Price Indexing in Transportation Construction Contracts

Prepared for:

The Transportation Research Board
AASHTO Standing Committee on Highways

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<u>SPECIAL NOTE</u>: This report **<u>IS NOT</u>** an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.

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Introduction

When market prices of cement, steel, asphalt, fuel or other commodities used in transportation infrastructure construction are increasing, state departments of transportation (DOTs) face demands to incorporate price indexing or cost escalation clauses into construction contracts. Agency decision makers seek guidance for judging if indexing and escalation clauses are warranted, whether or not the benefits an agency may gain using such clauses outweigh the costs, and how best to implement indexing.

This was a particularly important issue within the last five years. Fluctuating petroleum prices have led to increases and decreases in the costs of fuel and asphalt products. Rising demand from China and other developing countries drove up prices for steel and other building materials. The worldwide recession then led to drops in prices for many commodities.

Price indexing and cost escalation clauses shift business risk (and potential rewards from falling commodity prices) from the contractor to the DOT. While this shift in risk may benefit the agency through contractors' willingness to submit lower bids, the agency faces greater uncertainty in budgeting and managing the final costs of a project. There is little information available on how agencies' use of such clauses may affect construction-market competition or commodity prices within a regional market. There is also little information on how the effectiveness of these clauses vary based on their design, such as the trigger point for the index, the relative project size, the type of commodity or bid item, and the presence of opt-in or opt-out clauses. Data on the administrative costs of these clauses is also lacking.

The overall objectives of this research study are to:

1. Describe the current state of DOT practice in using price indexing or price adjustment clauses (PACs) in construction contracts

2. Collect data on the experience with adjustment clauses from state DOTs, highway construction contractors and other industries

3. Conduct a quantitative analysis of the effectiveness of the clauses using highway construction bid item data

4. Provide guidance for DOT staff making decisions about whether and how they should use such clauses.

This final report addresses these four objectives. It is designed to describe current practices, perceived effectiveness, administrative cost, statistical analysis of the effectiveness of the clauses, assess the risks and benefits of administering a PAC program, and to provide program design guidance to state DOTs.

Organization of the Report

The report has three sections and three appendices.

Section I presents the Research phase of the project and contains the first three chapters.

Chapter 1 reviews the experience of state DOTs that have used price indexing or price adjustment clauses as part of their construction contracts. The analysis makes use of available literature, contact with practitioners, and other sources that are available such as the AASHTO survey of state DOT practices that is already in place. In addition, the study team conducted a survey of state DOTs that collected information on perceived effectiveness, administrative costs, and barriers to implementation of new policies. The survey also examined how the recent extreme price fluctuations have altered DOT practices and attitudes toward these clauses. Responses from DOTs in all 50 states were recorded for this survey and the research team achieved a 100 percent response rate.

Chapter 2 reviews information collected from industry on indexing and cost escalation. Research on price adjustment clauses has generally been limited to state DOTs and their opinions. This chapter reports the results of a survey of highway construction contractors. The survey sought to ascertain how the industry views these clauses, their effectiveness, and their cost. The survey of highway construction contractors utilized a sample of 400 highway construction contractors and the survey team achieved a 25 percent response rate.

Chapter 3 reports on a statistical analysis that examined whether these clauses have a measurable effect on bid prices and the number of bids. This analysis used Oman System's comprehensive Bid Price database, which contains bid prices by item and project for 48 states. The analysis compared how the bid prices for specific pay items compares to the price index of commodity costs as the commodity costs fluctuate. It assessed whether this pattern is different for states with and without price adjustment clauses. The project team conducted a similar analysis for the number of bids per contract. The focus of this statistical analysis was on the general effectiveness of price indexes and escalation clauses. The analysis sought to ascertain whether these practices affect contractors' bidding practices. In addition, the analysis attempted to examine if there are factors that affect success such as the trigger point for the index, relative project size, type of commodity or bid item, the presence of opt-in or opt-out clauses, economic conditions such as rising or falling prices and institutional factors. This aided in developing guidelines describing the program design, economic conditions and institutional factors that may warrant DOT use and type of price indexing or cost escalation clauses in highway construction contracts.

Section II presents the Results and contains the fourth chapter and the conclusions.

Chapter 4 summarizes the results of the overall data collection phase of the research study. It summarizes current practices, perceived effectiveness, administrative cost, and the statistical analysis of the effectiveness of the clauses. It also assesses the risks and benefits associated with PAC implementation. It combines the knowledge gained to develop preliminary guidelines describing the program design, economic conditions and institutional factors that may warrant DOT use and type of price adjustment clauses in highway construction contracts.

Immediately following Chapter 4 and the conclusions is Section III, the Guidelines for PAC design and implementation guidelines to be used by state DOTs. Using a "strategic evaluation array," the study team recommends PAC methods and materials to include. This report highlights best practices and makes appropriate recommendations. This document can be viewed as a part of the larger report or as a stand-alone document.

Appendices A and B display copies of the contractor and DOT surveys.

Appendix C supplies selected existing PAC programs and sample spreadsheets.

Section I: Research

Chapter 1: Current Practice and Perceptions at State DOTs

With the recent fluctuation of market prices of cement, steel, asphalt, fuel or other commodities, contractors often request inclusion of price indexing or cost escalation clauses in construction contracts by state DOTs. The purpose of this chapter is to provide a review of current DOT price adjustment clause (PAC) practice. Three main data sources are used to provide this review, including a review of available literature, the 2009-updated AASHTO Subcommittee on Construction Survey on the Use of Price Adjustment Clauses and the study team's supplemental survey of state DOTs.

1.1 Current Literature

The consensus among state DOTs is PACs are beneficial, but they do not completely solve the problem of varying input prices. PACs represent a shift in risk from contractors to DOTs. This risk is then partially offset by lower bid prices and better market conditions. Overall, PACs appear to shift risk rather than mitigate it. The following paragraphs highlight several of the more important examples of current literature that discuss price adjustment clauses and price volatility in construction inputs.

The Wyoming Department of Transportation produced a 2009 paper titled "Materials Risk Management -- Beyond Escalation Clauses and Price Indexing."[1] The authors are Larry Redd of a private firm and Tim Hibbard, Assistant Chief Engineer, Operations, Wyoming Department of Transportation. The paper discusses the recent WYDOT study, "Asphalt Risk Management at WYDOT." Contractors are now facing more short and long-term price volatility than ever before. OPEC production cuts, tight refining capacities, a weak dollar, oil market speculation and coker capacity buildup all contributed to extreme market uncertainty. The study examined outcomes for three years following the introduction of an escalation "option" for contractors in early 2006.

The WYDOT escalation option used a Base Price Index (BPI) and Current Price Index (CPI) for adjustments, and the trigger value[2] was 10 percent. After three years with the clause WYDOT was pleased with more competitive contractor bids, but found that contractors still faced sizeable risks. The study estimated that in one construction season contractors realized approximately $2 million in additional costs and WYDOT paid out almost $7 million in escalation payments. This is largely because the escalation clause only shifted intermediate-term risks from contractor to DOT, whereas short-term risk appeared to remain with the contractor (long-term risk was not feasible to manage). The escalation clause was deemed a success for working with contractors and creating favorable bid conditions, but shifted risk more than it mitigated it.

[1] Redd, Larry and Tim Hibbard. "Materials Risk Management -- Beyond Escalation Clauses and Price Indexing." Wyoming Department of Transportation, 2009.

[2] A trigger value is a numerical threshold that activates a price adjustment clause due to a change in commodity pricing.

An article from the magazine Asphaltopics[3] discusses the large asphalt cement price fluctuations from three years ago. Prices jumped from $300 per ton in December 2005 to over $500 per ton in July 2006. For contracts without a price index, contractors were forced to include a significant premium in order to adequately cover their risk, which owners paid through the unit prices whether or not the risk was realized. However, when a price index was used, the risk premium was effectively eliminated. While the DOT bore the cost of increased asphalt cement when oil prices increased, they also benefited when prices decrease. The article states that while the cost seemed to fluctuate with asphalt cement price changes, the cost was in fact less because the risk premium was eliminated.

Georgia DOT (GDOT) sent out a survey requesting that each state complete 17 questions regarding liquid asphalt price indexes. Twenty-eight states, including Puerto Rico and District of Columbia, responded to the survey.[4] The primary purpose of the survey was to determine how many states were using a liquid asphalt price index, how the DOT implemented and processed the index, what their experience with the liquid asphalt price index was, and whether Georgia should adopt a price adjustment program for liquid asphalt. Of the 19 responses regarding the impact of liquid asphalt price indexes on the state's DOT, 13 states indicated "positive" impacts, 5 states indicated "none," and one state indicated a "negative" impact. According to the interviewed states, the administrative costs associated with a price index program are approximately 1-2 hours per month to produce the index and about 30 minutes per project to adjust the price of liquid asphalt. The study included a comparison of Georgia bid prices to bordering states that showed that Georgia contractors do not incorporate a price risk premium in their bids. Therefore, the study concluded that there were no quantifiable benefits associated with a liquid asphalt price index and the costs would necessarily exceed the benefits of adopting a price adjustment clause.

The Federal Highway Administration (FHWA) produced a report[5] analyzing the growth of highway construction and maintenance costs. These costs grew three times faster from 2003 to 2006 than their fastest rate during any 3-year period between 1990 and 2003, which significantly reduces the purchasing power of highway funds. The increase in cost is largely due to an increase in the cost of steel and asphalt, and represents a long-term shift in the demand and supply of these items. This article suggests that while recent price increases have been volatile, the industry can expect permanent upward shifts in the cost structure.

1.2 The AASHTO Survey

The Contract Administration Section of AASHTO's Highway Subcommittee on Construction conducts an annual survey of state DOTs and the District of Columbia and Puerto Rico and maintains a spreadsheet of survey results that summarizes the current use of price adjustment clauses for fuel, liquid asphalt, cement, steel, and other highway materials. The 2009 survey's summary spreadsheet includes general information regarding trigger values, indices, web

[3] "Over a Barrel: An Asphalt Cement Price Index Update," *Asphaltopics.* Fall 2009.
[4] Georgia Tech Research Institute, "A Study of Liquid Asphalt Price Indices Applications to Georgia Pavement Contracting," 2004.
[5] Federal Highway Administration, "Growth in Highway Construction and Maintenance Costs." September 26, 2007.

references, general comments and state DOT contacts.[6] The 2009 summary represents the fourth consecutive annual update.

According to the 2009 version, states currently utilize price adjustment clauses for a range of construction inputs. Currently, there are only three states that do not have a price adjustment clause program for fuel or any other construction input. These states are Arkansas, Michigan and Texas. California did not employ a price adjustment clause program from 2007 to 2009 but began a liquid asphalt PAC for contracts starting in February 2010. Exhibit 1-1 illustrates that most states include adjustment clauses for fuel (41) and asphalt cement (40).

Exhibit 1-1: Number of States that Use Price Adjustment Clauses

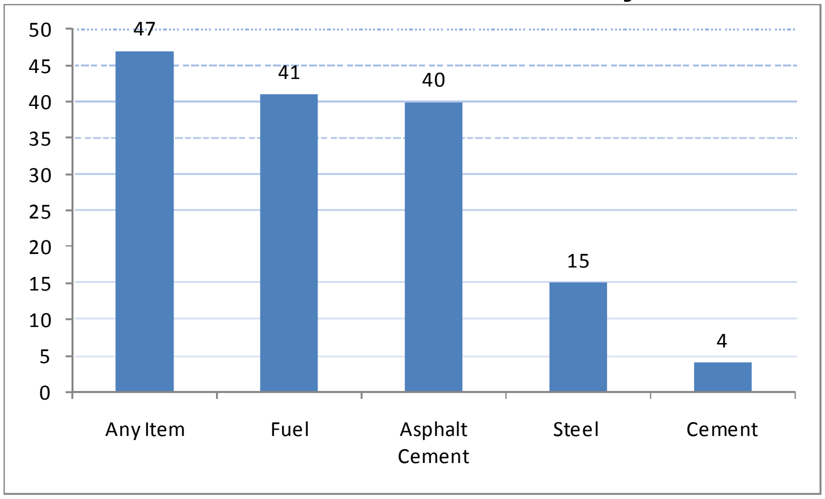
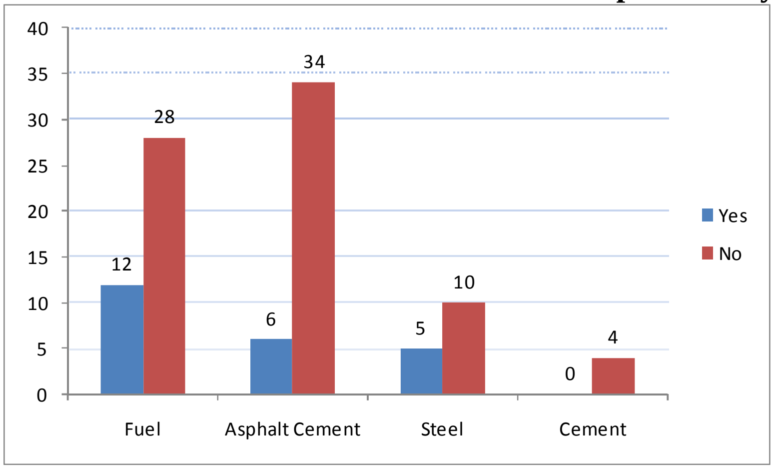


Exhibit 1-2 shows that a small percentage of states with PACs also have opt-in clauses, whereby contractors may choose to enter into a price adjustment program after contract award. For fuel and steel approximately a third of states with PACs for those items include opt-in policies.

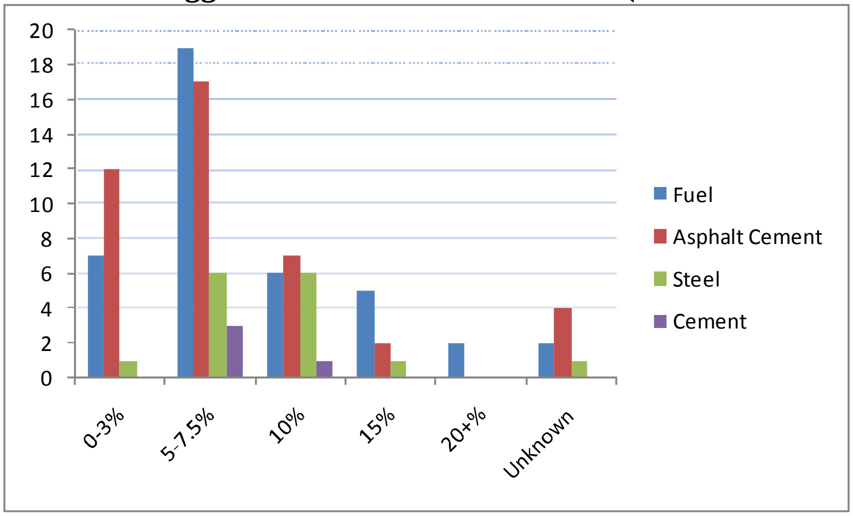
Exhibit 1-2: Number of States that have an Opt-In Policy



[6] AASHTO Subcommittee on Construction, Contract Administration Section, Survey on the Use of Price Adjustment Clauses, http://www.fhwa.dot.gov/programadmin/contracts/aashto.cfm , Fall 2009.

Exhibit 1-3 indicates that there is a broad distribution in "trigger values." These are percent changes in material pricing that initiate the relevant adjustment clauses. However, a large group of states use 5.0-7.5 percent as the trigger value.

Exhibit 1-3: Trigger Points for Price Escalation (Number of States)



1.3 Survey of DOT Perceptions, Costs and Barriers

The AASHTO survey discussed in the previous section covers many of the practices in place. However, it did not query state DOTs as to their perceptions of the efficacy of the programs. Therefore, the survey conducted for this study was designed to elicit information and opinions on perceived effectiveness, administrative costs, and barriers to implementation of new policies. In addition, the survey collected opinions on how the recent extreme price fluctuations altered practices and attitudes toward these clauses. The remaining subsections of Chapter 1 review the methodology and results of this survey.

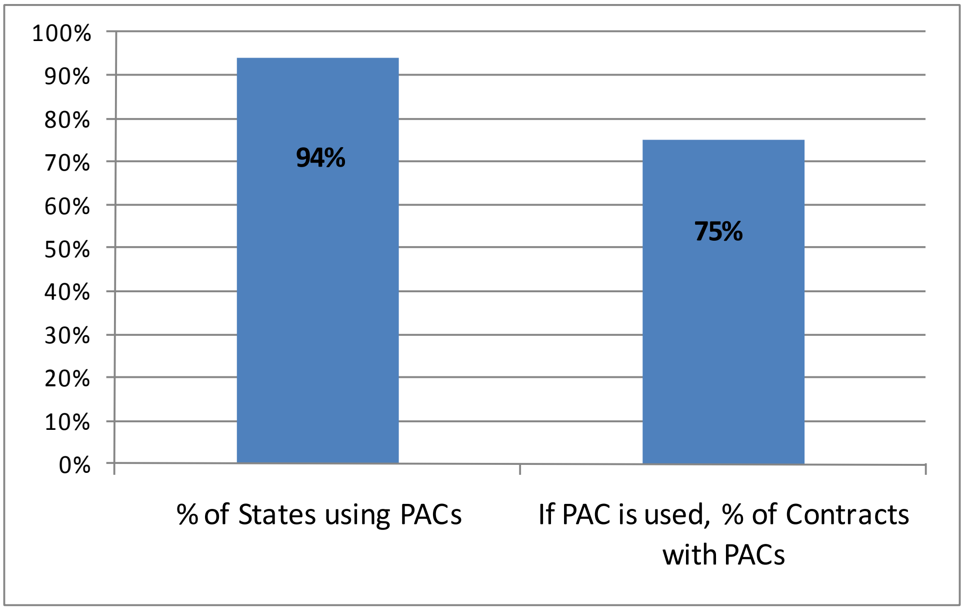
1.4 DOT Survey Methodology and Response

The final survey for state DOTs is provided in Appendix A. Before finalizing the survey, the project team provided a copy to NCHRP panel members who provided comments and revisions. These changes were made and the final survey was administered online via Survey Monkey on November 20, 2009. A total of 35 initial responses were collected and individual phone calls to the remaining 15 DOTs succeeded in achieving participation from all 50 states.

1.5 Aspects of the Current Program

Exhibit 1-4 shows that 47 of 50 DOTs use a PAC for one or more construction input, which represents no change from the recent AASHTO survey.[7] Of those 47 states, the average percentage of contracts that include a PAC is approximately three quarters. Therefore it appears that where PAC procedures are in place, they are used in the majority of contracts.

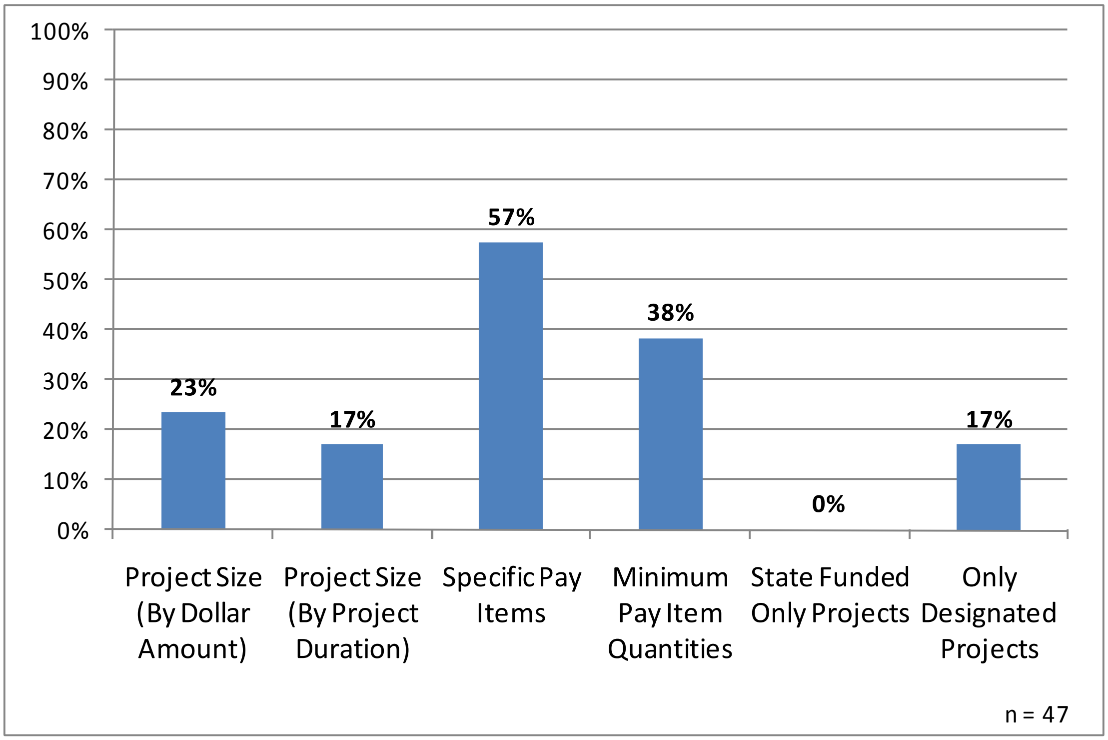
Exhibit 1-4: Current State DOT Use of PACs



For the remaining one quarter of contracts that are eligible but do not utilize a PAC, DOTs were asked to list the conditions for which these contracts are exempt. Exhibit 1-5 shows that just over half of DOTs exclude projects from these clauses for specific pay items, 38 percent exclude projects based on minimum pay item quantities, 23 percent exclude projects by dollar amount, 17 percent by project duration and 17 percent exclude only designated projects. No DOTs reported that they exclude projects because they are funded solely on the state level. The conclusion is that projects are generally excluded due to the type of specific pay item or a measure of small size in dollar, pay item quantity or duration. Specific pay items are most likely not included due to small amounts of fuel or construction inputs consumed or lack of reliable data on the level of usage for those pay items.

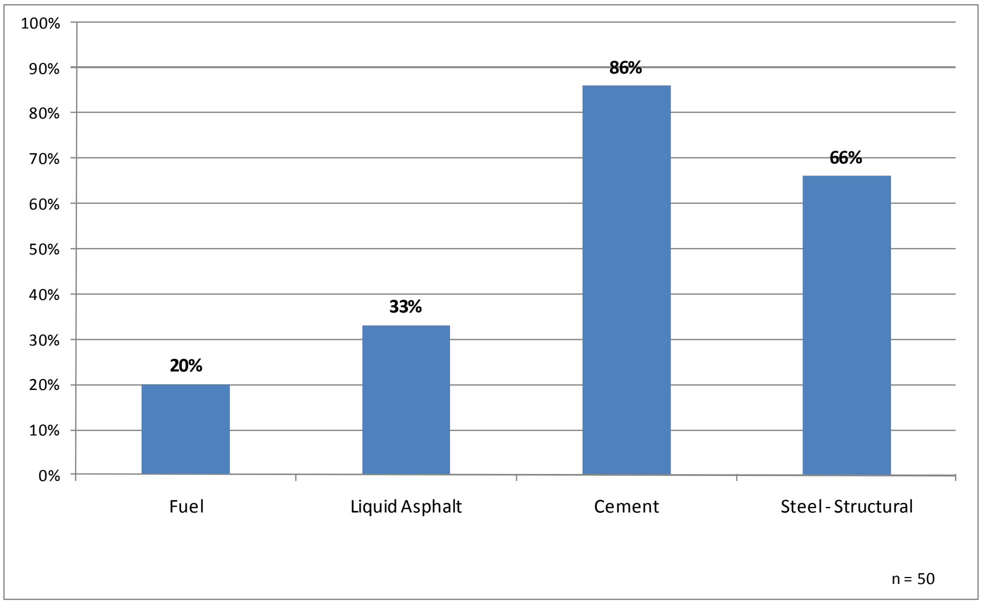
[7] The percentages in this chapter were generally calculated based on the number of responding DOTs, however, not all DOTs responded to every question. Therefore, within each table or chart the number of responding DOTs is listed as, for example, n=45.

