. Some FAA projects also call for a minimum requirement for the general contractor to self-perform. While these goals may be set by statute, and there may be some benefit to employing them, it is at least worth noting this requirement could also affect bid participation.

Conclusions

The information presented in this paper can be used to better anticipate the effect of the economic forces on large construction projects. When the unemployment rate is low, owners should anticipate receiving fewer bids and therefore tailor the solicitation documents to encourage greater competition. Failure to attract bidders can result in paying over 50% more than historical data predicts. Owners should avoid using evaluation criteria that unnecessarily limits competition, particularly when related to prior experience since it does not appear to affect project outcomes. Finally, given the relationship between the number of prequalified bidders and the bid factor, it may be worth considering the pros and cons of announcing the number and names of prequalified vendors who will be invited to bid.

Acknowledgements

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