# Analysis of the Effect of Offering Price Adjustment Clauses on Highway Construction Bid Prices in Georgia


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## Introduction

- Significant volatility in the price of asphalt cement leads to considerable uncertainty about transportation project costs.

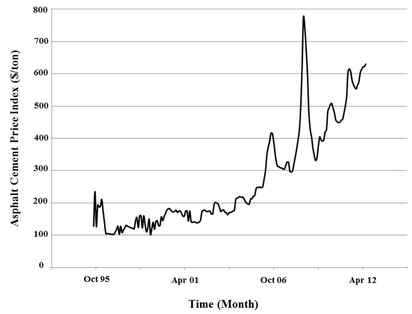


Figure 1: Asphalt Cement Price Index in Georgia

### Issues:

- Hidden Price Contingencies *(Eckert & Eger 2005)*
- Very Short-term Price Guarantees *(Ashuri & Lu 2010)*
- Not Enough Bidders *(Skolnik 2011)*

### Current Strategy:

- Price Adjustment Clause (PAC)
  - Eliminating the risk premiums of bids and reducing project costs by Sharing the risk between owner and contractors.
  - PAC has been offering for asphalt cement in Georgia since September 2005.

### Research Background:

- Asphalt cement price is a significant factor for transportation projects cost (Wang & Liu 2012).
- 40 state Department of Transportation use PAC for asphalt cement *(AASHTO 2009).*
- A survey and interview with five border states of Georgia indicates that four of them (FL, NC, TN & SC) are satisfied with PAC for asphalt cement (Eckert & Eger 2005).
- A quantitative analysis in Oklahoma state indicates that PAC is successful to reduce the difference between winner bids and engineering estimates (Kosmopoulou & Zhou 2011).
- A quantitative analysis of different states with and without PAC indicates that the effectiveness of PAC is not similar in different states (Skolnik 2011).

## Research Motivation

- What is the impact of offering PAC for asphalt cement on bid prices in Georgia?

## Research Objective

- Assess the impact of offering PAC for asphalt cement on submitted bid prices by highway contractors.

## Research Methodology

- Multivariate Regression Analysis
  - Detecting unusual observations
  - Finding the best subset
  - Evaluation of the model
  - Residual Analysis
  - Multicollinearity Diagnosis

## Data Set

- Detailed information of 3326 transportation projects in the state of Georgia from January 1995 to May 2012.
- Four major line items:

Table 1: Four Major Line Items Related to Asphalt Mixture

| Item Code | Item Description |
|---|---|
| 402-1812 | Recycled Asphalt Concrete Leveling, Include Bitumen |
| 402-3190 | Recycled Asphalt Concrete 19 mm, GP 1 Or 2, Include Bitumen |
| 402-3130 | Recycled Asphalt Concrete 12.5 mm Superpave, GP 2 |
| 402-3121 | Recycled Asphalt Concrete 25 mm Superpave, GP 1 Or 2 |

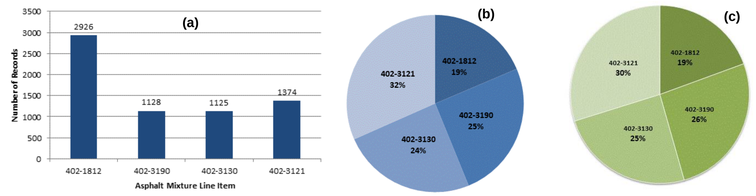


Figure 2: a) Number of records for each line item. b) Distribution of the total quantity for each line item from 1998 to 2012 and c) Distribution of the total dollar value for each line item from 1998 to 2012

## Regression Models

- **Response Variable:** Bid Prices
- **Potential Explanatory Variables:**

1. Number of Bidders
2. Duration
3. Quantity
4. Total Contract Price
5. Relative value of all asphaltic items
6. Relative value of the item
7. Location
8. Asphalt Price Index
9. Changing Rate of AC Index
10. Eligibility for PAC
11. Before or After Sept 05
12. More than 1 year