Exhibit 1-5: Contract Conditions for PAC Exclusion



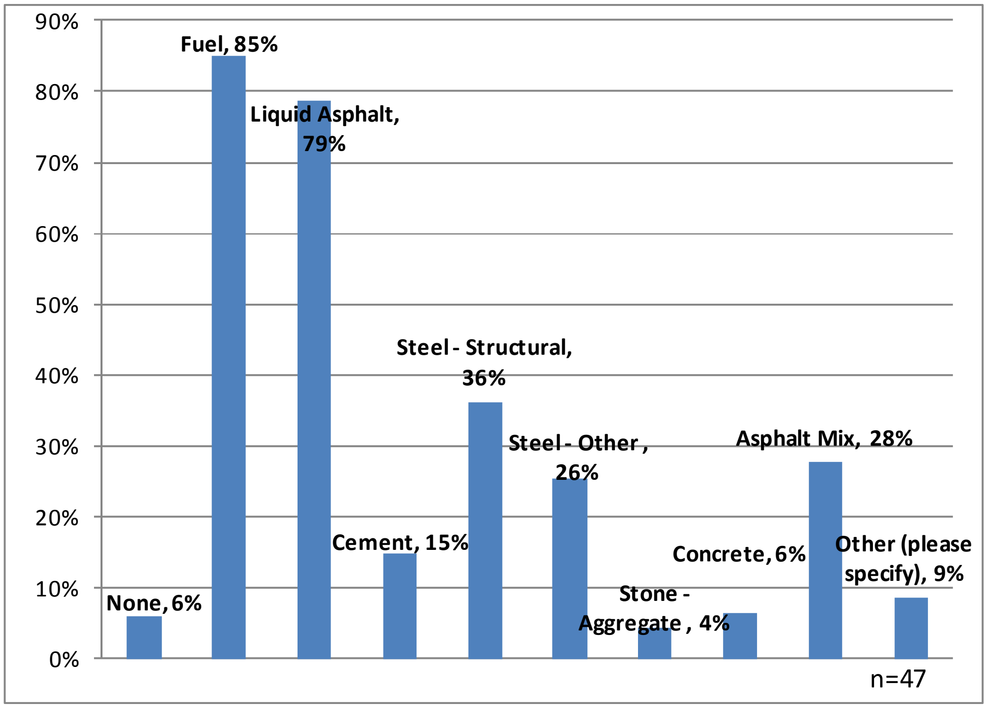
For the 57 percent of states that exclude PACs from projects based on specific pay items, the percentage of items excluded are shown in Exhibit 1-6. As shown in the exhibit, most states exclude cement and steel, while a few exclude fuel and liquid asphalt. DOTs were asked to explain their reasoning for excluding certain items. For fuel, one state reported the lack of current fuel usage factors and an administrative burden that is too high, two states are in the process of writing specifications, and four states explained there is not enough industry interest at present. For the few states that exclude liquid asphalt, their reason is a lack of adequate industry interest. The consensus on cement is that the market is stable and thus not enough industry interest exists to index it. For steel, the lack of industry interest in addition to the inability of stakeholders to agree on index language and specifications lead to its exclusion.

Exhibit 1-6: Items Excluded from PACs



Of the items that are included, the overwhelming majority of states use PACs for fuel and liquid asphalt. Cement, structural steel, other types of steel, aggregate stone, concrete and asphalt mix are indexed to a lesser degree. Exhibit 1-7 shows the percentage of DOTs that utilize PACs for common construction items.

Exhibit 1-7: Items Included in PACs



For the "Other (please specify)" field, four states entered the following responses:

- An adjustment is applied for asphalt density as applicable.
- Emulsified Asphalt is included at 60 percent of what comes from the source (works off of the Asphalt Index).
- Fuel is not an "item" but is a PAC for 12 items such as Excavation, Backfill, etc.
- Fuel adjustment is used but only for grading and earthwork operations.

1.6 Current DOT Program Costs

Determining the costs of PAC programs to DOTs is an important aspect in determining the efficiency of these programs. Of the 30 states to respond with cost information, the average number of man-hours per month spent on administering theses clauses is 86 hours (with a minimum of 1 hour per month and maximum of 400 hours per month). This is the equivalent of approximately 1,000 hours per year. While states were not asked to provide hourly costs, at a per hour cost of $50, the yearly cost would total $50,000. A per hour cost of $100 would imply a yearly cost of $100,000 per state.

Following the hours question, DOTs were asked to list any other costs associated with implementing and maintaining PACs. Two costs are listed, subscription costs and initial automation /system programming costs. The average monthly subscription cost for the 26 states that responded is $291, or approximately $3,500 a year. One state estimates the initial programming cost to be $5,000 and another estimates it at $50,000.

The survey also requested states to provide yearly payments and returns since 2006. Approximately half of the states provided estimates. Average yearly payments and returns (in millions of dollars) are shown in Exhibit 1-8. It must be noted that 2009 figures are likely underreported due to invoices and tabulations that had not been reported at the time of the survey. Over the four year period, average DOT payments exceed their returns by approximately four times ($58 million to $14 million), or approximately $11 million a year. This gap in payments and returns represents the shift in risk from contractor to DOT when PACs are used. Note that in 2009, states actually collected more payments than they paid out in returns. An official from the Oregon DOT stated:

> “We have been viewing the total cash flow position (more payments out or cash from contractors) of the agency and determined that by running a rolling 2 year average project life for cash flow position of the agency on the indexes – that process appears to be a good indicator on the performance of the index in general over time. At this time our initial data suggests ODOT may be in a very cash positive position compared to the contractors based on the last two years compared to the aggregate costs per year absorbed by the contractors, indicating we are actually removing profits from the contract community – which would suggest an even higher trigger or some other way to manage the index systems.”[8]

[8] Email correspondence with John Riedl, Oregon DOT. 1 March 2010. In a follow-up conversation with Mr. Riedl he indicated that further research is needed in this area to determine better methods to manage index costs for better cost controls for index systems.

This suggests that risk can be added in both directions, as contractors can absorb additional costs in years when prices are falling and a PAC is in place.

Exhibit 1-8: Average Yearly DOT PAC Payments and Returns

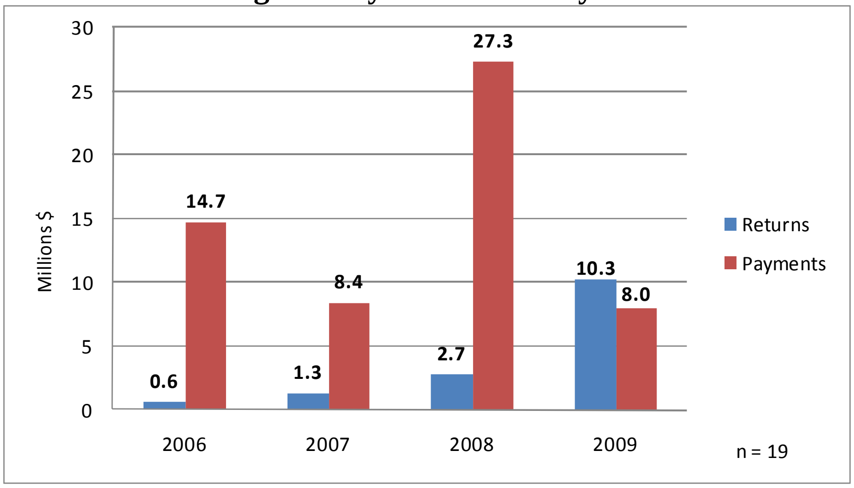


Exhibit 1-9 provides the reported payments for each responding state from 2006 through 2009 as well as the average annual payment for each state. States are listed in descending order of magnitude for average annual payments. Florida, Pennsylvania, North Carolina, Ohio, Virginia and South Carolina reported average annual payments of greater than $10 million.

Exhibit 1-9: PAC Payments by State

State:	2006 Payments	2007 Payments	2008 Payments	2009 Payments	2009 Amounts are:	Average Annual Payment
Florida	$69,918,062	$31,460,205	$103,755,002	$22,804,479	Actual	$56,984,437
Pennsylvania	$43,204,954	$23,575,498	$109,017,382	$16,101,104	Actual	$47,974,735
North Carolina	$43,824,959	$19,038,905	$94,148,646		Actual	$39,253,128
Ohio	$21,274,743	$26,141,723	$44,231,830	$43,500,000	Estimated	$33,787,074
Virginia	$27,237,938	$5,916,936	$54,227,319	$1,670,902	Actual	$22,263,274
South Carolina	$38,299,465	$9,190,954	$22,384,686	$5,050,402	Actual	$18,731,377
Utah	$8,228,015	$16,909,754	$14,128,608	$490,258	Actual	$9,939,159
Missouri		$230,258	$2,963,602	$33,017,722	Actual	$9,052,896
Oregon	$10,000,000	$10,000,000	$4,000,000	$3,000,000	Estimated	$6,750,000
New Mexico*	$4,915,260	$4,915,260	$4,915,260	$9,830,520	Estimated	$6,144,075
Oklahoma	$495,677	$64,507	$19,426,333	$1,950,750	Actual	$5,484,317
New Hampshire	$5,100,000	$1,450,000	$10,100,000	$2,100,000	Estimated	$4,687,500
Maine	$1,759,712	$4,999,255	$9,758,815		Actual	$4,129,446
Wyoming	$953,000	$1,958,000	$7,611,000	$1,973,000	Actual	$3,123,750
Nevada	$2,868,873	$803,841	$5,227,136	$1,162,492	Actual	$2,515,586
Washington		$10,245	$7,991,769	$1,965,747	Actual	$2,491,940
Idaho	$111,022	$16,635	$2,252,418	$4,140,939	Estimated	$1,630,254
Colorado	$1,250,000	$1,250,000	$1,250,000	$1,250,000	Estimated	$1,250,000
North Dakota	$2,562	$1,572,063	$1,434,857	$1,173,907	Actual	$1,045,847
Total	$279,444,241	$159,504,039	$518,824,662	$151,182,222		$277,238,791
Average	$14,707,592	$8,394,949	$27,306,561	$7,956,959		$14,591,515
*New Mexico gave payment as percentages of program - worked backwards to derive annual payments						

Exhibit 1-10 provides the reported returns for each responding state from 2006 through 2009 as well as the average annual return for each state. States are listed in descending order of magnitude for average annual returns. Florida, North Carolina, Pennsylvania, South Carolina, Idaho and Oklahoma have average annual returns of greater than $1 million. Ohio, Missouri, New Mexico and Wyoming listed payments (Exhibit 1-9) but not returns. These states do have provisions for deductions in the case of a negative price adjustment but they do not publish them.

Exhibit 1-10: PAC Returns by State

State:	2006 Returns	2007 Returns	2008 Returns	2009 Returns	2009 Amounts are:	Average Annual Return
Florida	$5,190,119	$12,953,233	$16,144,533	$55,240,111	Actual	$22,381,999
North Carolina				$38,615,378	Actual	$9,653,845
Pennsylvania	$1,988,379	$1,871,145	$18,450,966	$13,932,762	Actual	$9,060,813
South Carolina	$1,402,596	$2,498,515	$2,908,249	$23,829,665	Actual	$7,659,756
Idaho	$1,672	$16,942	$377,832	$5,327,869	Estimated	$1,431,079
Oklahoma	$308,837	$1,697,842	$464,316	$2,296,944	Actual	$1,191,985
Virginia	$119,513	$509,195	$19,655	$3,134,523	Actual	$945,722
Oregon			$500,000	$3,000,000	Estimated	$875,000
New Hampshire	$300	$5,500	$48,000	$3,300,000	Estimated	$838,450
Washington			$128,582	$2,517,277	Actual	$661,465
Utah	$25,886	$1,667	$1,901,156		Actual	$482,177
Nevada			$92,253	$1,722,016	Actual	$453,567
Maine				$1,726,364	Actual	$431,591
Colorado	$25,000	$25,000	$25,000	$25,000	Estimated	$25,000
North Dakota				$57,937	Actual	$14,484
Ohio						
Missouri						
New Mexico						
Wyoming						
Total	$9,062,302	$19,579,039	$41,060,542	$154,725,847		$56,106,932
Average	$604,153	$1,305,269	$2,737,369	$10,315,056		$3,740,462

An analysis was conducted to compare the size of the PAC program in relation to total state highway spending. Exhibit 1-11 provides data on the net average annual payment from 2006 through 2009, the 2008 state highway disbursement and the ratio of payment to program disbursement. States are listed in descending order of magnitude for this ratio. Utah, South Carolina and North Carolina have payment to program disbursement ratios of greater than one percent. Disbursements under the PAC program represent less than 1.5 percent of direct highway spending. For two-thirds of the states reporting data, the PAC program payments represent less than two-thirds of one percent of direct highway spending.

Exhibit 1-11: PAC Payment to Program Disbursement

State	Average Annual Payment	Average Annual Return	Net Annual Payment	State Disbursements**	Payment to Program Net Disbursement Percentage
Utah	$ 9,939,159	$ 482,177	$ 9,456,982	$ 662,653,000	**1.43%**
South Carolina	$ 18,731,377	$ 7,659,756	$ 11,071,621	$ 932,608,000	**1.19%**
North Carolina	$ 39,253,128	$ 9,653,845	$ 29,599,283	$ 2,760,039,000	**1.07%**
Pennsylvania	$ 47,974,734	$ 9,060,813	$ 38,913,921	$ 4,321,650,000	**0.90%**
Virginia	$ 22,263,274	$ 945,722	$ 21,317,552	$ 2,560,269,000	**0.83%**
New Hampshire	$ 4,687,500	$ 838,450	$ 3,849,050	$ 495,546,000	**0.78%**
Maine	$ 4,129,446	$ 431,591	$ 3,697,855	$ 541,280,000	**0.68%**
Oregon	$ 6,750,000	$ 875,000	$ 5,875,000	$ 1,058,047,000	**0.56%**
Florida	$ 56,984,437	$ 22,381,999	$ 34,602,438	$ 6,385,280,000	**0.54%**
Oklahoma	$ 5,484,317	$ 1,191,985	$ 4,292,332	$ 1,141,639,000	**0.38%**
Nevada	$ 2,515,586	$ 453,567	$ 2,062,019	$ 585,664,000	**0.35%**
North Dakota	$ 1,045,847	$ 14,484	$ 1,031,363	$ 350,337,000	**0.29%**
Colorado	$ 1,250,000	$ 25,000	$ 1,225,000	$ 990,411,000	**0.12%**
Washington	$ 2,491,940	$ 661,465	$ 1,830,475	$ 2,403,865,000	**0.08%**
Idaho	$ 1,630,254	$ 1,431,079	$ 199,175	$ 564,564,000	**0.04%**
Ohio	$ 33,787,074	NA	NA	$ 2,529,912,000	**NA**
New Mexico*	$ 6,144,075	NA	NA	$ 491,526,000	**NA**
Wyoming	$ 3,123,570	NA	NA	$ 480,370,000	**NA**
Missouri	$ 9,052,896	NA	NA	$ 1,834,577,000	**NA**

* New Mexico gave payments as percentages of porgram - worked backwards to derive annual payments

**http://www.fhwa.dot.gov/policyinformation/statistics/2008/sf2.cfm, the sum of "Capital Outlay" and "Maintenance and Services"

1.7 Fuel Price Adjustment Clauses

The most commonly used item in construction PACs is fuel, as noted in Exhibit 1-7. Exhibit 1-12 shows the methods used by DOTs to index fuel. The methods and respective descriptions are as follows[9]:

- *Fuel use per unit*[10] – This method estimates the amount of fuel used in accomplishment of various units of work under average conditions. For each non-structural unit of work (excavation, aggregates, asphaltic concrete, and Portland cement concrete pavement), fuel usage factors for diesel and gasoline consumption per unit of work are given. The process involves applying the quantities of completed work to the fuel factors, summing the total used for each separate item, and then applying price adjustment.

- *Specified Total Fuel Requirement Method* – The contracting agency develops its own estimate of fuel required to complete the project and enters this amount in the bidding documents. The estimate can either be given in total gallons or dollars, with the base price also furnished in the proposal. This method also requires establishing a fuel allocation schedule which estimates the amount of fuel used by the contractor at various stages of project completion. As each increment of work is completed the contacting agency applies

[9] These descriptions, with the exception of the invoice method, are derived from the following document: FHWA "Development and Use of Price Adjustment Contract Provisions, 1980. http://www.fhwa.dot.gov/programadmin/contracts/ta50803.cfm

[10] This method may be adopted for other materials as well. The generic term for this method is "Indexed material use per unit."

the percentage of fuel used to date (less previous amounts estimated) to the total estimated fuel.

- *Bid Item Method* **–** The bidder enters a lump sum amount for fuel cost in the proposal to construct the project. This lump sum bid is limited to a maximum amount set by the State, and must be warranted by the bidder to include all fuel to be used on the project. The lump sum item is used in determining the rank of bidders, and is a pay item in the contract. A fuel allocation schedule is also required for the use of this method. Payment of the lump sum bid is made on progress estimates in accordance with the percentages given in the allocation schedule.

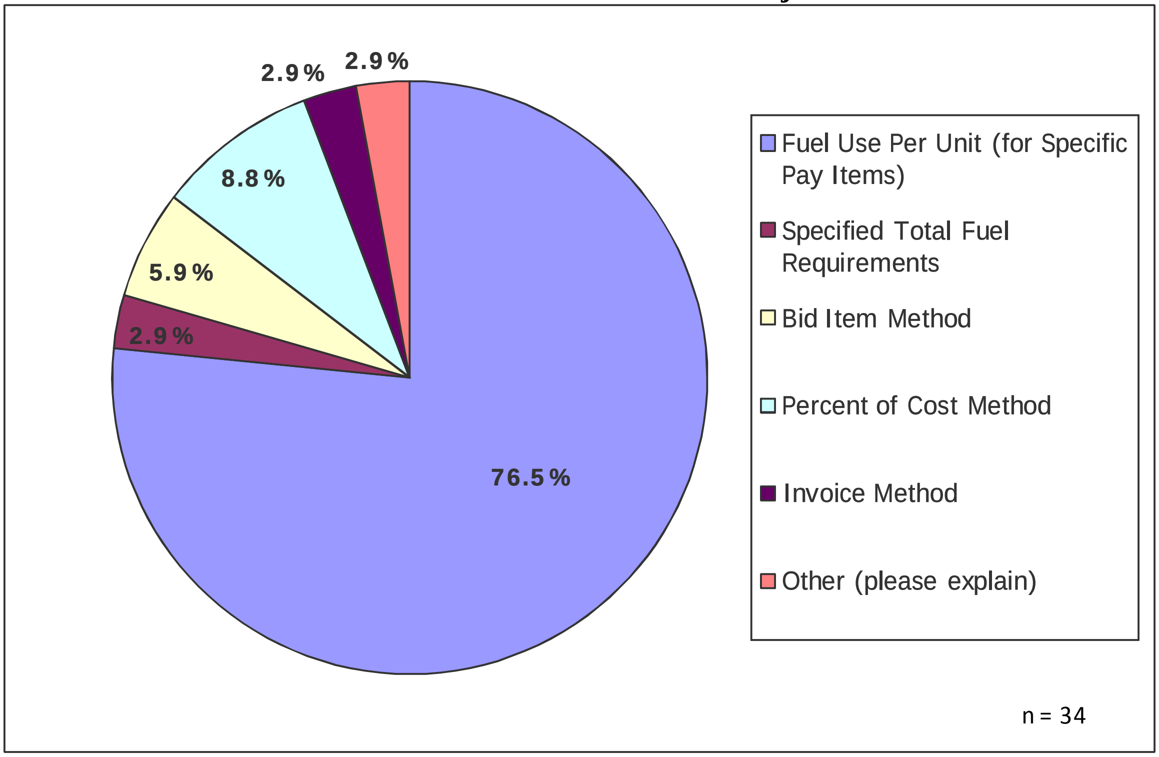
- *The Percent of Cost Method* – This method requires the establishment of factors for different types of projects which represent the approximate cost of fuel as a percentage of total construction cost. The amount of fuel used is simply calculated periodically using the percentage factor applied against the actual dollar volume of work completed and paid on a progress estimate (with no retainage deducted) to establish the estimated amount (in dollars) of fuel costs expended by the contractor.

- *Invoice Method* – This method requires the contractor to submit actual invoices from the project to the DOT. These invoices will show the quantity and price paid. These invoice quantities and prices will be the basis of the calculation for the price adjustment payments. The amounts will be entered into the formula that the DOT uses to calculate the amounts (using the difference in actual price and the project "as-bid" index price).

Fuel use per unit (for specific pay items), is used by over 75 percent of states. Users of other methods are as follows as follows:

- Specified total fuel requirements – Colorado
- Bid item method – Nevada, Utah
- Percent of cost method – Georgia, North Dakota, Wyoming
- Invoice method – Connecticut
- Other – Alabama uses either fuel use per unit or bid item methods depending on the commodity

Exhibit 1-12: Method of Fuel Price Adjustment



According to survey responses, 76 percent of state DOTs believe that updated fuel usage factors would improve their fuel PACs and 64 percent say that additional fuel usage factors would improve their fuel PACs. Such high percentages show that even for the most commonly used price adjustment clause there is still a need for additional technical information. The NCHRP, anticipating this demand, has undertaken project 10-81, Fuel Usage Factors in Highway and Bridge Construction. This project is scheduled to begin in 2010 and will facilitate the dissemination of updated fuel usage factors.

1.8 DOT Perceptions

A key focus of this survey was to gather opinions on the current perceptions of PACs among DOT personnel. This includes perceptions as to the benefits to the market, benefits to stakeholders, and the changing need for these clauses. In this analysis, DOTs that perceive a significant benefit ("moderate benefit" or "large benefit") are compared to DOTs that perceive little to no benefit ("small benefit or "no benefit").

