

# Initial Cost Uncertainty in LCCA

## Problem

The CSHub has conducted probabilistic pavement life cycle cost analyses (LCCA) for a range of scenarios. Interestingly, preliminary results have shown that initial cost variability can be a significant contributor to total life-cycle cost uncertainty in some scenarios. As such, it is important to quantify the drivers of initial cost uncertainty for an LCCA.

## Approach

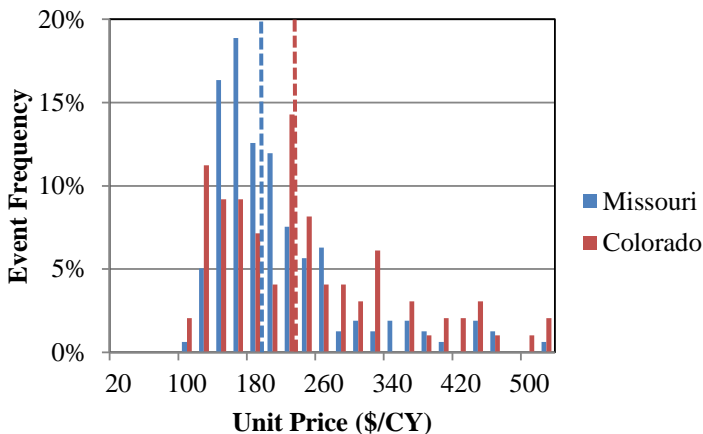
We have characterized unit-cost uncertainty by leveraging the fact that cost is oftentimes a function of quantity. We have used historical bid data to quantify the relationship between cost and quantity by regressing average cost with respect to bid quantity. Other factors not captured by this relationship, such as seasonality, day versus night construction, and transportation costs are modeled by using the standard error of the regression equation when conducting a Monte Carlo simulation.

More recently, we have analyzed historical bid data for multiple states in order to understand how the cost of LCCA inputs varies by location. A better understanding of this geographical variation will facilitate insights into the drivers of uncertainty in LCCA.

## Findings

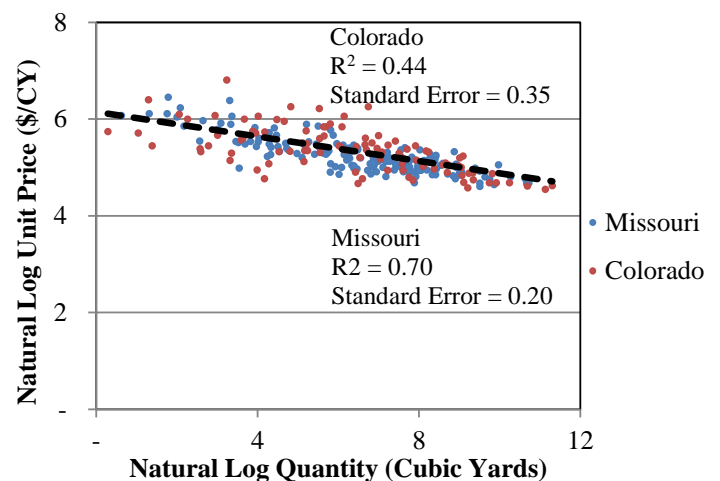
As shown in Figure 1, at first glance there is a considerable amount of variation in the unit-bid price of concrete for both the state of Colorado and Missouri over a 3 year period.

**Figure 1** Historical Unit-Price of Concrete Pavement Layer Prices for Missouri and Colorado from 2010-2012 via the Oman Bid Systems Database. Dashed lines represent the *unweighted* mean unit-price



The mean unit-price between the locations (dashed lines) is quite different. Some of the uncertainty, however, can be explained by characterizing the relationship between bid price and bid quantity, as shown in Figure 2. The established regression equation between the two states is nearly identical, implying there is actually little difference in cost between the two states when accounting for quantity from a deterministic standpoint. The standard error of the regression, however, is significantly higher for Colorado, which implies that less of the uncertainty is explained by quantity. Therefore, a concrete pavement scenario in Colorado would likely have wider variation in total life-cycle cost.

**Figure 2** Regression analysis of cost versus quantity for the same two datasets. The dashed line is the regression equation for Missouri, which is nearly identical for Colorado (omitted for clarity).



## Impact

Using historical bid data to characterize uncertainty in initial costs for LCCAs will help improve the accuracy of probabilistic LCCAs. Some of the cost variation can be explained by understanding the implication of bid quantity, but the amount of variation that can be explained can vary significantly from state to state for similar bid items. Future work will explore including other factors that could impact initial costs.

## More

Research presented by Omar Swei, graduate student in the CSHub, supervised by Randolph Kirchain and Jeremy Gregory.



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