## Analysis and Results

- Detecting unusual observations
  - Large Standardized Residuals Criterion
- Finding the best subset
  - Backward Elimination Process
  - Variables with zero coefficient are not significant to explain the variation of the response variable

Table 2: Results of finding best subset for each line item

| Explanatory Variable | 402-1812 | | 402-3190 | | 402-3130 | | 402-3121 | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | P-value | Coef. | P-value | Coef. | P-value | Coef. | P-value |
| # Bidders | -0.57 | 0.000 | -0.89 | 0.000 | -0.77 | 0.000 | -0.96 | 0.000 |
| AC Index | 0.04 | 0.000 | 0.02 | 0.000 | 0.03 | 0.000 | 0.01 | 0.000 |
| Eligibility | 5.43 | 0.000 | -2.27 | 0.002 | 1.08 | 0.064 | -4.19 | 0.000 |
| > 1 year | 0.00 | NA | 0.00 | NA | 0.00 | NA | 0.00 | NA |
| Before Sept. 05 | 15.21 | 0.000 | 22.99 | 0.000 | 17.36 | 0.000 | 25.69 | 0.000 |
| Ln Quantity | -6.23 | 0.000 | -7.24 | 0.000 | -6.33 | 0.000 | -5.74 | 0.000 |
| Ln Tot. bid | 5.19 | 0.000 | 5.62 | 0.000 | 4.32 | 0.000 | 4.25 | 0.000 |
| Duration | -0.002 | 0.004 | 0.00 | NA | 0.00 | NA | 0.00 | NA |
| Item % | 48.11 | 0.000 | 20.23 | 0.000 | 13.26 | 0.000 | 10.53 | 0.000 |
| Asphalt % | 0.00 | NA | 0.00 | NA | 0.00 | NA | 0.00 | NA |
| Rate of AC | 15.54 | 0.000 | 11.62 | 0.001 | 0.00 | NA | 0.00 | NA |
| R1 | -3.07 | 0.000 | 0.00 | NA | 0.00 | NA | 1.20 | 0.040 |
| R2 | -4.10 | 0.000 | 1.95 | 0.001 | 0.00 | NA | 1.06 | 0.050 |
| R3 | -6.90 | 0.000 | 0.00 | NA | 0.00 | NA | 0.00 | NA |
| R4 | -2.70 | 0.000 | 2.21 | 0.001 | 1.13 | 0.027 | 1.47 | 0.020 |
| R5 | 0.00 | NA | 4.04 | 0.001 | 3.57 | 0.000 | 2.81 | 0.000 |
| R6 | -4.90 | 0.000 | 0.00 | NA | 1.72 | 0.001 | 1.44 | 0.010 |
| R7 | -3.51 | 0.000 | 0.00 | NA | 0.00 | NA | 0.00 | NA |
| R-Sq(adj) | 87.1% | | 81.9% | | 88.4% | | 88.1% | |

- Evaluation of the model
  - Analysis of Variance (ANOVA) test *OK!*
- Residual Analysis *OK!*
  - Patternless
  - Constant Variance
  - Normally Distributed

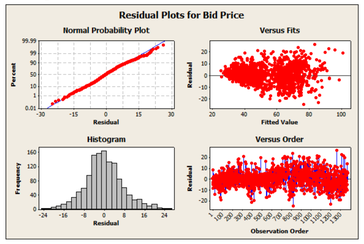


Figure 3: Residual Analysis

- Multicollinearity Diagnosis
  - Variance Inflation Factor (VIF) test
  - VIF for all variables are less than 10 *OK!*

## Conclusions

Offering PAC has mixed impact on actual bid prices

| Line Item | Result |
|---|---|
| 402-1812 | Expected bid prices for eligible projects are ***higher*** than those for ineligible projects |
| 402-3190 | Expected bid prices for eligible projects are ***lower*** than those for ineligible projects |
| 402-3130 | PAC eligibility is not a significant factor to explain the variation of bid prices |
| 402-3121 | Expected bid prices for eligible projects are ***lower*** than those for ineligible projects |