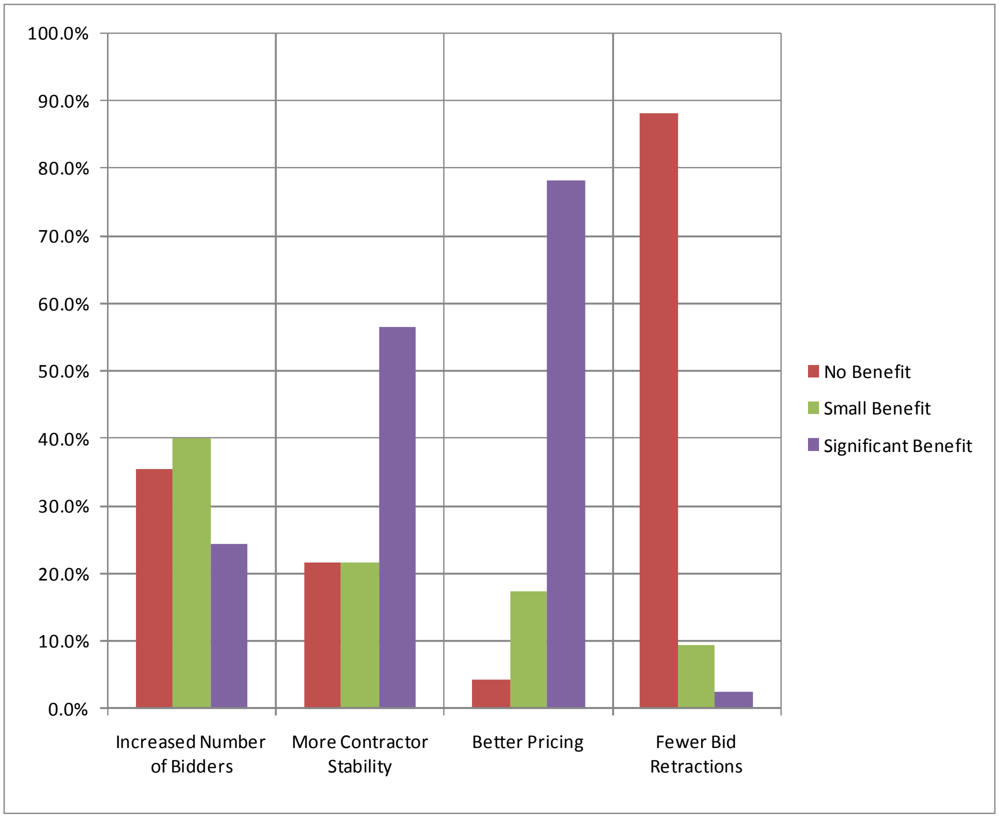
Exhibits 1-13 and 1-14 provide data in table and graphical format, respectively, on how DOTs perceive market benefits from implementing their PAC program. DOTs were queried as to how PAC programs provide benefits in terms of increased number of bidders, more contractor stability, better pricing and fewer bid retractions. A total of 24 percent of DOTs perceive PACs as providing a significant (moderate or large) benefit in terms of the number of bidders, but 76 percent perceive little to no benefit. In terms of increased contractor stability, 56 percent perceive a significant benefit and the remaining 44 percent see little to no benefit.

Approximately three quarters of the responding DOTs perceive a significant benefit to pricing, and the remaining DOTs perceive a small benefit. No DOTs believe PACs lead to fewer bid retractions, and 10 percent perceive only a small benefit. Overall, the majority of the DOTs that responded perceive a significant benefit of PACs in contractor stability and better pricing. In terms of increased number of bidders and fewer bid retractions, more than three quarters of respondents see little or no benefit.

Exhibit 1-13: PAC Market Benefit Table

Answer Options	No Benefit	Small Benefit	Significant Benefit	n=
Increased Number of Bidders	35.6%	40.0%	24.4%	45
More Contractor Stability	21.7%	21.7%	56.5%	46
Better Pricing	4.3%	17.4%	78.2%	46
Fewer Bid Retractions	88.1%	9.5%	2.4%	42

Exhibit 1-14: PAC Market Benefit Chart



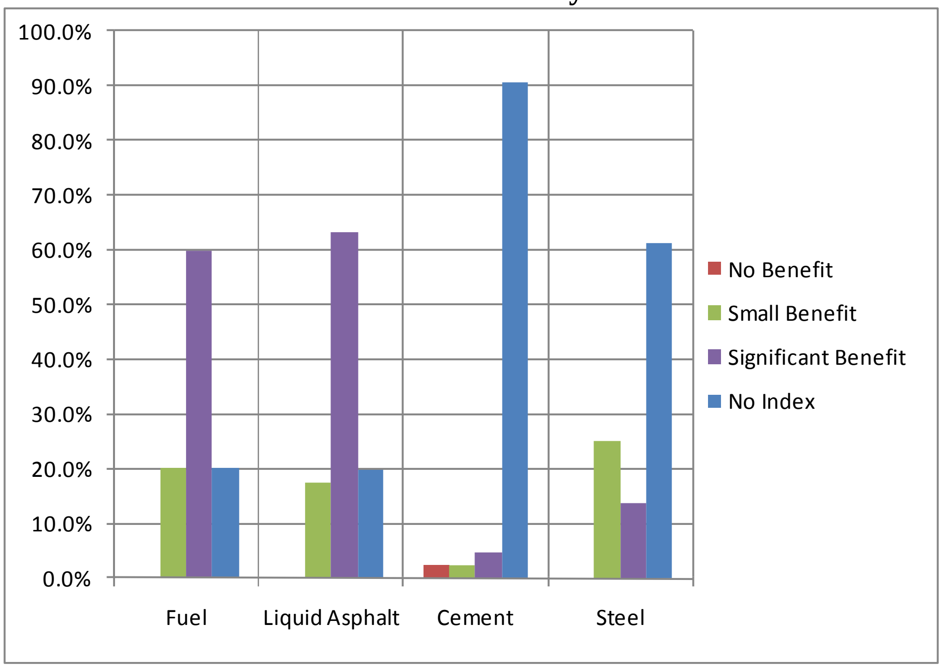
Exhibits 1-15 and 1-16 show the level of benefit to DOTs from implementing a PAC for specific commodities. For fuel, 60 percent of DOTs perceive a significant benefit, 20 percent perceive a small benefit and 20 percent do not index fuel. The perception of liquid asphalt is largely the same as fuel, with slightly more states perceiving a significant benefit and fewer states perceiving a small benefit. In terms of cement, almost no DOTs currently index it. Of the four

DOTs that do index cement, one sees no benefit, one sees small benefit and two see a moderate benefit. A total of 61 percent of DOTs do not index steel. For the remaining states that do index it, 25 percent perceive a small benefit and 11 percent perceive a moderate benefit. In terms of construction inputs, the majority of state DOTs believe PACs provide a significant benefit to fuel and liquid asphalt contracts. The majority of DOTs do not currently index cement and steel.

Exhibit 1-15: PAC Commodity Benefit Table

Answer Options	No Benefit	Small Benefit	Significant Benefit	No Index	n=
Fuel	0.0%	20.0%	60.0%	20.0%	45
Liquid Asphalt	0.0%	17.4%	63.1%	19.6%	46
Cement	2.4%	2.4%	4.8%	90.5%	42
Steel	0.0%	25.0%	13.7%	61.4%	44

Exhibit 1-16: PAC Commodity Benefit Chart

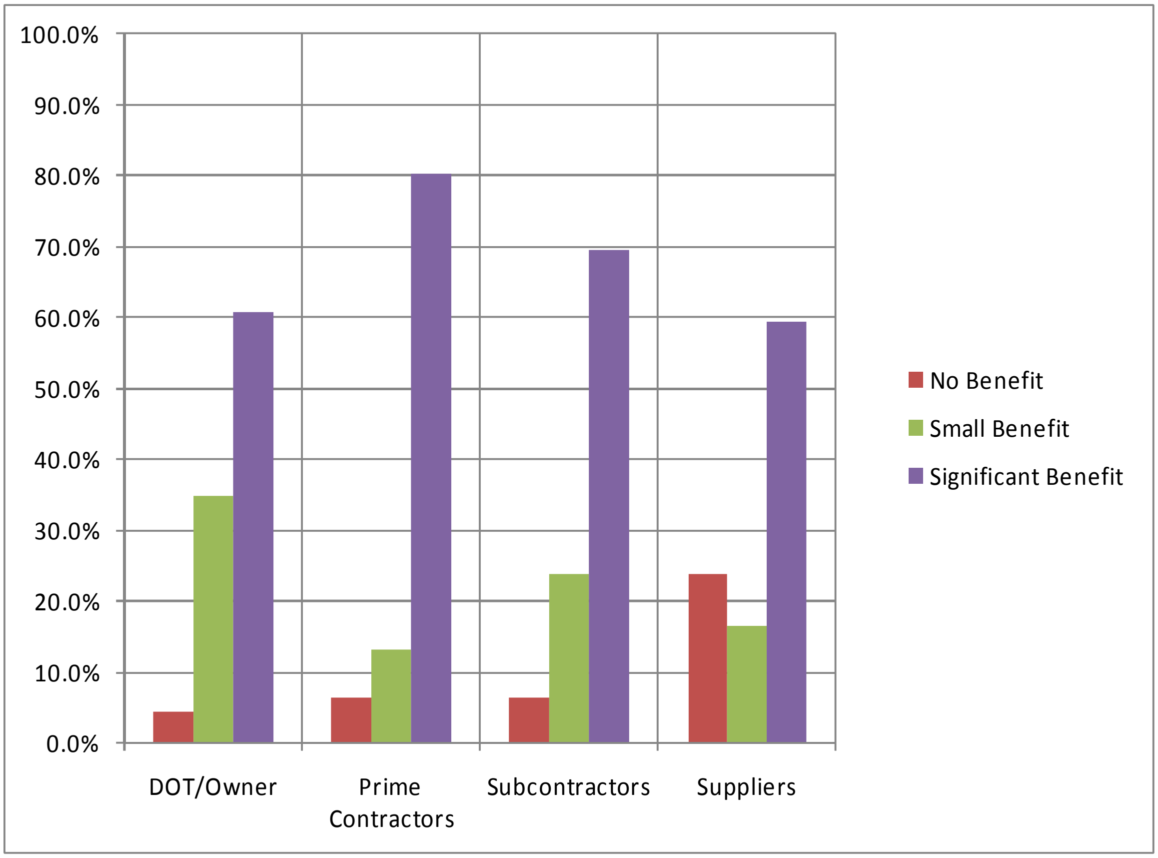


Exhibits 1-17 and 1-18 describe how DOTs perceive the level of benefit for the various stakeholders from implementing a PAC. Stakeholders include: DOTs, prime contractors, subcontractors, suppliers and others. A total of 61 percent of responding DOTs perceive their own benefit as significant, and approximately 35 percent perceive their own benefit as small. Over three quarters of DOTs believe the level of prime contractor benefit to be significant. DOTs hold a similar perception of subcontractors, with slightly less benefit overall. In terms of suppliers, DOT perceptions are spread fairly evenly across the levels of benefit. DOTs are also asked to list others that benefit from PACs and the corresponding level of benefit. Two DOTs list taxpayers as benefiting moderately or largely; if prime contractors remove speculative additives from their bids, the final bid price is lower and less state funds are used. Overall, prime contractors are seen as the primary beneficiaries, followed by subcontractors and state DOTs and then suppliers.

Exhibit 1-17: PAC Stakeholder Benefit Table

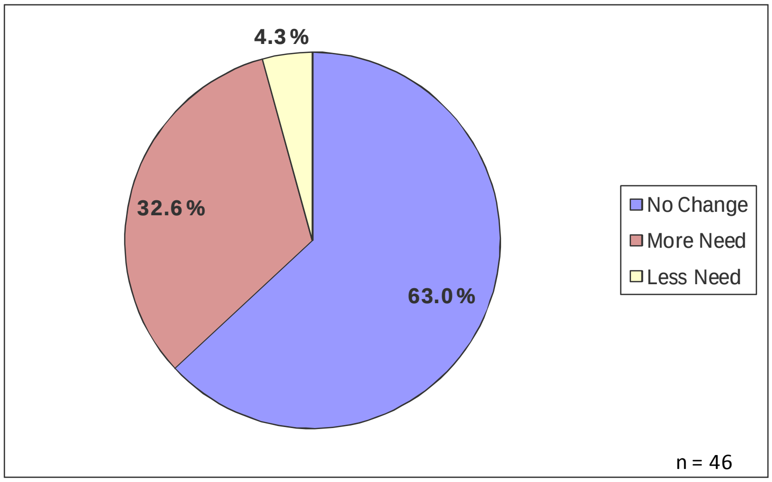
Answer Options	No Benefit	Small Benefit	Significant Benefit	n=
DOT/Owner	4.3%	34.8%	60.9%	46
Prime Contractors	6.5%	13.0%	80.4%	46
Subcontractors	6.5%	23.9%	69.6%	46
Suppliers	23.8%	16.7%	59.5%	42

Exhibit 1-18: PAC Stakeholder Benefit Chart



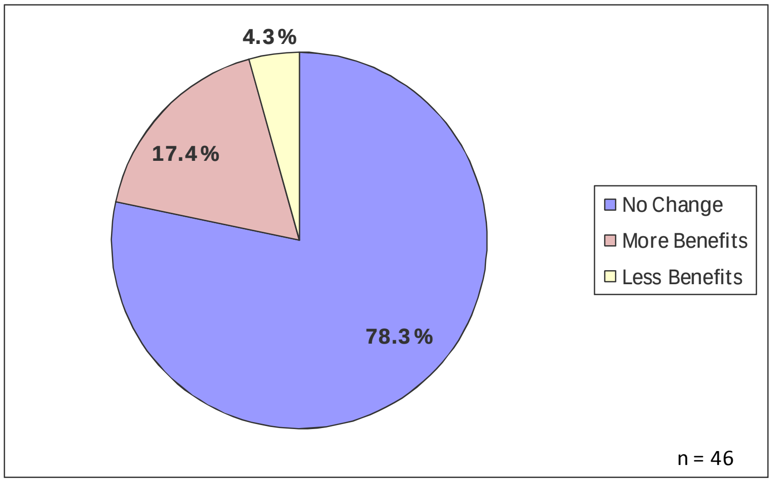
The year 2004 was marked by large price fluctuations in steel, cement and liquid asphalt, and 2008 by large price fluctuations in fuel and asphalt. Given these unexpected variations, DOT perceptions on the need for PACs changed with a third of DOTs indicating an increased need and only two respondents indicating less need. Exhibit 1-19 shows the percentage of DOTs that perceive there is more need, less need or no change in the need for PACs.

Exhibit 1-19: Need of PACs Given Recent Price Fluctuations



DOTs were also asked how the benefits from PACs changed following the recent price fluctuations. As shown in Exhibit 1-20, the consensus is that there was no change in benefit, with 17 percent indicating an increase.

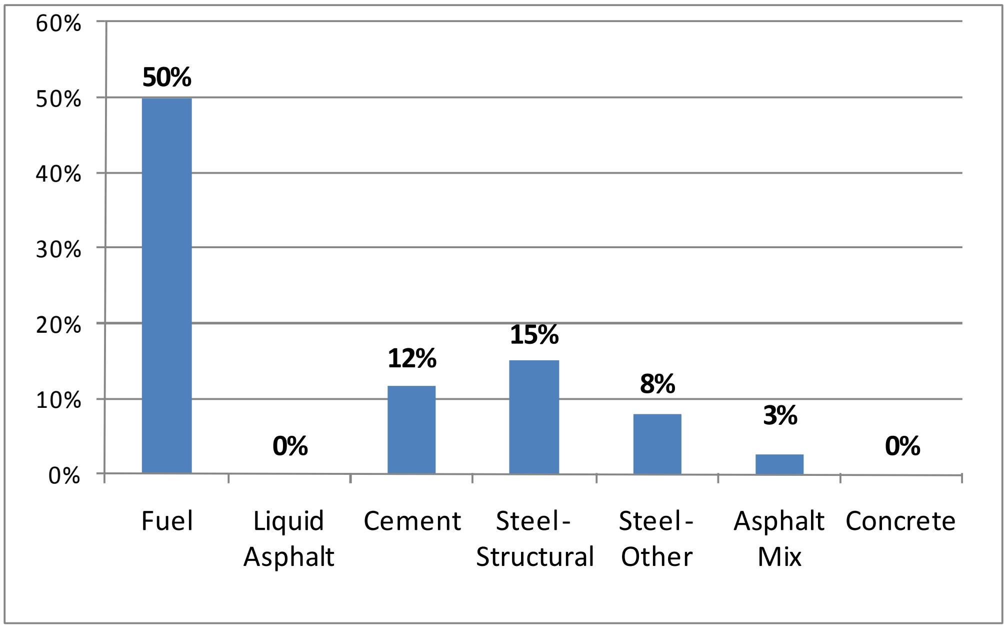
Exhibit 1-20: Benefit of PACs Given Recent Price Fluctuations



1.9 DOT Future Plans and Changes

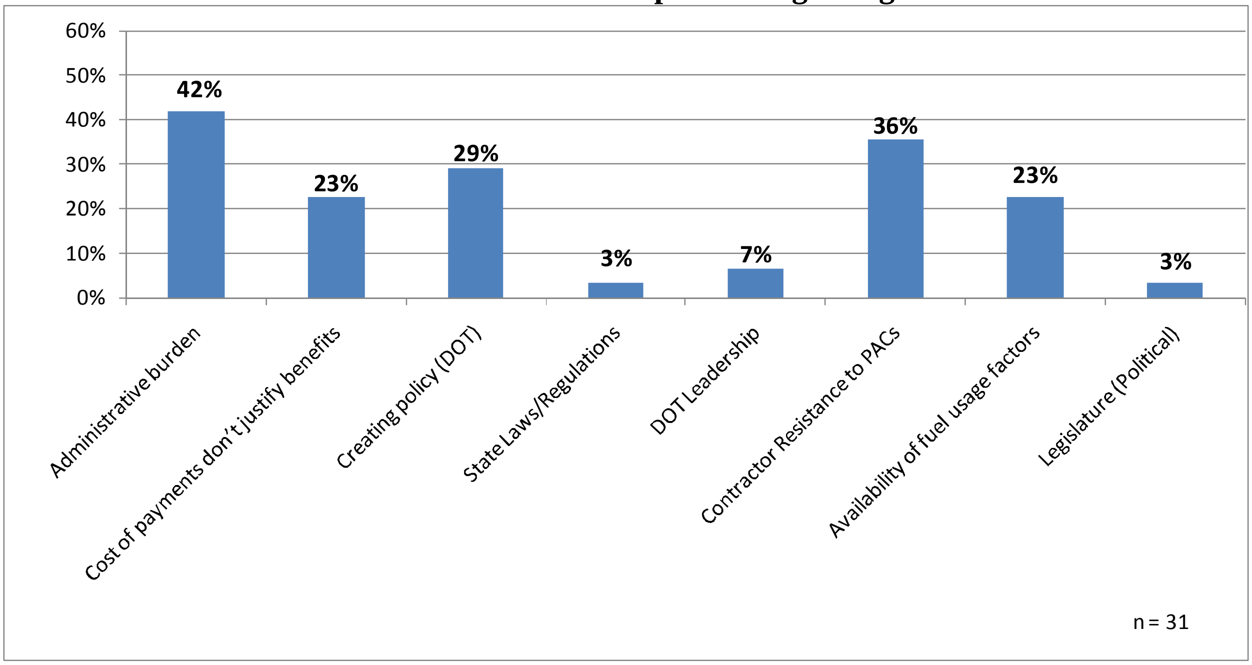
Exhibit 1-21 provides the percentage of DOTs considering the addition of fuel, liquid asphalt, cement, structural and other types of steel, asphalt mix or concrete into their PACs. Percent values were calculated by dividing the number of DOTs who do not have a PAC but are considering creating one by the total number of states that do not have PACs. Of the ten states that do not currently have a fuel PAC, five are considering creating one. Structural steel, cement and other steel are under consideration by 15, 12 and eight percent respectively of those DOTs that do not index them. No states are currently considering liquid asphalt or concrete.

Exhibit 1-21: Future PAC Items



To gain a better understanding of the potential difficulties DOTs face when implementing PACs, the survey queried DOTs on the barriers to implementing or using PACs (Exhibit 1-22). A total of 31 DOTs responded to this question. The most cited barrier, at 42 percent, is administrative cost. A total of 36 percent of DOTs believed contractor resistance to PACs is a barrier. Between 23 and 29 percent believed the process of creating the policy within the DOT and the lack of updated fuel usage factors are barriers, and that the costs of the programs do not justify the benefits. State regulation, DOT leadership and political forces were perceived as barriers by a smaller percentage of DOTs. When asked to explain other potential barriers, answers of interest included the difficulty in maintaining federal participation due to economic conditions, the lack of a supplier industry structure set up to handle cement price adjustment clauses, the lack of high-quality price index sources and the difficulty in determining market costs for commodities.

Exhibit 1-22: Barriers to Implementing/Using PACs



When asked whether improvements can be made to the current adjustment clause program, roughly half answered "yes" and half answered "no." For DOTs that answered "yes," a follow-up explanation was solicited. Responses are listed in Exhibit 1-23.

Exhibit 1-23: DOT Suggestions for PAC Improvement

DOT	Comment/Suggested Improvement
California	Best practices on how to manage the necessary funds to make adjustment payments needs to investigated. Currently in California funds are set aside in each contract which results in several million dollars tied up that can't be used.
Colorado	Instead of each state inventing their own methods or relying on private sources for indexing, it would be helpful if there were a FHWA indexing method. Also, it would be very helpful if there were standard fuel usage factors available.
Connecticut	Continual evaluation of the specifications and adjustments is needed.
Idaho	A study on fuel adjustment price factors is needed, as it is a central repository of price adjustment specifications.
Illinois	How to better handle large additions to contracts due to fluctuating prices
Nevada	Having indexes that accurately reflect actual market conditions is critical. We currently use ENR for Steel indexes. ENR does not publish Steel prices in the magazine regularly but we do have access to ENR online. A more regular single source would be helpful.
New Hampshire	Fuel factors need to be updated.
New Jersey	Accurate and more current fuel usage factors.
New York	We need to reduce the administrative burden of use of steel adjustment, because the steel is frequently not paid for as steel by weight, but rather as a unit of something that contains steel.
North Dakota	Any program can be improved but we have not identified any specific improvements.
Ohio	A better method to index steel prices.
Pennsylvania	Computer systems that are used to administer the Department's construction contracts could be programmed to compute price adjustments based on the monthly pay quantity for applicable contract items. Computations are currently done manually with the assistance of standardized Excel spreadsheets.
Rhode Island	Producer price indexes for which steel projects were based on was discontinued. This created a problem contractually. Better if there were direction as to which indices will become discontinued and which will continually update so as to help the DOT choose the best index.
Utah	Consistent application of acceptable risk levels within the price adjustment clauses before they become effective, i.e. 5 percent, 15 percent etc. Also consistent use of opt out clauses.
Vermont	Automated calculations; improved usage factors.
Virginia	Better fuel usage factors, make fuel price adjustment mandatory and not optional, make asphalt content standard (by mix) and automate calculations, pay only on virgin binder with no payments for binder recovered from RAP, steel-work on better index for DOT specific commodities.
Washington	A little more flexibility on the part of our DOT to use adjustments.

1.10 Conclusions on DOT Current Practice

The vast majority of states use a price index. According to the AASHTO survey and the selected survey for this report, only three of fifty states do not currently employ a price adjustment clause. For the states that do have PACs, nearly all use them for fuel and liquid asphalt, with a smaller percentage using them for steel and cement. A wide variety of trigger points are used, from any change in price up to a 20 percent change, but the majority use trigger points between 5 and 7.5 percent.

Specific pay items are the leading criteria for PAC exclusion, with minimum pay item quantities and project size and duration as other often used criteria. The construction items most commonly excluded from PACs are cement and steel. This is largely because of market stability for these items and a current lack of industry interest to index them. Roughly 20 percent of states plan to add PACs for fuel, cement and structural steel in the future.

Administrative burden is the most highly cited barrier to using and /or implementing a PAC program. On average, states spend 86 hours per month administering their state's PAC program. Other highly cited barriers include the difficulty of creating PAC policy within the DOT, contractor resistance, low benefits relative to costs, and a lack of adequate fuel usage factors. Initial programming costs are cited by two states as ranging between $5,000 and $50,000.

The following is a summary of the percentage of DOTs that perceive significant (moderate or large) benefits from PACs:

Perceived Benefits of PACs to Market Conditions

- Number of bidders – 24 percent significant benefit
- Contractor stability – 56 percent significant benefit
- Better Pricing – 78 percent significant benefit
- Fewer Bid Retractions – 2 percent significant benefit

Perceived Benefits of PACs per Commodity

- Fuel – 60 percent significant benefit
- Liquid Asphalt – 63 percent significant benefit
- Cement – majority do not index, of the 10 percent that do, half perceive a significant benefit
- Steel – majority do not index, of the 39 percent that do, 13 percent perceive a significant benefit

Perceived Benefits of PACs to Stakeholders

- DOT – 61 percent significant benefit
- Prime Contractors – 81 percent significant benefit
- Subcontractors – 70 percent significant benefit
- Suppliers – 60 percent significant benefit; responses range across levels of benefit
- Others –Two respondents perceive a significant benefit to taxpayers

Given the recent price fluctuations, 33 percent of states perceive an increased need for PACs and 17 percent perceive an increased benefit from PACs.

Chapter 2: Current Contractor Practice and Perceptions

With the recent fluctuation of market prices of cement, steel, liquid asphalt, fuel or other commodities, contractors often request inclusion of price indexing or price adjustment clauses (PACs) in construction contracts by state DOTs. The purpose of this chapter is to provide a review of current construction contractor PAC practice and to derive conclusions on their perceptions of PACs. This chapter has five sections, including Survey Methodology, Current Program, Fuel Price Adjustment Clauses, Perceptions and Future Plans and Changes. The main data source for this analysis is a survey developed by the study team and sent to 400 contractors.

The consensus among surveyed construction contractors is that PACs are beneficial to all stakeholders, for all commodities, and to the market overall. For the contractors that do have PACs, nearly all use them for fuel and liquid asphalt and a smaller percentage use them for asphalt mix, steel, cement and concrete. Nearly all responding contractors claim they add contingencies to their bids in the absence of PACs. The problem of increased material price risk in contracts is largely mitigated by the inclusion of such clauses. Since the large price fluctuations in 2004 and 2008, the majority of contractors believe there is a greater need and a greater benefit for PACs.

2.1 Contractor Survey Methodology and Response

The final survey for contractors is provided in Appendix B. The 400 contractors selected for the online survey were chosen based on a random sample of bids to ensure a representative sample of contractors. This report analyzes responses from 100 contractors, the equivalent of a 25 percent response rate, gathered over a period of seven weeks. The initial survey was administered online via Survey Monkey on January 18, 2010. A total of 39 responses were collected by January 28. Three follow-up emails were sent in one week intervals between January 29 and February 18. As of February 18, 52 contractor responses were recorded. The survey protocol included phone calls to every contractor who had not responded after five weeks. On March 11, 100 contractor responses were recorded. The 25 percent response rate essentially doubles the response rate from a fuel usage survey sent to 3,000 contractors by the American Road Builders Association and the Associated General Contractors of America.[11]

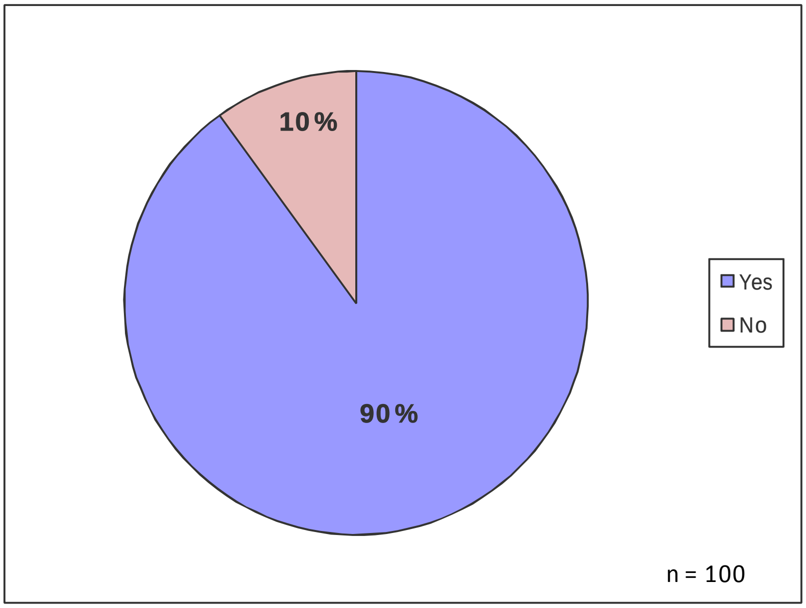
2.2 Aspects of the Current Program

Exhibit 2-1 provides survey responses on the utilization of PAC programs. In terms of responding contractors, which do not necessarily represent population statistics, 90 of 100, or 90 percent, of the contractors' primary states utilize a PAC program. The percentages in this chapter were generally calculated based on the number of responding contractors, however, not all contractors responded to every question. Therefore, within each table or chart the number of responding contractors is listed as, for example, n=75. Of the ten contractors whose states do not use PACs in their construction contracts, five represent Arkansas, Michigan and Texas, the only

[11] FHWA, published in Technical Advisory T5080.3 on December 10, 1980.

three states that do not employ PACs for any commodities. Two of the remaining five contractors are based in Indiana and the others in Georgia, Iowa and Tennessee. These respondents do not explain why their firms do not participate in a PAC program. These contractors may opt-out of PAC programs.

Exhibit 2-1: Current Contractor Use of PACs



Contractors were asked how, if at all, the presence of a PAC changes the bidding environment. For contractors not using PACs, they were instructed to answer on how they might expect PACs to affect the bidding environment. Exhibits 2-2 and 2-3 provide data on how contractors responded to a series of eight bidding environment factors. Exhibit 2-2 provides the data in table format while Exhibit 2-3 provides the data in bar graph format.

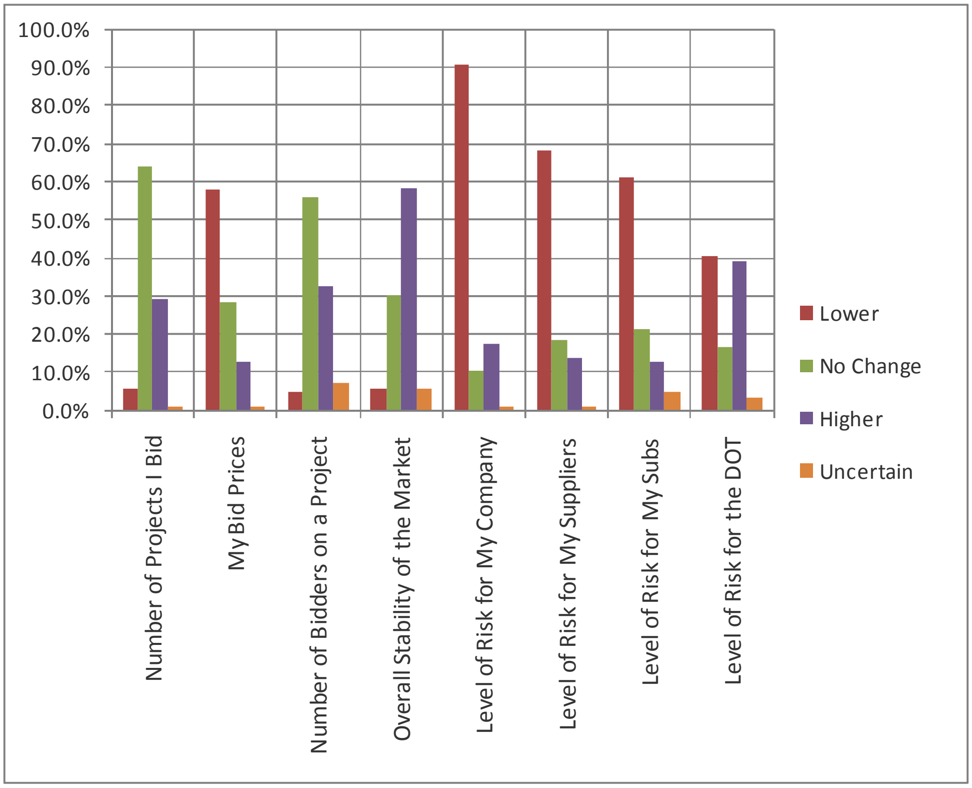
Three of the eight answer options relate to the individual firm, and the remaining five answer options relate to either market conditions in general or other stakeholders. The individual firm answer options are: “number of projects I bid,” “my bid prices,” and “level of risk for my company.” A total of 64 percent of contractors believe that a PAC program has no effect on the number of projects they bid. Approximately 29 percent think their number of bids is moderately or significantly higher, and 6 percent believe the number of bids they make is moderately lower. The consensus among surveyed contractors, therefore, is that PAC programs do not strongly affect the number of bids, although there is a moderate shift towards increased bidding. The majority of contractors, 58 percent, state that PAC programs lower their bid prices. Approximately 28 percent believe PACs do not affect their bid prices, and 13 percent state higher prices. In terms of changes to the level of risk for their firm, 71 percent of contractors believe their risk is lower, of which 31 percent believe their risk is significantly lower. Approximately 18 percent believe their risk is higher with the presence of PACs. Several contractors commented that PACs cut both ways; contractors receive payouts from project owners (DOTs) during times of escalating material prices but must give contract dollars back to the DOTs in times of falling prices. Contractors may be less willing to opt into a PAC program if such DOT reimbursement is a possibility.

Answer options relating to the market and other stakeholders include: “number of bidders on a project,” “overall stability of the market,” “level of risk for my suppliers,” “level of risk for my subs” and “level of risk for the DOT.” In terms of the total number of bidders on a project, a total of 56 percent of contractors state no change, and 33 percent indicate that PACs result in a higher number of bidders. Approximately 58 percent of responding contractors believe that PAC programs create higher overall stability in the market, with approximately 30 percent answering no change. In terms of the level of risk for other stakeholders, 66 percent of responding contractors perceive a lower level of risk for suppliers and 61 percent perceive a lower level of risk for subs. For DOT risk level, approximately 40 percent perceive lower levels of risk and 40 percent perceive higher levels of risk. The general consensus among contractors is that risk is either lower or unchanged for suppliers and subs, whereas contractors are generally split on the effect of PAC programs on DOTs.

Exhibit 2-2: PAC Effects Table

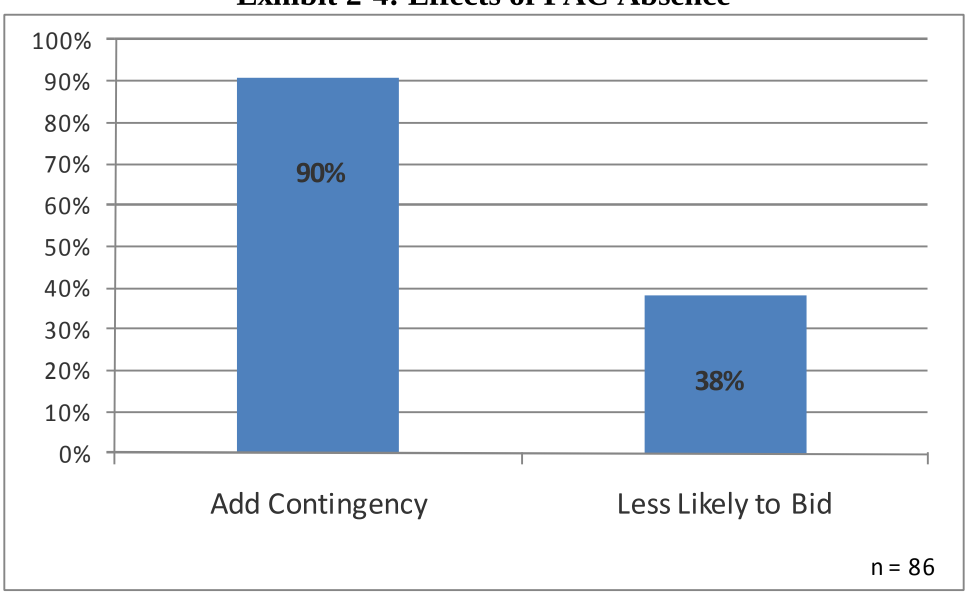
Answer Options	Significantly Lower	Moderately Lower	No Change	Moderately Higher	Significantly Higher	Uncertain	n =
Number of Projects I Bid	1%	5%	64%	16%	13%	1%	86
My Bid Prices	15%	42%	28%	7%	6%	1%	85
Number of Bidders on a Project	0%	5%	56%	26%	7%	7%	86
Overall Stability of the Market	2%	4%	30%	36%	22%	6%	86
Level of Risk for My Company	31%	40%	11%	12%	6%	1%	85
Level of Risk for My Suppliers	28%	38%	19%	8%	6%	1%	86
Level of Risk for My Subs	25%	37%	21%	8%	5%	5%	85
Level of Risk for the DOT	18%	23%	17%	36%	4%	4%	84

Exhibit 2-3: PAC Effects Chart



Contractors were also asked how their bids differ when contracts lack a PAC. Exhibit 2-4 provides a compilation of responses on how bid prices and number of bids change without a PAC. Approximately 91 percent of contractors add contingencies to their bid prices when there is no PAC in place to cover the material price risk. Approximately 38 percent of contractors are less likely to bid projects when there is no PAC.

Exhibit 2-4: Effects of PAC Absence



On average, contractors spend approximately 10 man-hours per month administrating the PAC program for their firm, with a high of 40 hours and a low of zero hours. This is the equivalent of approximately 120 hours per year. Contractors were not asked to provide hourly costs as they might not wish to divulge such information and response rates may have dropped. However, as an example, a per hour cost of $50 would total $6,000 for the year. A per hour cost of $100 would imply a yearly cost of $12,000 per contractor.

To determine how DOTs can improve PACs and make them more efficient, the survey asks contractors about problems when PACs are in place. The problems listed on the survey were partially derived from the Wyoming Department of Transportation paper titled “Materials Risk Management -- Beyond Escalation Clauses and Price Indexing.” This paper is discussed in more detail in the Literature Review provided in Chapter 1. Contractor responses are shown in Exhibits 2-5 and 2-6. One issue regarding PACs is the timing on invoices versus the index payment calculations. This problem involves a discrepancy in the date the materials are purchased and the index date used by DOTs. Half of the contractors do not believe this is a problem for the PAC program. Approximately 36 percent perceive a slight problem with this timing issue, with the remaining 14 percent calling it a moderate or major issue

A high trigger value for index payments is also a complaint of some contractors. Approximately 37 percent believe elevated trigger values are not currently a problem with PAC programs, 38 percent believe they are a slight problem, and 25 percent believe they are a moderate or major problem.

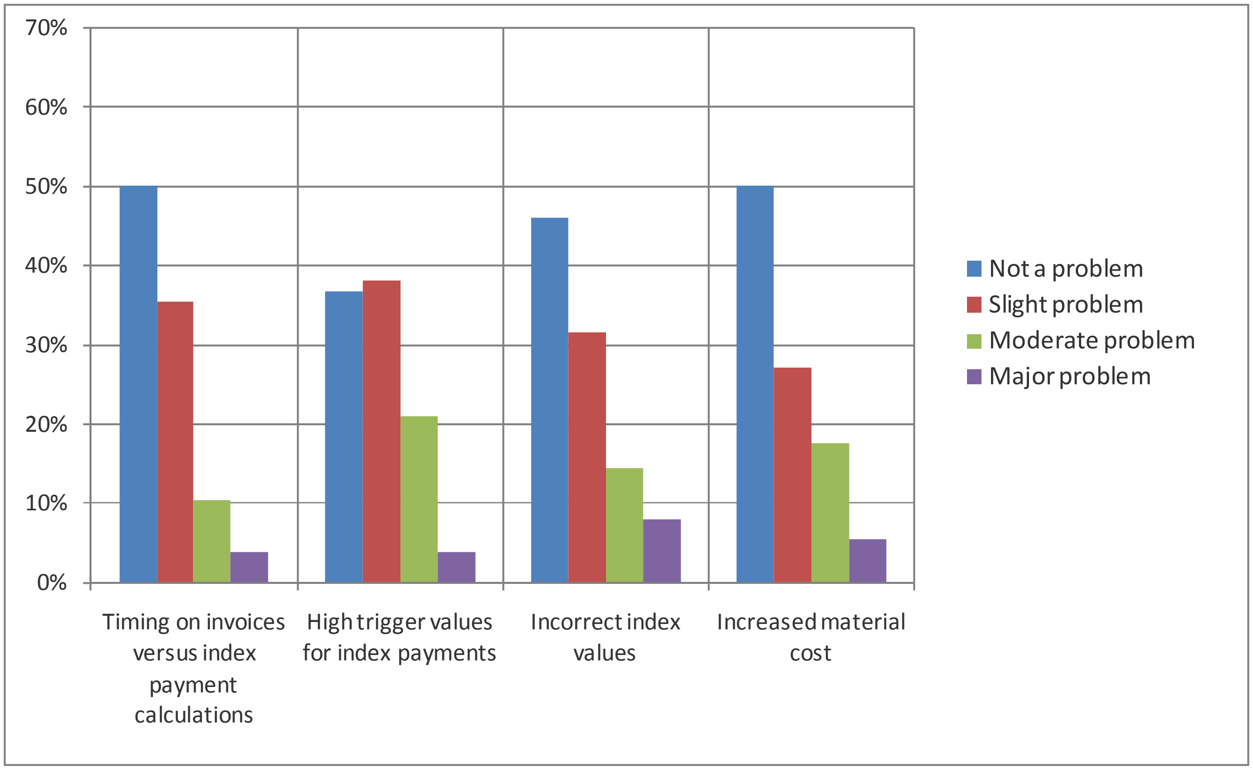
Another commonly cited problem is incorrect index values, either due to outdated indexes or incorrect calculations. Approximately 46 percent of contractors believe this is not a problem, 32 percent believe it is a slight problem, 14 percent believe it is a moderate problem and 8 percent believe it is a major problem.

The survey also asks if increased material costs are still a problem when a PAC program is in place. The desired consequence of PAC programs is to mitigate this issue. A total of 50 percent of contractors do not believe increased material costs are a problem when PACs are in place, and 27 percent perceive it as a slight problem. When asked if other problems exist for contracts with PACs, no additional problems were listed. Overall, no more than 25 percent of contractors find significant problems (moderate or major problems) for contracts with PACs.

Exhibit 2-5: Problems for Contracts With PACs Table

Answer Options	Not a problem	Slight problem	Moderate problem	Major problem	n =
Timing on invoices versus index payment calculations	50%	36%	11%	4%	76
High trigger values for index payments	37%	38%	21%	4%	76
Incorrect index values	46%	32%	15%	8%	76
Increased material cost	50%	27%	18%	5%	74

Exhibit 2-6: Problems for Contracts With PACs Chart



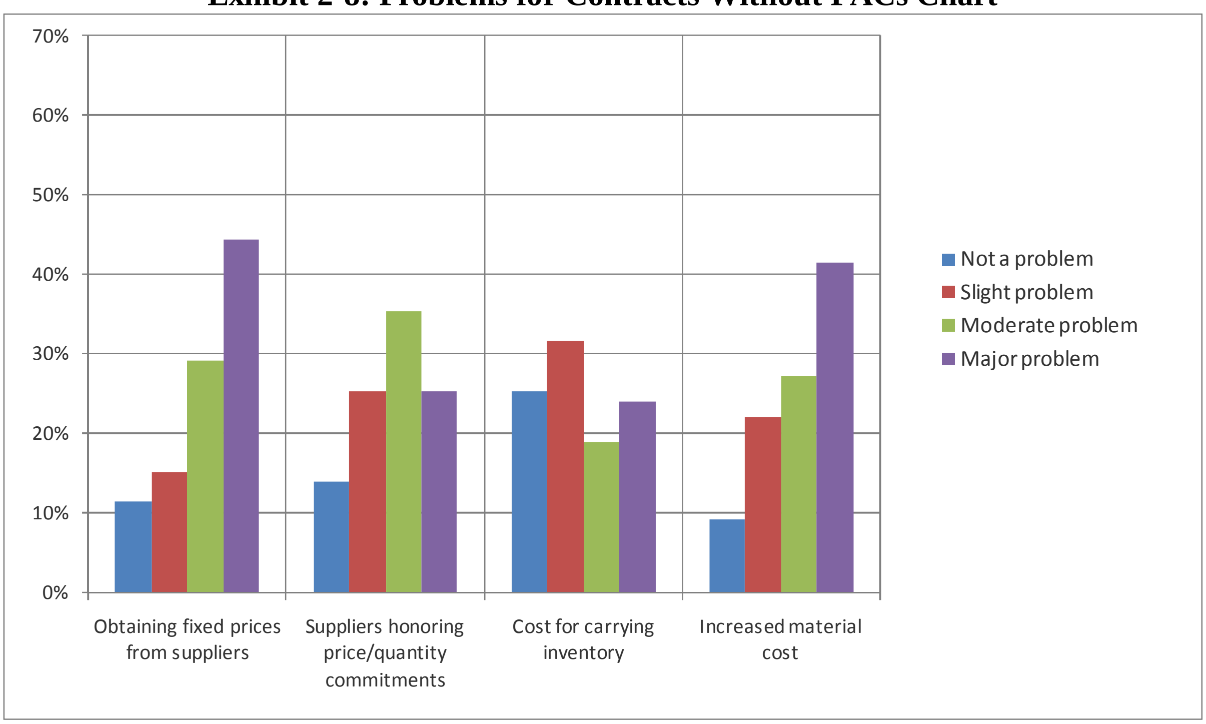
Exhibits 2-7 and 2-8 show common problems experienced by contractors on projects without PAC programs. Obtaining fixed prices from suppliers is a major problem for most contractors. A total of 44 percent of responding contractors believe it is a major problem and 29 percent state it is a moderate problem. Most contractors also believe suppliers honoring price and quantity commitments is a significant issue, with 35 percent perceiving it as a moderate problem, 25 percent perceiving it as a major problem and 25 percent perceiving it as a slight problem. The issue of costs for carrying inventory when contracts lack a PAC is less agreed upon; contractors are almost evenly split on the four answer options, with slightly more believing it is a slight problem. Increased material costs, which PACs are designed to mitigate for contractors, are cited as a major problem by 42 percent of contractors when PACs are absent. Only 9 percent of contractors believe it is not an issue when PACs are absent. When PACs are in place, 50 percent believe material costs are a non-issue and only 5 percent believe they are a major problem (Exhibit 2-5). These discrepancies show that contractors believe that PACs do in fact mitigate the consequences of increased material costs.

When asked if additional problems exist for contracts without PACs, four contractors responded. A major problem for an Illinois contractor is decreased material costs. When they get a firm price for a project at bid time and then the price for asphalt decreases at the time they construct the project, they end up paying above market price. For an Alabama contractor, a moderate problem is determining a proper way to hedge the increase in material costs without losing the bid. Kentucky expressed concern that the lack of PAC programs could drive smaller companies out of business. A slight problem for a Mississippi contractor is the duration of projects, as costs tend to fluctuate more on longer projects.

Exhibit 2-7: Problems for Contracts Without PACs Table

Answer Options	Not a problem	Slight problem	Moderate problem	Major problem	n=
Obtaining fixed prices from suppliers	11%	15%	29%	44%	79
Suppliers honoring price/quantity commitments	14%	25%	35%	25%	79
Cost for carrying inventory	25%	32%	19%	24%	79
Increased material cost	9%	22%	27%	42%	77

Exhibit 2-8: Problems for Contracts Without PACs Chart



To gain a better understanding of current contractor practice, the survey queried contractors on their price arrangements with suppliers for various construction items. Exhibits 2-9 and 2-10 show these price arrangements.[12] For liquid asphalt, half of responding contractors purchase as needed, followed by 37 percent that lock in a price for a specific time period. Approximately 18 percent of contractors lock in liquid asphalt prices with suppliers for large contracts and 15 percent lock in prices for all contracts.

For diesel fuel, approximately 64 percent of contractors purchase the item as needed. Approximately 29 percent of contractors lock diesel fuel prices in for a specific time period and a small percentage lock prices for large contracts or for all contracts.

A similar pattern is seen with gasoline. A total of 81 percent of contractors purchase as needed, 16 percent lock prices in for a specific time period, and a small percentage lock prices for large contracts or for all contracts.

With cement and steel, price arrangements tend to vary across the answer options. For cement, the most prevalent arrangement, but only by a slight margin, is a price lock for a specific time period. An equal percentage of contractors lock steel prices for specific time periods and purchase as needed.

When asked about other items, three companies responded that various price locks arrangements exist for pipe and utility, one company locks prices on all contracts for aggregates and trucking and one company locks prices on large contracts for reinforcing steel and geotextile fabrics. One Pennsylvania company commented on the timing difficulties with steel suppliers and the DOT: "Most steel suppliers will only hold their quoted prices for ten to twenty days. The problem is getting a signed contract from the DOT or prime contractor in time to place an order with the supplier before the price increases."

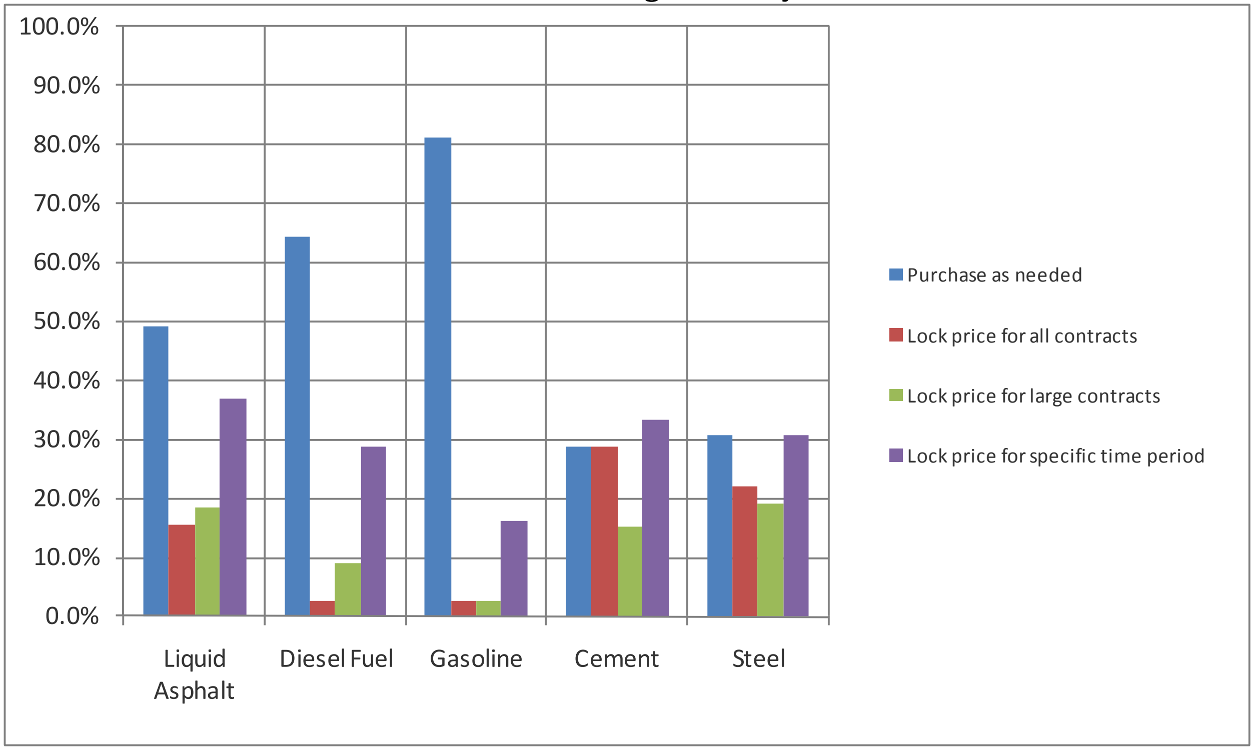
To conclude, it appears most contractors purchase liquid asphalt, diesel fuel and gasoline as needed, but more lock in prices for specific time periods for liquid asphalt (37 percent) than diesel (24 percent) or gasoline (14 percent). Cement and steel pricing arrangements are more varied.

Exhibit 2-9: Price Arrangements by Item Table

Answer Options	Purchase as needed	Lock price for all contracts	Lock price for large contracts	Lock price for specific time period	n=
Liquid Asphalt	49%	15%	19%	37%	65
Diesel Fuel	65%	3%	9%	29%	76
Gasoline	81%	3%	3%	16%	74
Cement	29%	29%	15%	33%	66
Steel	31%	22%	19%	31%	68

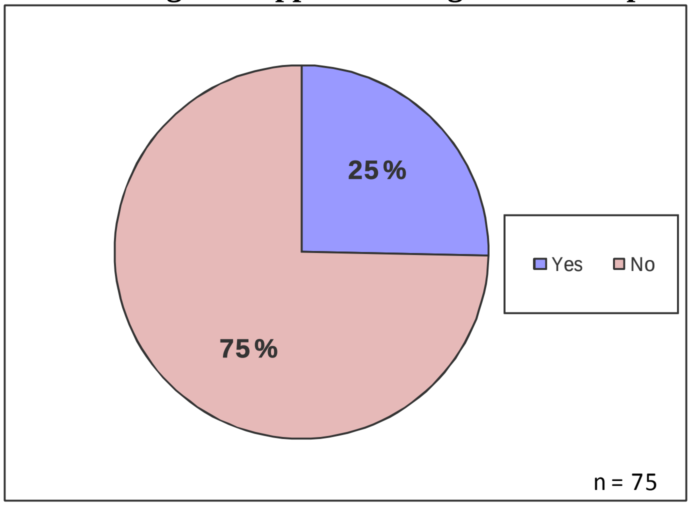
[12] Note that some items add to over 100 percent because contractors can have multiple pricing arrangements for one item.

Exhibit 2-10: Price Arrangements by Item Chart



When asked whether supplier price relationships change with the introduction of a PAC program, the majority of contractors say no. For those pricing relationships that do change with the introduction of a PAC, most contractors explain that the supplier prices float with the index.

Exhibit 2-11: Change in Supplier Pricing Relationship with PAC



2.3 Fuel Price Adjustment Clauses

As revealed in the survey of state DOTs, the most commonly used item in construction PACs is fuel. Exhibit 2-12 shows the actual makeup of fuel price adjustment methods faced by contractors, and Exhibit 2-13 shows the preferred makeup of fuel price adjustment methods. The actual distribution of fuel price adjustment methods for contractors is 61 percent fuel use per unit, 27 percent bid item method, 8 percent use the percent of cost method and 5 percent invoice method. No responding contractors are subject to contracts that have the specified total fuel requirements method. The actual and preferred distributions are largely the same. However, there is slightly less preference for fuel use per unit, slightly more preference for the invoice method and two contractors prefer the specified total fuel requirements method.

Exhibit 2-12: Used Method of Fuel Price Adjustment

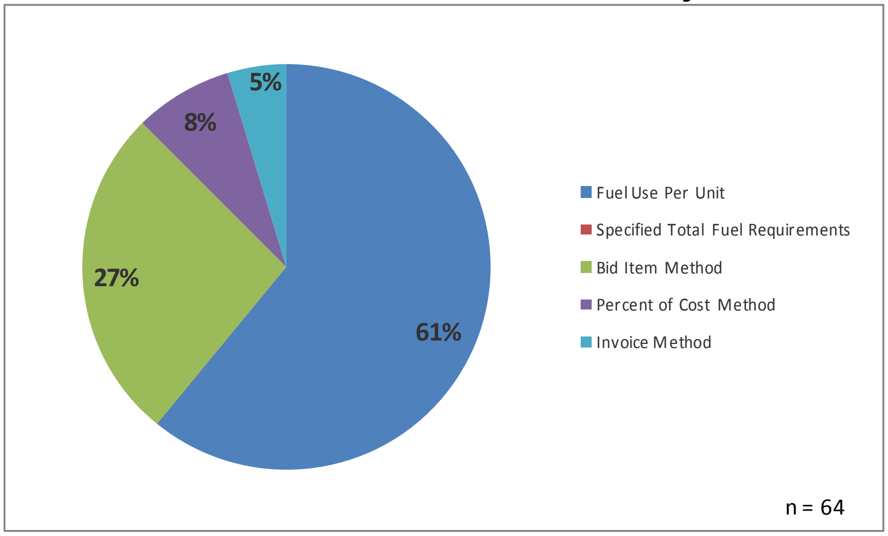
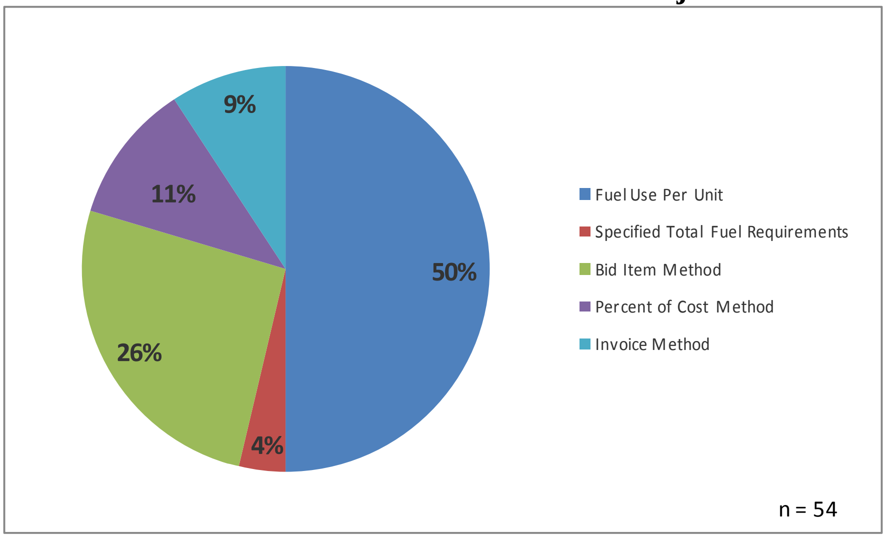
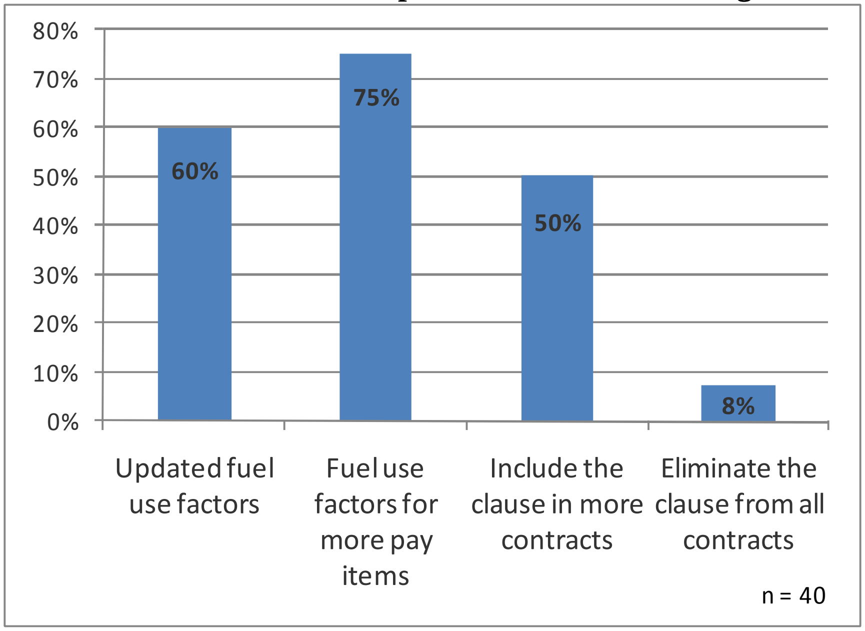


Exhibit 2-13: Preferred Method of Fuel Price Adjustment



The majority of contractors use and prefer the fuel use per unit method. Therefore, a follow-up question is asked to determine what changes contractors would like made to this method. This question was only asked of contractors that currently use the fuel use per unit method. Exhibit 2-14 shows potential alterations and additions to the method and the percentage of contractors that would like to see those changes. Approximately 60 percent of contractors using the method would like to see updated fuel usage factors, 75 percent would like to see fuel usage factors for more pay items and 50 percent would like it included in more contracts. Of the contractors whose states currently use the fuel use per unit method, only 8 percent would like it eliminated from contracts all together. The NCHRP is already aware of the need for updated and additional fuel usage factors. NCHRP Project #10-81 is designed to collect data and develop updated fuel usage factors for highway and bridge construction.

Exhibit 2-14: Fuel Use per Unit Preferred Changes



2.4 Perceptions

A key focus of this survey is to gather opinions on the current state of PACs, including benefits to the market, benefits to stakeholders, and the changing need for these clauses. Exhibit 2-15 shows contractor perceptions of the need for PACs given the recent price fluctuations in 2004 and 2008. The majority of contractors, 59 percent, believe there is currently a greater need for PACs. Approximately 36 percent believe there is no change in the need for clauses and only 5 percent believe there is less need.

Exhibit 2-15: Need of PACs Given Recent Price Fluctuations

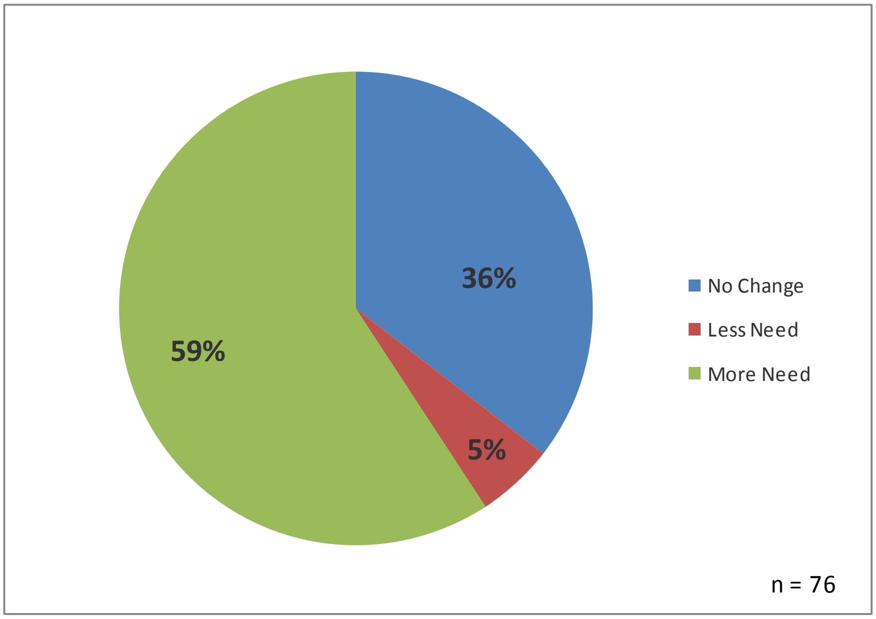
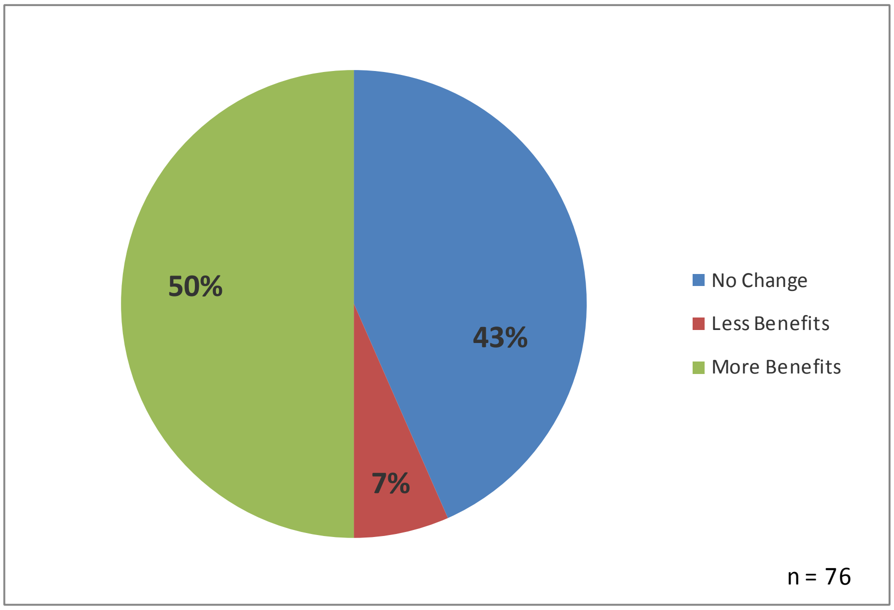


Exhibit 2-16 shows contractor perceptions of the benefits from PACs given the recent price fluctuations. Approximately 50 percent of contractors believe there are more benefits from PACs given recent price fluctuations, 43 percent perceive no change in benefits, and 7 percent find fewer benefits.

Exhibit 2-16: Benefit of PACs Given Recent Price Fluctuations

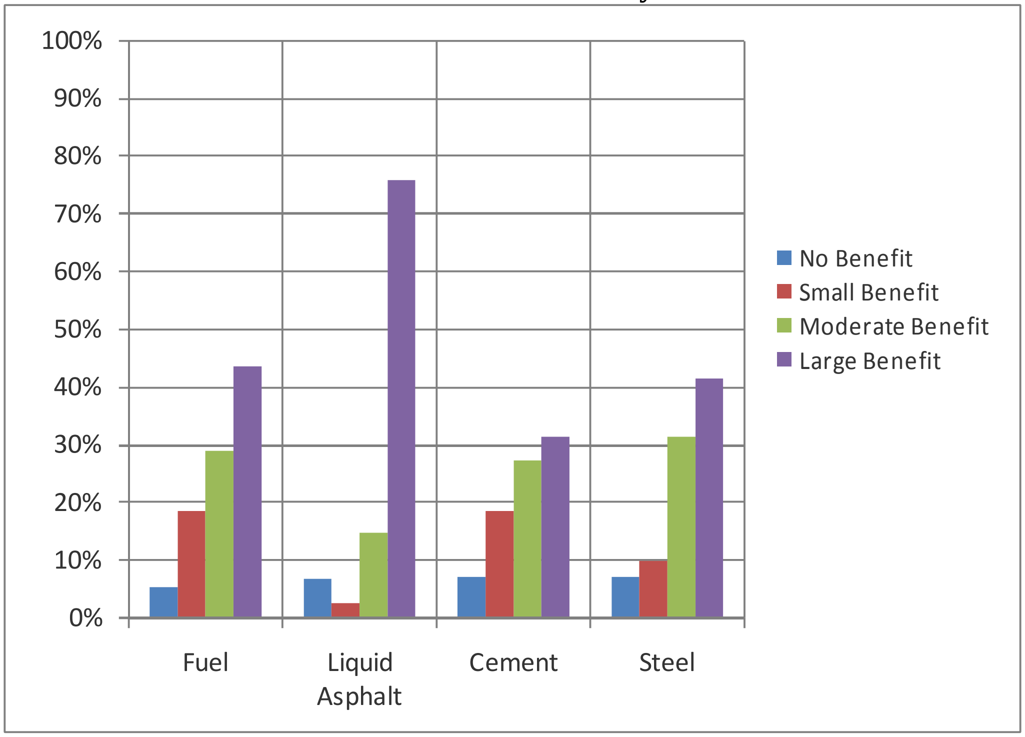


Exhibits 2-17 and 2-18 show contractor perceptions of the benefit of PACs for various construction items. If PACs were to be implemented or modified for only some items or for some items before others, this analysis provides a measure of priority. The analysis of these exhibits compares contractors that perceive a significant benefit (“moderate benefit” or “large benefit") to contractors that perceive little to no benefit ("small benefit or "no benefit"). Only contractors subject to clauses for the following construction items responded to the survey question. Approximately 72 percent of contractors believe there is a significant benefit from PAC programs for fuel. Almost all contractors, at 91 percent, find PAC programs to be a significant benefit for liquid asphalt, with 76 percent of users perceiving a large benefit. A total of 58 percent of contractors subject to cement PACs believe the clauses are a significant benefit and 72 percent find PAC programs to be a significant benefit for steel. It can be concluded in general, that at least 93 percent of contractors find some benefit from PAC programs for each construction commodity.

Exhibit 2-17: Benefit of PACs by Item Table

Answer Options	No Benefit	Small Benefit	Moderate Benefit	Large Benefit	n=
Fuel	5%	18%	29%	43%	76
Liquid Asphalt	7%	3%	15%	76%	75
Cement	7%	19%	27%	31%	70
Steel	7%	10%	31%	41%	70

Exhibit 2-18: Benefit of PACs by Item Chart

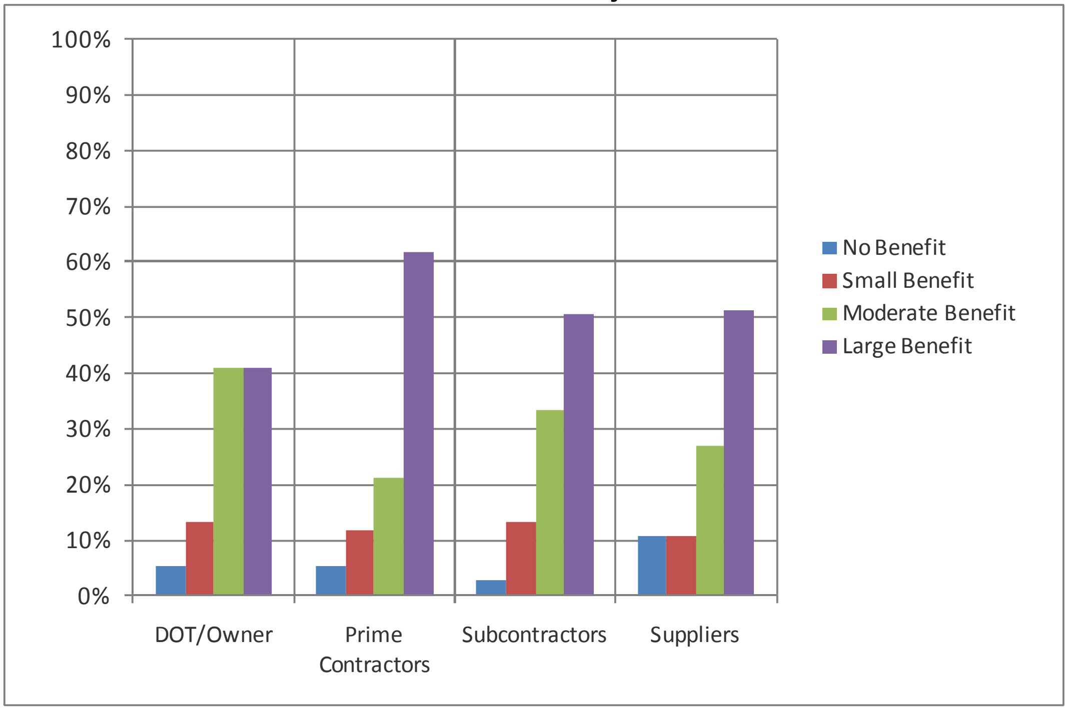


Exhibits 2-19 and 2-20 provide contractor perceptions of the benefit of PACs for various stakeholders in the construction industry. Approximately 82 percent of contractors believe that DOTs benefit significantly from PAC programs, with half of that group citing a moderate benefit and half citing a large benefit. Only 5 percent of contractors believe that DOTs receive no benefit. When asked about prime contractors, 83 percent believe they benefit significantly, with 62 percent citing a large benefit. A total of 84 percent of contractors believe subcontractors benefit significantly. Of all stakeholders, contractors cite suppliers as benefiting the least, but the majority still finds suppliers benefiting significantly, at 78 percent. In conclusion, a large majority of contractors perceive significant benefits from PAC programs to all stakeholders in the construction industry.

Exhibit 2-19: Benefit of PACs by Stakeholder Table

Answer Options	No Benefit	Small Benefit	Moderate Benefit	Large Benefit	n=
DOT/Owner	5%	13%	41%	41%	76
Prime Contractors	5%	12%	21%	62%	76
Subcontractors	3%	13%	33%	51%	75
Suppliers	11%	11%	27%	51%	74

Exhibit 2-20: Benefit of PACs by Stakeholder Chart



2.5 Future Plans and Changes

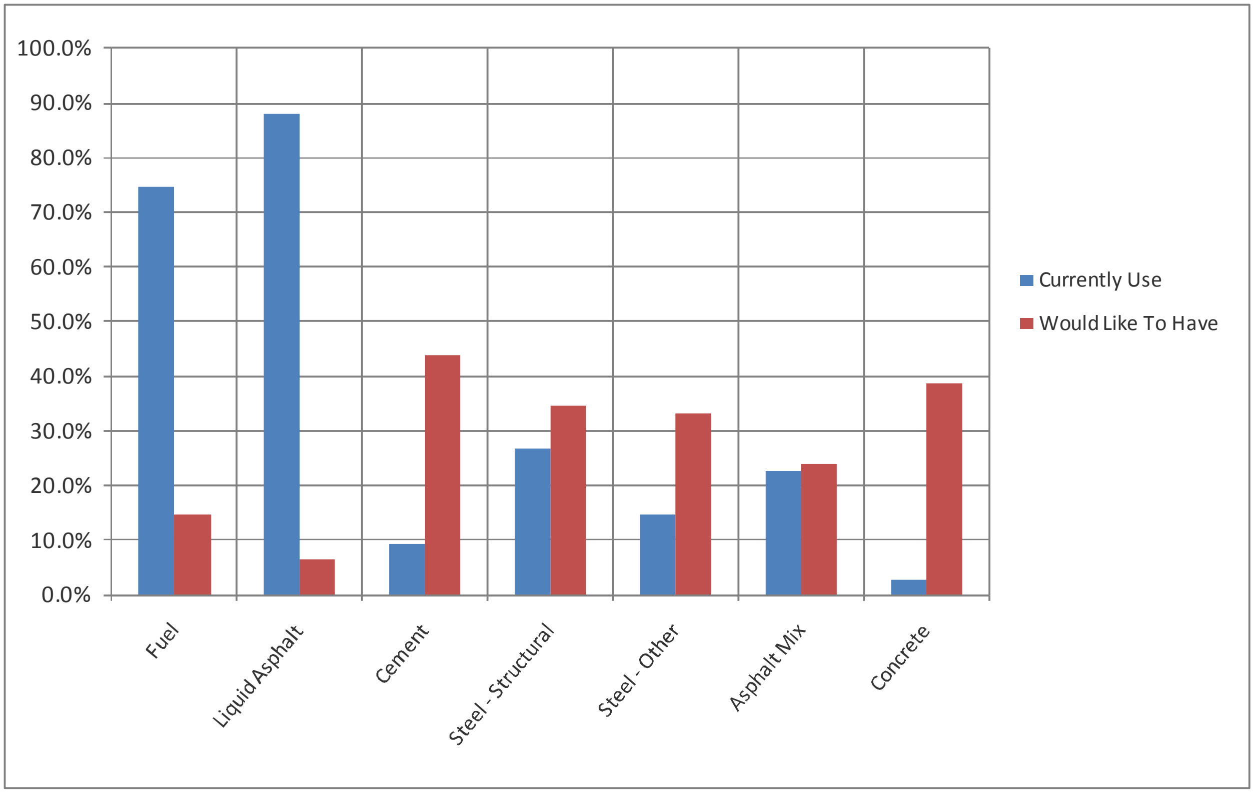
Exhibits 2-21 and 2-22 show the percentage of contractors currently subject to PACs on various construction items as well as the percentage of contractors that would favor contracts with PACs for various items. Fuel, liquid asphalt, cement, structural steel, other types of steel, asphalt mix and concrete are considered. The large majority of responding contractors are subject to fuel and liquid asphalt PACs – 75 and 88 percent respectively. Cement, steel, asphalt mix and concrete, on the other hand, are only indexed between 3 and 27 percent of contractors. When asked what other items contractors use, one contractor from Virginia listed aggregate.

In terms of items that states do not currently include but contractors would like them to include in the future, cement was the leading item at 44 percent. A total of 39 percent of contractors would prefer concrete to be indexed in the future, 35 percent selected structural steel, 33 percent selected other types of steel, 24 percent selected asphalt mix, 15 percent would like fuel and 7 percent would like liquid asphalt. When asked what other items contractors would prefer to have indexed, a contractor from Mississippi cited pre-stressed concrete beams, a Tennessee contractor cited stone and pipe materials, an Illinois contractor indicated aggregates, and a Pennsylvania contractor would like to see aluminum and copper added. This analysis can help DOTs focus resources on implementing PACs for items that are preferred by contractors.

Exhibit 2-21: Used and Wanted PAC Items Table

Answer Options	Currently Use	Would Prefer To Have	n=
Fuel	75%	15%	67
Liquid Asphalt	88%	7%	71
Cement	9%	44%	40
Steel - Structural	27%	35%	46
Steel - Other	15%	33%	36
Asphalt Mix	23%	24%	35
Concrete	3%	39%	31

Exhibit 2-21: Used and Wanted PAC Items Table



Seven contractors state they are not in favor of PACs. Regarding cement and steel, a Missouri contractor believes that suppliers quote firm prices and if prices go down, suppliers will not agree to lower their price. One Indiana contractor is opposed to fuel, cement and steel PACs. For fuel, they believe that hedging is available through NYMEX, for cement, suppliers are currently giving fixed prices, and for steel, the contractor states that it has no experience. An Oklahoma contractor believes the fuel PAC program is too complicated, but provides no further explanation. The remaining 93 responding contractors are in favor of PACs.

Contractors were asked if there are any improvements that can be made to the current PAC program. Approximately 47 percent say no and 53 percent say yes. Of those who believe improvements can be made, Exhibit 2-22 gives a sample of contractor explanations.

Exhibit 2-22: Contractor Suggestions for PAC Improvement

Contractor's Prime State	Comment/Suggested Improvement
California	Calculations of the index need to be more consistent.
Georgia	Eliminate length of time requirement for index.
Illinois	Illinois offers the asphalt price adjustment on some jobs over 1,500 tons. We would like them to be consistent and offer it on all jobs over 1,500 tons.
Illinois	Simplification in tracking and reporting needed.
Indiana	The index number needs to reflect the market area in which we work. It needs to be more responsive to the changes.
Kansas	Cement and steel should be added.
Kentucky	I think that more items can be indexed. Our DOT has had good open dialog with industry about indexing.
Kentucky	In times of rapid price fluctuation, costs on asphalt go up much faster than the index.
Mississippi	I believe that there needs to be some adjustment made to the way the PAC is calculated, mainly for grading projects. The way it is now, if fuel prices go up, it pays fairly well, but when the fuel prices decrease, it takes away too much. This could be revised to be fairer to both the owner (when prices increase) and the contractor (when prices decrease).
New Mexico	Add an adjustment for fuel based on a predetermined gallons per unit for items of work that have energy as a major component such as material haul, hot mix, excavation/grading.
North Carolina	Would rather see the indexing based on national published averages more closely related to the bid date/invoice date.
North Carolina	There needs to be more adjustment clauses on more items.
Ohio	Price adjustments for fuel and steel are greatly dampened from actual cost incurred and only buffer a small percentage of the risk of increase.
Oklahoma	Regional adjustment indexes for binders are delayed (based on which part of the month actual work is performed). Private subscriptions are too expensive, resulting in reliance on the DOT to promulgate the rates.
Pennsylvania	The 10 percent window at today's higher prices is too large. It should be reduced to at least 5 percent if not totally eliminated. At 10 percent we cover the window on the upside with higher prices and we benefit from it when prices fall, therefore it would be more cost effective for all if the price adjustment clause was dollar for dollar without any window, thereby lowering our bid prices.
Pennsylvania	Eliminate steel and develop a more accurate index.
South Carolina	Updated cost structure, more items for use.
South Carolina	Keep with the adjustments as they hit.
Tennessee	Add more items.
Tennessee	Update adjustment factors and include more items.
Tennessee	Update the usage rate factors.
Virginia	The benefit is too low. The method of adjustment is based on a percent of the consumer price index, not the actual cost of the material at the date of purchase. I would like the method of calculation changed to cover more of the escalation risk.

Lastly, contractors were asked if they would like to provide any additional information. The nine responses are shown in Exhibit 2-23.

Exhibit 2-22: Additional Contractor Comments

Contractor's Prime State	Additional Comments
Indiana	A must for the DOT to get the best value for the taxpayer.
Kentucky	Price adjustments appear to be less effective when they are used on expected single bid contracts. Kentucky has recently increased its threshold trigger from +-5 percent to +-10 percent of the index for fuel and asphalt. We also have a minimum expected project cost threshold before an index is used.
Kentucky	Some of my competitors delayed the completion of their contracts that did not have an adjustment clause waiting on the cost to come down. This could have been an owner's decision with an applicable clause.
Michigan	We don't need them as an industry unless the duration of the projects is extended to several years.
New York	The reason that these adjustments are so important is that we are all at the mercy of the raw material producers. If they do not want to give out pricing prior to bid we have the unsavory option of either not bidding or building a lot contingency into our pricing. This has a negative impact to the owner in that they are over paying and dealing with less competition or having the contractor default on the job because they can't cover the increase in material pricing.
Oklahoma	Encourage owners to pay for stockpiled materials at the point of manufacture.
Oklahoma	You only need adjustment clauses for project 6 month or longer.
Tennessee	With these ever changing markets it would be nice to be able to lock pricing down on a per job basis.
Tennessee	If a particular State has this clause then it should be incorporated in all contracts that the State uses. For example, if the DOT uses it then it should also be used in contract issued by the State Board of Regents or the Finance Department, etc.

2.6 Conclusions on Current Practice

The vast majority of responding contractors are subject to PACs, and the vast majority also believes they are beneficial. For the contractors whose states utilize PACs, nearly all opt to use them when available for fuel and liquid asphalt and a smaller percentage for steel, asphalt mix, cement and concrete. In terms of adding items, between 35 and 45 percent of contractors would like to see cement, concrete and steel PACs.

With regard to supplier pricing arrangements, the majority of contractors purchase liquid asphalt, diesel fuel and gasoline as needed. The price arrangements for cement and steel, on the other hand, range across all categories. Pricing relationships with suppliers do not generally change with the introduction of PACs.

The majority of contractors are subject to the fuel use per unit method for their fuel PACs, and more contractors prefer this method to any other. When asked how this method could be improved, the majority of responding contractors indicate that fuel use factors fuel need to be updated, that fuel use factors for more pay items are necessary and that the method should be included in more contracts.

The presence of PACs changes the bidding environment for contractors in a variety of ways. In terms of number of projects bid, the majority of contractors are not affected by the inclusion of a PAC. However, approximately a third of contractors increase the number of projects they bid when contracts include PACs. The majority of contractors claim to lower their bid prices and believe the overall level of risk for their firm to be lower when PACs are in effect. Most contractors also believe the overall level of risk for suppliers and subcontractors is lower with PACs. For DOTs, however, the perceived level of risk is split fairly evenly. It is the consensus among responding contractors that the overall stability of the market is greater with the inclusion of PACs.

When PACs are not in place, almost all responding contractors claim they add contingencies to their bids to cover the material price risk. In addition, 38 percent of contractors state they are less likely to bid projects without PACs.

Problems for contractors vary depending on whether the contract includes a PAC. For contracts with PACs, the biggest problem is high trigger values for index payments. Timing on invoices versus index payment calculations, incorrect index values and increased material costs, on the other hand, are cited by approximately half of responding contractors as not an issue. For contracts without PACs, the majority of contractors find problems with increased material costs and obtaining fixed prices from suppliers. Also cited as problems, but to a slightly lesser extent, are suppliers honoring price/quantity commitments and costs for carrying inventory. As expected, the issue of increased material costs is mitigated significantly with the presence of PACs.

Just over half of responding contractors believe there is a greater need for PACs and a greater benefit from PACs since the large price fluctuations in 2004 and 2008. Remaining contractors largely believe there is no change in need or benefit, and only a small percentage believes there is less need and less benefit.

The following is a summary of the percentage of contractors that perceive significant (“moderate” or “large”) benefits from PACs:

Perceived Benefits of PACs by Commodity

- Fuel – 72 percent significant benefit
- Liquid Asphalt – 91 percent significant benefit
- Cement – 58 percent significant benefit
- Steel – 72 percent significant benefit

Perceived Benefits of PACs to Stakeholders

- DOT – 82 percent significant benefit
- Prime Contractor – 83 percent significant benefit
- Subcontractors – 84 percent significant benefit
- Suppliers – 78 percent significant benefit

Chapter 3: Assessment of Price Adjustment Clause Impact

The purpose of this chapter was to provide a review of the quantitative impacts of price adjustment clauses (PACs). The key potential benefit of implementing PACs in construction contracts is the reduction of risk, which increases bid competition. Increases in bid competition can lead to reductions of bid prices and increased numbers of bids per project. To examine these potential benefits quantitatively, a statistical analysis was conducted using data from the comprehensive Bid-Tabs database collected by Oman Systems, Inc. This database, currently used for FHWA's new Highway Construction Cost Index, contains bid prices and quantities by pay item for each project for all 50 states.

The statistical analysis examined how the bid prices for specific pay items compare to the price index of commodity costs as the commodity costs fluctuate and assesses whether this pattern is different for states with and without cost escalation clauses. In addition, the analysis attempted to examine if there are factors that affect success such as the trigger point for the index, relative project size, type of commodity or bid item, the presence of opt-in or opt-out clauses, economic conditions such as rising or falling prices and institution factors.

The remainder of this chapter is split into two sections. First, an explanation of the database and the states selected is provided. Second, a review of the statistical analysis and quantitative conclusions on PACs is provided.

3.1 Selected States and Database Review

The selection of appropriate sample states was the first step of the analysis. Three criteria were used to select these states. First, the state must have (or not have) a PAC in place during the entire study period. The years analyzed were 2007, 2008 and 2009. Second, the state must use standard pay items that use unit prices. Florida, for example, uses lump sum bidding, where no quantities or unit prices are available.[13] Other states, such as North Carolina, Ohio, Pennsylvania and Virginia use "non-standard" pay items. Non-standard items are defined as pay items that are not consistent from project to project. Depending on the tendency of the state to use non-standard items, this may reduce the frequency of items available for use in the study. Third, the state must have a large enough database of bids in order to obtain a sample size of specific pay items large enough to perform the statistical analysis.

There were four states that met these criteria that do not use PACs: Arkansas, California, Michigan and Texas. These states were treated as the control group. They are all large DOT program states and are fairly geographically dispersed. There were other states that met one criterion but did not meet the others. Regarding states with PACs, the following four were identified: Illinois, Tennessee, Missouri and Oregon. Exhibit 3-1 shows the sample states. For states with PACs, more detailed information on their respective programs is listed in Exhibit 3-2.

[13] Greg Davis of FDOT confirmed that some contracts are bid lump sum. The Oman Systems database shows that approximately 30 percent of asphalt contracts and approximately 10 percent of overall contracts were bid lump sum in 2009. While Florida uses individual pay items for other work, the inclusion of lump sum contracts would create a statistical bias.

Exhibit 3-1: Sample States

States with NO Price Adjustment Clause	States with Price Adjustment Clause
Arkansas	Illinois – fuel, asphalt mix, steel
California	Tennessee – fuel, liquid asphalt
Michigan	Missouri – fuel, liquid asphalt
Texas	Oregon - fuel, liquid asphalt, steel

Exhibit 3-2: Sample State PAC Details

State	Fuel	Asphalt Cement	Steel	Portland Cement
Illinois	Index: Average of the Platt's Oilgram PAD 2 St. Louis Area - ULSD	Index: PG 64-22 from IDOT's approved list of certified sources for PG Asphalt Binders	Index: Materials Cost Index - Engineering News Record	None
	Trigger Value: 5%	Trigger Value: 5%	Trigger Value: 5%	
	Opt-in Clause: Yes	Opt-in clause: Yes	Opt-in clause: Yes	
Tennessee	Index: TDOT Index (two component index, Producer Price Index and price TDOT pays for fuel)	Index: TDOT index (posted terminal prices)	None	None
	Trigger Value: 5%	Trigger Value: 5%		
	Opt-in clause: No	Opt-in clause: No		
Missouri	Index: Based on Platts Oilgram Pad 2	Index: Based on Poten & Partners report for Kansas City and St. Louis areas averaged	None	None
	Trigger Value: None - 0%	Trigger Value : None - 0%		
	Opt-in clause: Yes	Opt-in clause: Yes		
Oregon	Index: OPIS Listing	Index: Poten & Partners, Inc. Index	Index: BLS Final IDWPUSISTEEL1, PPI, non-seasonally adjusted index	None
	Trigger Value: 25%	Trigger Value: 5%	Trigger Value:10%	
	Opt-in clause: No	Opt-in clause: No	Opt-in clause: Yes	

After the identification of the states, specific pay items were identified for use in the study. Running a pay items summary report in the database for each of the primary categories, as listed in Exhibit 3-3, allowed for the isolation of pay items with a large bid frequency and a unit of measure that is consistent and measurable (such as tons, cubic yards or pounds). Conversion between these standard measurements is a simple exercise. In some cases there were a range of pay items where the specifications and pricing make it possible to combine like items to get a larger sample. In some categories a secondary pay item is included. The primary pay items are:

- Base Stone
- Asphalt[14]
- Grading
- Bridge

Exhibit 3-3 shows lists of these pay items for each sample state as they appear in the Bid Price database.

[14] Many states bid asphalt as "in-place mix." States that bid aggregate and liquid as separate items still have many pay items that are a total mix price. It is relatively straightforward to determine the liquid content in a mix because the material specifications have a high and low end percentage for each mix type.

Exhibit 3-3: Sample State Bids Price Database

State	Category	Pay Item	Units	Frequency
ARKANSAS	Base Stone	Aggregate Base (Class 7)	TON	500
	Asphalt	Mineral Aggregate Surface Course	TON	656
	Grading	Unclassified Excavation	C.Y.	309
		Compacted Embankment	C.Y.	272
	Bridge	Class S Concrete - Bridge	C.Y.	127
		Reinforcing Steel	LBS	477
CALIFORNIA	Base Stone	Class 2 Aggregate Base	C.Y.	884
	Asphalt	Asphalt Concrete – Type A	TON	578
		Hot Mix Asphalt – Type A	TON	665
	Grading	Roadway Excavation	C.Y.	1,407
		Imported Borrow	C.Y.	457
	Bridge	Structure Concrete - Bridge	C.Y.	359
		Bar Reinforcing Steel	LBS	521
TEXAS	Base Stone	Fl Base (Compacted in Place)	C.Y.	294
	Asphalt	D Grade HMA – Type C	TON	838
		Asphalt (AC-20-5TR)	GAL	405
	Grading	Excavation (Roadway)	C.Y.	1,945
		Embankment (Type C)	C.Y.	720
	Bridge	Class C Concrete	C.Y.	1,545
		Structural Steel (Misc)	LBS	309
MICHIGAN	Base Stone	SUBBASE, CIP	C.Y.	1,448
		Aggregate Base	TON	581
	Asphalt	HMA, 13A	TON	1,087
		HMA, 4C	TON	701
	Grading	Embankment , CIP	C.Y.	1,325
		Excavation, Earth	C.Y.	1,903
	Bridge	Substructure Concrete	C.Y.	562
		Superstructure Concrete	C.Y.	630
ILLINOIS	Base Stone	Aggregate Base, Type B	TON	1,303
	Asphalt	Hot Mix Surface Course, Mix C, N50	TON	1,273
	Grading	Earth Excavation	C.Y.	2,031
	Bridge	Concrete Structures	C.Y.	1,121
		Reinforcement Bars	LBS	1,853
TENNESSEE	Base Stone	Mineral Aggregate – Type A Base	TON	1,111
	Asphalt	Acs Mix (PG64-22) Grading D	TON	817
		Bit Plant Mix Base (HM) Grading B	TON	667
	Grading	Unclassified Excavation	C.Y.	599
		Borrow Excavation (Unclassified)	C.Y.	408
	Bridge	Class A Concrete (Bridges)	C.Y.	288
		Steel Bar Reinforcement (Bridges)	LBS	280
OREGON	Base Stone	Aggregate Base	TON	234
	Asphalt	Level 3, ½" Dense HMAC	TON	188
		PG 70-22 Asphalt in HMAC	TON	153
	Grading	General Excavation	C.Y.	358
	Bridge	No items will meet requirements (most are lump sum)		
MISSOURI	Base Stone	Type 1 Aggregate for Base (4" Thick)	S.Y.	637
	Asphalt	Bit Pavement Mix PG 64-22 BP-1	TON	820
		Bit Pavement Mix PG 64-22 Base	TON	308
	Grading	Class A Excavation	C.Y.	598
		Class 3 Excavation	C.Y.	498
	Bridge	Class B-1 Concrete (Culverts)	C.Y.	163
		Reinforcing Steel	LBS	523

To compare bids in the database with actual market values, the state indices in Exhibit 3-2 were collected on a monthly basis for the years 2007 through 2009. Four of the ten indices were replaced by surrogate indices, as they required subscription purchases not funded by this project.[15] For the sample states not utilizing PACs in the selected years, a national price index was used.

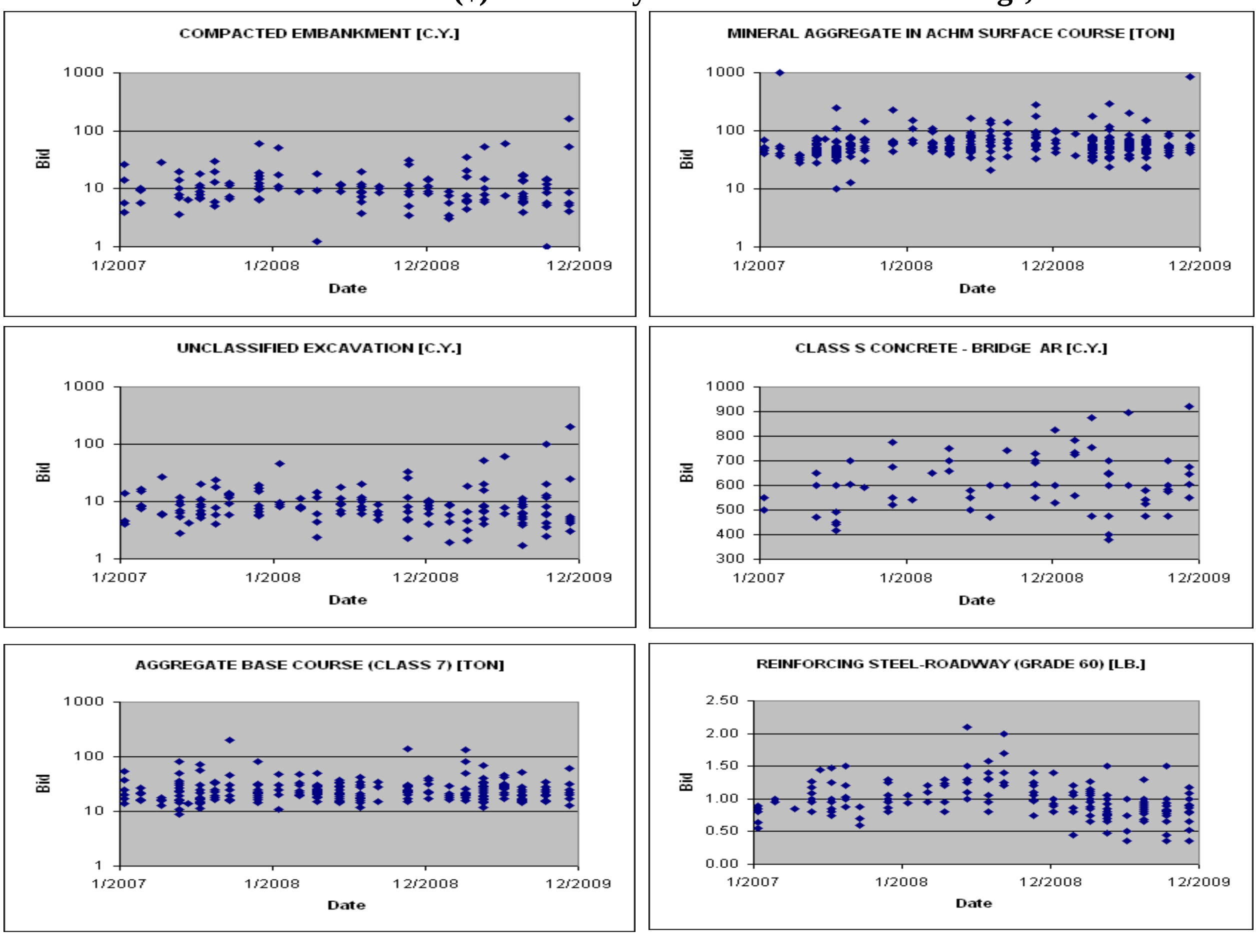
[15] The statistical data obtained from these surrogate indices proved to be consistent with the six state indices.

3.2 Analysis of Pay Item Bids

Bid data were collected for the four states with a PAC in effect (IL, MO, OR and TN), and for the four control states (AR, CA, MI, and TX) with no PACs in effect during the study period. As explained above, the data contained bid quantities and unit bid prices for five categories of pay items: asphalt mix (tons); base stone (cubic yards), grading (cubic yards), bridge concrete (cubic yards), and reinforcing steel (pounds).[16] Related pay items in each state were grouped into the five pay item categories used in this study.

An example of the pay item micro data included in the five categories is shown in Exhibit 3-4 for Arkansas, a state with no PACs. Lettings occur usually on a monthly basis, with multiple bids received for the contracts let on each date. The prices shown are the lowest awarded bids for the specified pay item. The bids for a given pay item generally range over one or more orders of magnitude. The time series plots show that the large cross-sectional variation of bids across contracts at each letting tends to mask the temporal effects of rapidly changing prices of energy and steel during the study period.

Exhibit 3-4: Lowest Bids ($) for Six Pay Items in Arkansas Lettings, 2007 to 2009



[16] Bridge concrete and reinforcing steel bar ("rebar") are secondary pay items under the bridge primary category. Statistical analyses performed on these two secondary categories results in five total statistical analyses performed on the four primary pay categories listed below the "Sample State PAC Details" exhibit.

In Arkansas, the pay items named unclassified excavation and compacted embankment were included in the pay item category named grading. Note that these two pay items have the same units and roughly the same cost per unit. In other states the corresponding pay items have different names, but were assigned to the five categories if they were for similar items purchased in the same units. Intimate knowledge of the construction trades was required for the assignment of pay items to categories.

In addition to the bid price, the data base includes the quantity that was bid on each contract. This variable explains in part the large cross-sectional variation in bids seen in Exhibit 3-4. The scatter plots in Exhibit 3-5 demonstrate the relationship of bid price and quantity for the six Arkansas pay items shown in Exhibit 3-4. The bid prices and bid quantities are related due to economies of scale, with contracts for larger quantities generally attracting a lower bid per unit delivered. Very small quantities often result in large and erratic bids at the left of the charts. Note that the prices of some pay items require a log scale, while the quantities extend over many orders of magnitude for all pay items. The extremely large range of values suggests the use of logarithms in modeling the price and quantity data.

Exhibit 3-5: Bid Prices ($) for Six Pay Items in Arkansas Lettings versus Quantity Bid

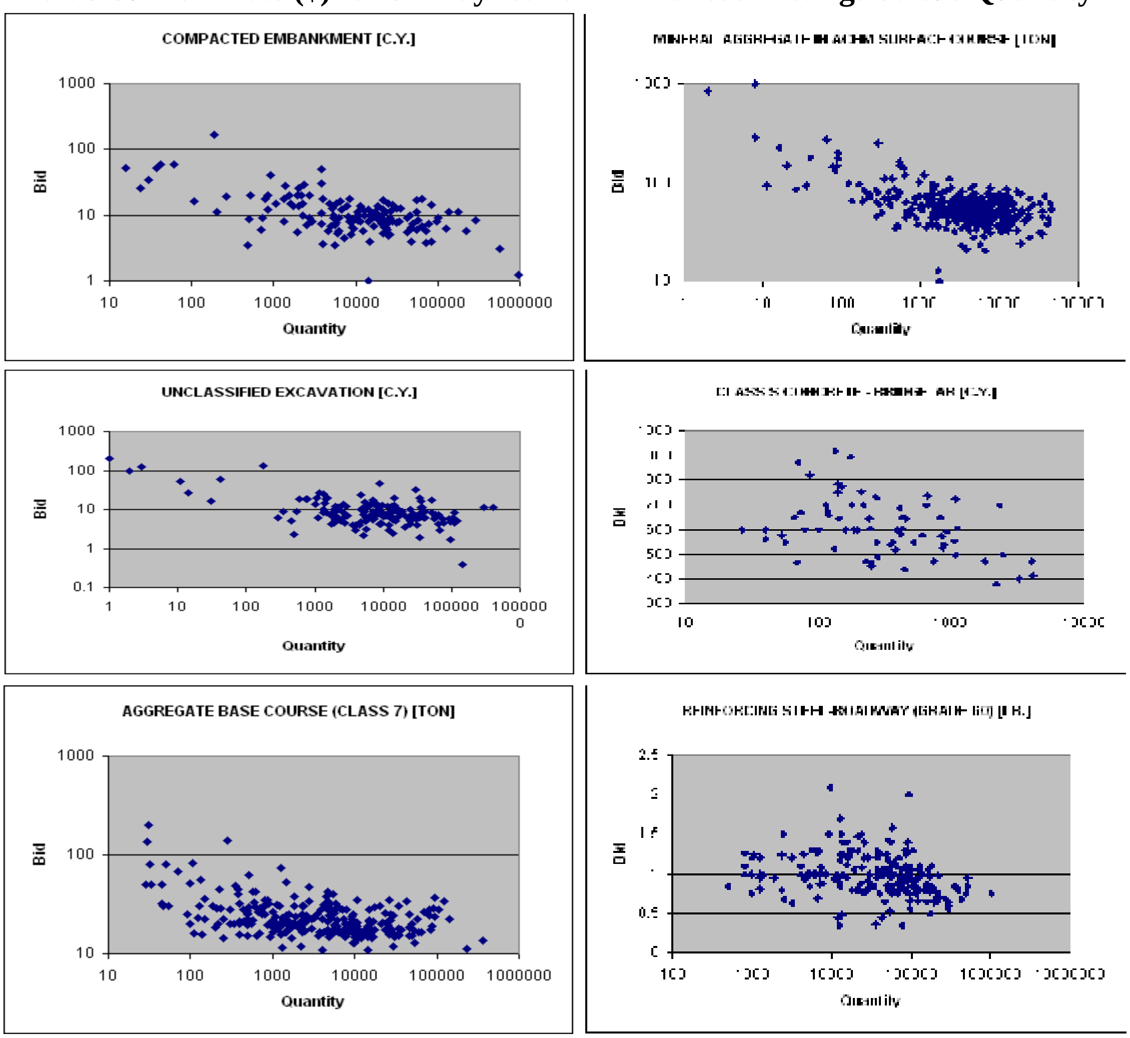


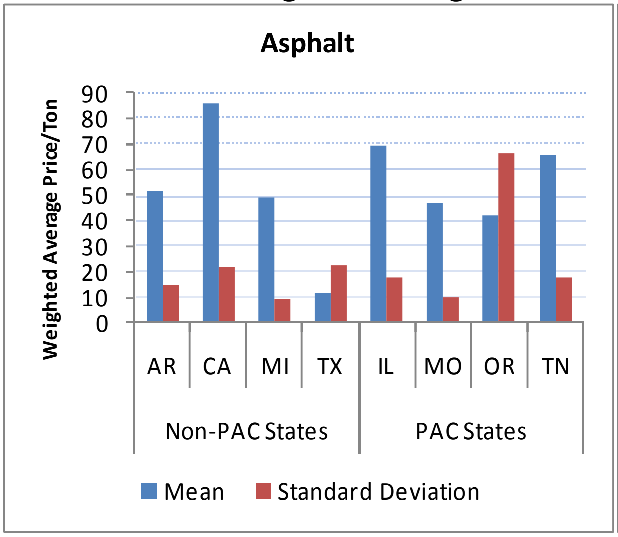
Exhibit 3-6 contains a summary of the number of bids and the un-weighted and weighted mean and standard deviation of the low bids for all lettings during the three-year study period. The mean represents the average unit price bid for that construction item in that state and the standard deviation is a measure of the amount of variation in the unit prices. The bar graphs in Exhibits 3-7 compare the weighted mean and standard deviation from Exhibit 3-6 for states with no PACs (left bars) and states with PACs (right bars). Examination of the plots shows that the weighted mean bids in states with or without a PAC are roughly comparable for asphalt mix and grading. For base stone and concrete, the PAC states appear to have somewhat lower weighted mean bids. For steel, the high bids in Texas distort the comparison. Overall, there is some indication that bids are lower, at least for some items, in states with price adjustment clauses. However, these differences may reflect differences between states in the average sizes of projects bid as well as other factors. Therefore, a regression model, which can control for such differences, is introduced below.

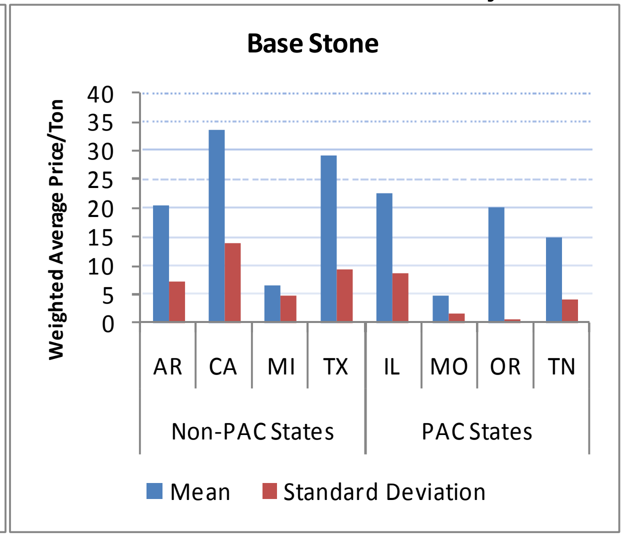
In all five categories, the variations of weighted mean bids across states range as high as a factor of 5 or 10. The individual pay items in the data set have bid ranges that may span several orders of magnitude. The standard deviations generally appear proportional to the mean values. In this case, the logarithmic transformation is often used for the dependent variable in the regression model to stabilize the variance from the regression line.

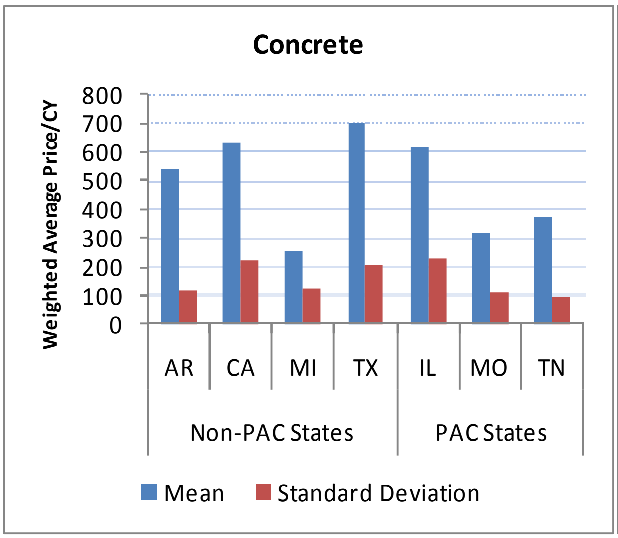
Exhibit 3-6: Weighted and Un-weighted Mean and Standard Deviation of Bid Prices in All Lettings

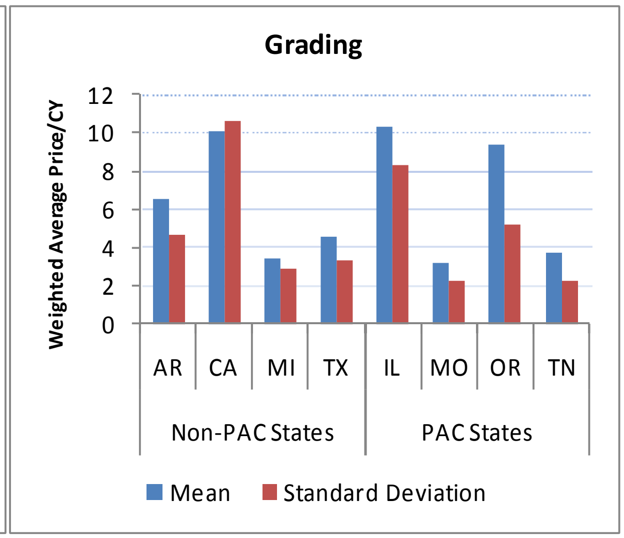
				All Lettings			
				Un-weighted		Weighted	
Category	PAC	State	N	Mean	Std. Deviation	Mean	Std. Deviation
Asphalt	NO	AR	378	64.3	70.4	51.6	14.6
		CA	626	145.1	126.4	85.5	22.0
		MI	859	62.0	26.4	49.1	9.4
		TX	614	49.3	35.6	12.0	22.7
		Total	2,477	80.2	82.5	22.1	30.9
	YES	IL	675	119.0	171.9	69.2	18.0
		MO	569	81.1	122.5	47.1	10.0
		OR	175	125.7	193.6	42.5	66.0
		TN	786	99.6	58.8	65.8	17.6
		Total	2,205	102.9	131.7	54.3	33.6
Base Stone	NO	AR	271	25.6	18.3	20.6	7.1
		CA	444	75.9	64.7	33.6	14.0
		MI	1,018	12.0	9.5	6.7	4.7
		TX	148	43.5	24.1	26.3	9.3
		Total	1,881	31.5	42.6	19.4	14.0
	YES	IL	737	36.7	54.5	22.5	8.5
		MO	322	8.4	9.0	5.0	1.7
		OR	4	30.0	11.5	20.0	0.8
		TN	598	21.7	12.6	15.0	4.0
		Total	1,661	25.8	38.9	12.5	6.7
Concrete	NO	AR	69	610.1	116.1	538.7	114.5
		CA	181	1,311.9	1,770.8	629.2	223.7
		MI	599	328.1	314.2	257.0	125.5
		TX	775	799.1	269.6	697.5	206.9
		Total	1,624	674.5	718.7	530.7	261.3
	YES	IL	579	866.9	590.2	620.8	231.0
		MO	82	390.3	202.8	320.0	109.8
		TN	146	454.7	221.3	372.5	96.5
		Total	807	743.9	549.0	462.9	211.5
Grading	NO	AR	313	13.0	19.6	6.6	4.7
		CA	936	67.3	195.6	10.1	10.6
		MI	1,620	8.5	10.6	3.4	2.9
		TX	1,339	12.9	30.8	4.6	3.3
		Total	4,208	23.3	97.1	6.2	6.9
	YES	IL	1,053	26.5	29.3	10.3	8.3
		MO	553	18.3	50.0	3.2	2.3
		OR	183	17.5	14.0	9.4	5.2
		TN	516	12.1	16.9	3.7	2.3
		Total	2,305	20.6	33.2	4.2	3.9
Steel	NO	AR	250	1.0	0.3	0.9	0.2
		CA	436	1.7	2.3	0.8	0.3
		TX	157	8.3	7.4	5.7	3.5
		Total	843	2.7	4.5	0.8	0.4
	YES	IL	967	2.1	2.7	1.3	0.4
		MO	386	1.2	0.6	1.1	0.2
		TN	142	0.8	0.4	0.7	0.1
		Total	1,495	1.8	2.3	1.1	0.4

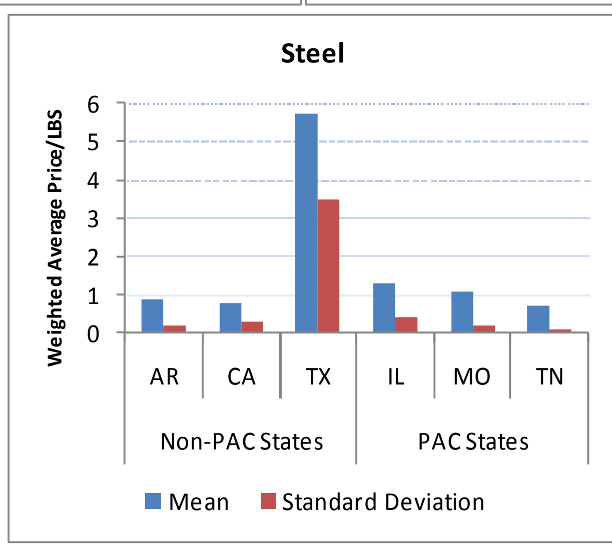
Exhibit 3-7: Weighted Average Mean and Standard Deviation of Bids for Pay Items











Exhibits 3-8 and 3-9 contain the un-weighted and weighted mean and standard deviation for lettings during periods of falling prices and rising prices, respectively. The dates for the periods of rising and falling prices are discussed below.

Exhibit 3-8: Weighted and Un-weighted Mean and Standard Deviation of Bid Prices in Lettings during Falling Prices

				Falling Prices			
				Un-weighted		Weighted	
Category	PAC	State	N	Mean	Std. Deviation	Mean	Std. Deviation
Asphalt	NO	AR	43	75.4	45.5	57.1	17.7
		CA	119	146.8	108.6	86.3	28.1
		MI	96	75.8	29.4	58.6	12.8
		TX	108	55.9	40.3	12.8	23.3
		Total	366	93.0	78.9	20.2	31.2
	YES	IL	103	132.7	116.1	75.4	20.7
		MO	139	83.9	50.8	52.5	9.0
		OR	25	97.5	240.7	54.5	75.9
		TN	117	118.7	55.4	80.3	19.3
		Total	384	108.5	97.4	59.3	31.0
Base Stone	NO	AR	42	26.9	19.3	23.5	7.1
		CA	88	79.9	82.9	31.9	13.3
		MI	187	12.7	9.6	6.5	4.5
		TX	30	36.5	10.7	25.0	9.4
		Total	347	33.5	51.2	19.4	13.6
	YES	IL	93	43.0	67.5	23.3	10.4
		MO	82	8.1	7.7	5.2	6.0
		OR	--	--	--	--	--
		TN	99	24.2	14.8	14.0	4.3
		Total	274	25.8	42.7	10.5	6.4
Concrete	NO	AR	17	649.9	99.2	637.7	90.0
		CA	41	1,576.1	3,051.6	708.7	257.3
		MI	140	336.7	333.7	269.5	146.4
		TX	153	829.7	288.0	733.1	173.2
		Total	351	711.6	1,138.0	597.1	287.5
	YES	IL	125	857.6	636.4	621.3	252.6
		MO	9	356.5	61.5	318.3	54.2
		TN	16	444.1	140.0	297.7	74.3
		Total	150	783.4	606.0	433.0	232.8
Grading	NO	AR	70	9.6	6.2	7.0	4.8
		CA	179	52.4	83.3	13.9	10.6
		MI	344	8.5	10.8	3.9	2.9
		TX	245	11.8	14.1	4.6	3.1
		Total	838	19.0	43.5	6.9	7.1
	YES	IL	208	26.3	23.3	12.9	7.4
		MO	123	26.8	99.0	3.3	2.3
		OR	30	17.3	11.2	15.8	5.5
		TN	84	11.5	10.3	3.5	1.5
		Total	445	23.1	54.9	4.2	3.8
Steel	NO	AR	59	1.1	0.3	1.1	0.2
		CA	93	1.9	1.8	0.8	0.3
		TX	33	7.7	4.5	8.7	3.5
		Total	185	2.7	3.3	0.9	0.6
	YES	IL	198	2.0	1.3	1.4	0.3
		MO	85	1.5	0.9	1.1	0.3
		TN	18	0.9	0.2	0.7	0.1
		Total	301	1.8	1.2	1.2	0.4

Exhibit 3-9: Weighted and Un-weighted Mean and Standard Deviation of Bid Prices in Lettings during Rising Prices

				Rising Prices			
				Un-weighted		Weighted	
Category	PAC?	State	N	Mean	Std. Deviation	Mean	Std. Deviation
Asphalt	NO	AR	335	62.8	72.9	51.1	14.2
		CA	507	144.7	130.3	85.3	20.2
		MI	763	60.3	25.5	48.1	8.4
		TX	506	47.9	34.4	11.8	22.6
		Total	2,111	78.0	82.9	22.6	30.8
	YES	IL	572	116.6	180.1	68.3	17.5
		MO	430	80.2	138.0	45.2	9.7
		OR	150	130.5	185.1	41.1	64.6
		TN	669	96.3	58.8	64.1	16.6
		Total	1,821	101.7	137.8	53.2	34.1
Base Stone	NO	AR	229	25.3	18.1	20.1	7.0
		CA	356	74.9	59.5	34.0	14.1
		MI	831	11.9	9.4	6.7	4.8
		TX	118	45.2	26.2	27.0	9.2
		Total	1,534	31.1	40.5	19.4	14.1
	YES	IL	644	35.8	52.4	22.4	8.2
		MO	240	8.5	9.5	5.0	1.7
		OR	4	30.0	11.5	20.0	0.8
		TN	499	21.2	12.1	15.2	3.9
		Total	1,387	25.8	38.1	12.9	6.6
Concrete	NO	AR	52	597.1	119.1	519.5	108.6
		CA	140	1,234.6	1,163.7	611.7	211.7
		MI	459	325.4	308.3	254.4	120.5
		TX	622	791.6	264.6	685.4	215.9
		Total	1,273	664.3	549.8	515.1	252.3
	YES	IL	454	869.4	577.5	620.6	225.8
		MO	73	394.4	213.8	320.2	113.8
		TN	130	456.0	229.6	393.3	91.6
		Total	657	734.8	535.3	469.5	206.0
Grading	NO	AR	243	14.1	21.9	6.5	4.7
		CA	757	70.8	213.6	9.5	10.5
		MI	1,276	8.5	10.5	3.3	2.9
		TX	1,094	13.2	33.4	4.6	3.3
		Total	3,370	24.4	106.3	6.1	6.8
	YES	IL	845	26.5	30.6	9.9	8.4
		MO	430	15.8	20.2	3.2	2.3
		OR	153	17.6	14.5	8.7	4.6
		TN	432	12.2	17.9	3.7	2.4
		Total	1,860	20.0	25.5	4.2	4.0
Steel	NO	AR	191	1.0	0.4	0.9	0.2
		CA	343	1.7	2.4	0.8	0.3
		TX	124	8.4	8.0	4.9	3.1
		Total	658	2.7	4.7	0.8	0.4
	YES	IL	769	2.1	3.0	1.2	0.4
		MO	301	1.2	0.5	1.1	0.2
		TN	124	0.8	0.4	0.7	0.2
		Total	1,194	1.8	2.5	1.1	0.4

The bid prices for the four PAC states and the four control states were used in a regression analysis to determine the factors that influence bid prices. States with PACs for each type of index are shown in Exhibit 3-10. Several states have PACs and an index for implementing the clause, but the actual index was not available for this study. In these cases, a surrogate index was used. The indices that were used in the study are shown in the table. Three states have fuel price indices available: Missouri, Illinois and Tennessee. Missouri and Illinois use the same index from Platt's Oilgram for St. Louis, MO. Tennessee has its own fuel price index. The Illinois/Missouri fuel index was used as a surrogate for the remaining states. For steel and asphalt mix, only one index was available. The Tennessee bituminous index was used as a surrogate for the remaining states for asphalt mix. The Illinois steel index was used in Illinois. Oregon has a steel index, but no pay items were identified in Oregon for steel.

Exhibit 3-10: States Price Indices and Surrogate Indices

	States with Price Indices			
Index Type	Illinois	Missouri	Tennessee	Oregon
Asphalt Index	*	*	TN-Bitum.	*
Surrogate Index**	TN-Bitum.	TN-Bitum.		TN-Bitum.
Fuel Index	IL-Fuel#	MO-Fuel#	TN-Fuel	*
Surrogate Index**				IL/MO-Fuel#
Steel Index	IL-Steel			OR-Steel@
Surrogate Index**				

Notes: Shaded area - no indexing in effect from 2007 to 2009.
* State has an index of this type, but it was not available.
** Denotes surrogate index that was used in this analysis for the * states.
\# Illinois and Missouri both use Platt's Oilgram PACD2 Index (St. Louis, MO).
@ Oregon has a steel index, but no pay items were identified for steel.

The basic regression model has the bid price as the dependent variable on the left of the equation and several explanatory variables on the right, including the quantity of the pay item requested for the job and the relevant price index from Exhibit 3-10. The variable "Clause" is an indicator variable for the states with a PAC.

In addition, several indicator variables were later added to the basic regression model. The variables Trig-Fuel, Trig-Steel, and Trig-Asphalt represent the trigger level used in the PAC (states with no PAC were assigned a trigger level of 100 percent). An indicator variable for the presence of an opt-in clause is also used in the multi-state models. In this case, states with no PAC were assigned a value of 0, states with a PAC with an Opt-in option were assigned a value of 1, and states with a PAC but no Opt-in option were assigned a value of -1. Depending on the model, these additional variables introduced troublesome multicollinearities[17] which resulted in unstable parameter estimates for the added variables and the PAC term.

The relevant price index in each regression varied according to the state and/or pay item category when possible. For asphalt mix, the relevant price index is the Tennessee bituminous price. This index is the only asphalt index available and it was used as a surrogate in all other states. A fuel

[17] The term multicollinearity refers to the correlation of two or more explanatory variables in a regression model. If there is a high correlation between two variables, it is difficult to separate the effect due to each variable. Multicollinearity often leads to unstable regression coefficient estimates for the correlated variables.

price index was not used for asphalt mix due to its high correlation with the bituminous price index shown in Exhibits 3-11 and 3-12. For the other four pay item categories, the relevant price index is the fuel price index.

Exhibit 3-11 shows the month-to-month percent changes in four price indices: the OR-Steel index, the MO/IL Fuel index, the TN-Fuel index, and the TN-Bituminous index. Exhibit 3-12 shows the three-month moving average of the month-to-month percent changes in the three indices. The TN-Fuel index is not shown, but it closely tracks the MO/IL Fuel price index. The three price indices follow the same pattern. Prices were rising (percent changes above 0), then falling, and then rising again. Based on a detailed inspection of the data for the MO/IL-Fuel price index, prices were rising from 1/1/2007 to 6/30/2008, falling from 7/1/2008 to 3/31/2009; then rising again from 4/1/2009 to 12/31/2009. (The other two indices have slightly later turning points, but the small differences in the dates were ignored.)

Exhibit 3-11: Month-to-Month Percent Changes in Price Indices

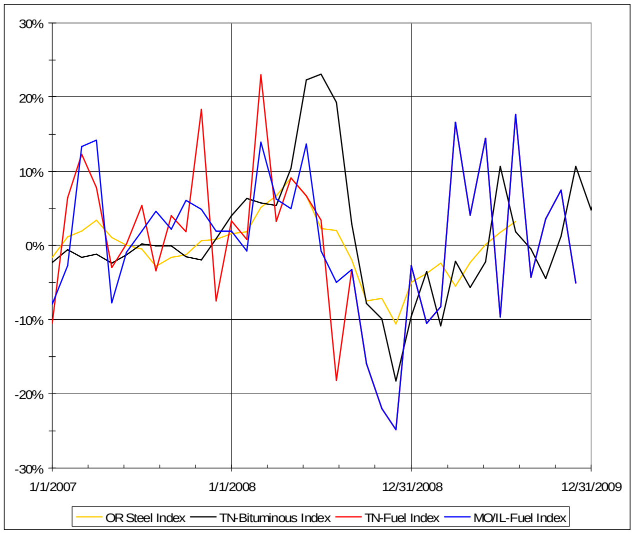
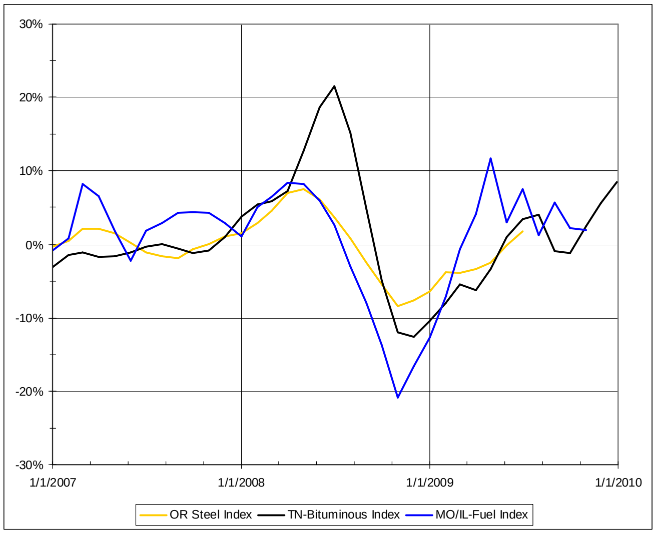


Exhibit 3-12: Three-Month Moving Average of Month-to-Month Percent Changes



Three sets of regressions were run, one for bids on all dates, one for bids during periods of rising prices, and a third for periods of falling prices. Let bi,j,t represent the bid price per unit for qi,j,t units of pay item i in state j at time t. Let pt represent the fuel (or bituminous) price index at time t. The basic regression equation is the same for each of the five pay item categories,

$$\text{Ln } b_{i,j,t} = b_0 + c\, x_j + d \text{ Ln } p_t + e \text{ Ln } q_{i,j,t} \text{ ,.}$$

where the notation Ln y denotes the natural logarithm of y for any symbol y. The regression coefficient b0 is a constant term. The "Clause" coefficient c is associated with an indicator variable xj which has a value of 1 for states with a PAC in effect (IL, MO, OR and TN), and a value of 0 for the four control states (AR, CA, MI, and TX) with no PACs in effect during the study period.

The coefficient b0 provides a measure of the average bid level for one unit of the pay item, while the PAC coefficient c adjusts this average price level for bids in the indicated states. If there is an effect due to the PAC, the coefficient c is expected to be negative, indicating that on average bids are lower in the states with PACs. The coefficient d measures the elasticity of bids with respect to the level of the fuel (or bituminous) price index. The price index elasticity is expected to be positive, indicating higher bids when the price indices are higher. The coefficient e measures the elasticity of bid prices with respect to the quantity of the pay item. The quantity elasticity is expected to be negative, indicating lower bids per unit for larger quantities of the item.

In the first set of regressions, the group of four states with a PAC of any type was compared to the control group of the four states with no PAC. In a second set of regressions, each state with a PAC was compared individually to the group of four control states with no PAC. A separate regression was run for each state with a PAC for the pay item category.

3.3 Group Comparisons of Pay Item Bids

Exhibits 3-13, 3-14 and 3-15 show the results of the first set of regression analyses comparing the two groups of states. There are three sets of regressions: Exhibit 3-13 shows the regression results for lettings on all dates; Exhibit 3-14 shows the results for lettings during the two time periods of rising prices; and Exhibit 3-15 for lettings during the period of falling prices. Each table contains three sets of regression results. The basic model shown at the top of each table includes estimates for the quantity, prices and PAC coefficients for each of the five pay item categories. The middle set of regressions includes the Opt-in variable, while the lower set of regressions includes both the Opt-in and the Trigger variable.

In Exhibits 3-13 and 3-14 the model with the Opt-in variable added has quantity and price elasticities which are very similar to those for the basic model. However, the PAC coefficients for the Opt-in model are all higher than those for the basic model when the Opt-in coefficient estimate is negative, and the PAC coefficients are lower when the Opt-in coefficient is positive. This pattern shows the multicollinearity effect on the PAC coefficient due to the addition of the Opt-in variable. Addition of the trigger variables shows more dramatic effects on the PAC coefficient. In this case, the two variables have a very high positive correlation and very erratic estimates for both coefficients. Compounding the problem is the fact that the PAC coefficient estimate and the constant term estimate also have a relatively high negative correlation before adding the Opt-in and trigger variables. The problems of multicollinearity are due partly to the relatively small sample size of only eight states in all, and only four states with PACs, Opt-in clause, and trigger levels. After examining the results of the statistical analysis and collecting from state DOTs on program disbursements, the study team evaluated whether the inclusion of additional control states would result in improved findings. These included the ability to overcome measurement problems such as multicollinearity and the ability of the statistical model to produce more significant and policy-relevant results. Additional analyses were conducted on five states with high PAC payments: Ohio, North Carolina, South Carolina, Pennsylvania, and Virginia. Of these five states, only Ohio possessed both an adequate sample size of pay items and the requisite distribution among the five pay item categories. A regression analysis performed on the Ohio data produced results consistent with the four control states. This data would not have had an appreciable effect on the quantitative outcomes of the study and therefore the analysis was not revised. Two of the four states use the same trigger level, but they differ in the presence of an opt-in clause.

Exhibit 3-13 Regression Results for Lettings on All Dates[18]

	Pay Item Category	Constant	Quantity Elasticity	Price Index Elasticity	Trigger	Opt-in	Price Adjustment Clause Effect
Basic Model	**Asphalt**	4.55	-0.24	0.23			0.04
	Significance	0.00	0.00	0.00			0.09
	Base Stone	4.31	-0.21	0.00			-0.06
	Significance	0.00	0.00	0.98			0.24
	Concrete	6.49	-0.14	0.08			0.16
	Significance	0.00	0.00	0.12			0.00
	Grading	2.98	-0.22	0.17			0.29
	Significance	0.00	0.00	0.00			0.00
	Steel	0.83	-0.20	0.31			-0.23
	Significance	0.00	0.00	0.00			0.00
With Opt-in Variable	**Asphalt**	4.54	-0.24	0.23		-0.03	0.05
	Significance	0.00	0.00	0.00		0.09	0.05
	Base Stone	4.68	-0.24	-0.03		-0.13	0.16
	Significance	0.00	0.00	0.63		0.00	0.00
	Concrete	6.53	-0.14	0.07		0.13	0.08
	Significance	0.00	0.00	0.20		0.00	0.03
	Grading	3.02	-0.22	0.16		0.15	0.22
	Significance	0.00	0.00	0.00		0.00	0.00
	Steel	0.83	-0.2	0.29		0.34	-0.44
	Significance	0.00	0.00	0.00		0.00	0.00
With Trigger and Opt-in Variables	**Asphalt**	4.08	-0.24	0.23	0.47	-0.03	0.50
	Significance	0.00	0.00	0.00	0.62	0.22	0.58
	Base Stone	-12.06	-0.21	-0.04	16.58	0.01	16.03
	Significance	0.00	0.00	0.61	0.00	0.83	0.00
	Concrete	-3.22	-0.13	0.07	9.65	0.17	9.28
	Significance	0.06	0.00	0.15	0.00	0.00	0.00
	Grading	0.67	-0.22	0.16	2.34	0.20	2.42
	Significance	0.16	0.00	0.00	0.00	0.00	0.00
	Steel	0.83	-0.20	0.29	0.00	0.34	-0.44
	Significance	0.00	0.00	0.00	0.98	0.00	0.00

[18] The second line after each pay item category in Exhibits 3-13, 3-14 and 3-15 is the significance level (p-value) of the estimated coefficient. A coefficient is usually considered significant if the p-value is 0.05 or lower, meaning that a coefficient this large or larger would occur by chance 1 time out of 20.

Exhibit 3-14: Regression Results for Lettings on Dates with Rising Prices

	Pay Item Category	Constant	Quantity Elasticity	Price Index Elasticity	Trigger	Opt-in	Price Adjustment Clause Effect
Basic Model	**Asphalt**	4.04	-0.24	0.31			0.05
	Significance	0.00	0.00	0.00			0.04
	Base Stone	4.94	-0.21	-0.12			-0.04
	Significance	0.00	0.00	0.27			0.48
	Concrete	6.85	-0.14	0.01			0.15
	Significance	0.00	0.00	0.85			0.00
	Grading	3.17	-0.22	0.14			0.27
	Significance	0.00	0.00	0.04			0.00
	Steel	0.66	-0.21	0.35			-0.23
	Significance	0.03	0.00	0.00			0.00
With Opt-in Variable	**Asphalt**	4.05	-0.24	0.31		-0.03	0.06
	Significance	0.00	0.00	0.00		0.09	0.02
	Base Stone	5.30	-0.23	-0.15		-0.11	0.18
	Significance	0.00	0.00	0.07		0.00	0.00
	Concrete	6.91	-0.13	-0.01		0.14	0.06
	Significance	0.00	0.00	0.94		0.00	0.09
	Grading	3.21	-0.22	0.13		0.14	0.20
	Significance	0.00	0.00	0.06		0.00	0.00
	Steel	0.69	-0.2	0.33		0.34	-0.45
	Significance	0.02	0.00	0.00		0.00	0.00
With Trigger and Opt-in Variables	**Asphalt**	2.86	-0.24	0.3	1.23	-0.02	1.24
	Significance	0.01	0.00	0.00	0.22	0.39	0.19
	Base Stone	-10.35	-0.21	-0.14	15.42	0.01	14.92
	Significance	0.00	0.00	-0.09	0.00	-0.73	0.00
	Concrete	-2.91	-0.12	0.00	9.73	0.18	9.34
	Significance	0.10	0.00	0.98	0.00	0.00	0.00
	Grading	0.92	-0.22	0.13	2.26	0.19	2.32
	Significance	0.10	0.00	0.05	0.00	0.00	0.00
	Steel	0.69	-0.20	0.33	0.00	0.34	-0.44
	Significance	0.02	0.00	0.00	0.98	0.00	0.00

Exhibit 3-15: Regression Results for Lettings on Dates with Falling Prices

	Pay Item Category	Constant	Quantity Elasticity	Price Index Elasticity	Trigger	Opt-in	Price Adjustment Clause Effect
Basic Model	**Asphalt**	4.31	-0.23	0.25			-0.02
	Significance	0.00	0.00	0.11			0.84
	Base Stone	3.48	-0.22	0.17			-0.12
	Significance	0.00	0.00	0.28			0.35
	Concrete	5.99	-0.16	0.18			0.22
	Significance	0.00	0.00	0.06			0.01
	Grading	2.45	-0.22	0.25			0.41
	Significance	0.00	0.00	0.00			0.00
	Steel	1.03	-0.18	0.25			-0.21
	Significance	0.00	0.00	0.00			0.00
With Opt-in Variable	**Asphalt**	4.33	-0.23	0.25		0.07	0.93
	Significance	0.00	0.00	0.12		0.73	0.91
	Base Stone	3.75	-0.25	0.16		0.12	2.45
	Significance	0.00	0.00	0.25		0.00	0.36
	Concrete	6.01	-0.15	0.17		0.3	0.17
	Significance	0.00	0.00	0.07		0.34	0.23
	Grading	2.52	-0.22	0.23		0.94	0.00
	Significance	0.00	0.00	0.01		0.01	0.00
	Steel	1.03	-0.18	0.24		0.25	0.08
	Significance	0.00	0.00	0.00		0.00	0.00
With Trigger and Opt-in Variables	**Asphalt**	7.79	-0.23	0.27	-3.55	-0.07	-3.43
	Significance	0.00	0.00	0.09	0.18	0.30	0.17
	Base Stone	-17.98	-0.22	0.14	21.54	-0.01	20.82
	Significance	0.00	0.00	0.28	0.00	0.94	0.00
	Concrete	-4.14	-0.15	0.18	10.07	0.13	9.73
	Significance	0.48	0.00	0.06	0.08	0.25	0.08
	Grading	-0.18	-0.22	0.23	2.74	0.25	2.88
	Significance	0.87	0.00	0.01	0.01	0.00	0.00
	Steel	4.88	-0.18	0.24	-3.84	0.47	-4.22
	Significance	0.05	0.00	0.00	0.12	0.00	0.09

Exhibit 3-16 shows the basic regression model coefficients with standard error of estimation, t-statistics, significance levels and residual degrees of freedom for all lettings, rising prices and falling prices. Regression coefficients with a significance level less than 0.05 are statistically significant, i.e. significantly greater than (or less than) 0.

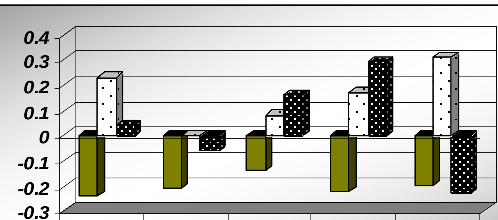
Exhibit 3-16: Basic Regression Model Coefficients with Standard Errors, t-Statistics, Significance Levels and Residual Degrees of Freedom

		All Lettings				Rising Prices				Falling Prices			
CATEGORY	PARAMETER	Constant	Ln_Q	Index*	Clause	Constant	Ln_Q	Index*	Clause	Constant	Ln_Q	Index*	Clause
Asphalt	COEF	4.55	-0.24	0.23	0.04	4.04	-0.24	0.31	0.05	4.31	-0.23	0.25	-0.02
	SE	0.33	0.01	0.05	0.02	0.55	0.01	0.09	0.03	1.02	0.02	0.16	0.08
	T	13.79	-24.00	4.60	2.00	7.37	-40.23	3.37	2.07	4.22	-13.17	1.60	-0.21
	SIG	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.04	0.00	0.00	0.11	0.84
	DFE	4678	4678	4678	4678	3928	3928	3928	3928	746	746	746	746
Base Stone	COEF	4.31	-0.21	0.00	-0.06	4.94	-0.21	-0.12	-0.04	3.48	-0.22	0.17	-0.12
	SE	0.48	0.01	0.09	0.05	0.59	0.01	0.11	0.06	0.88	0.03	0.16	0.13
	T	8.98	-21.00	0.00	-1.20	8.34	-16.97	-1.10	-0.71	3.98	-7.74	1.07	-0.94
	SIG	0.00	0.00	0.98	0.24	0.00	0.00	0.27	0.48	0.00	0.00	0.28	0.35
	DFE	2801	2801	2801	2801	2273	2273	2273	2273	524	524	524	524
Concrete	COEF	6.49	-0.14	0.08	0.16	6.85	-0.14	0.01	0.15	5.99	-0.16	0.18	0.22
	SE	0.29	0.01	0.05	0.03	0.36	0.01	0.07	0.03	0.53	0.02	0.09	0.08
	T	22.38	-14.00	1.60	5.33	18.94	-15.16	0.19	4.51	11.35	-6.83	1.92	2.75
	SIG	0.00	0.00	0.12	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.06	0.01
	DFE	2427	2427	2427	2427	1926	1926	1926	1926	497	497	497	497
Grading	COEF	2.98	-0.22	0.17	0.29	3.17	-0.22	0.14	0.27	2.45	-0.22	0.25	0.41
	SE	0.28	0.01	0.05	0.03	0.37	0.01	0.07	0.03	0.47	0.01	0.08	0.07
	T	10.64	-22.00	3.40	9.67	8.62	-36.94	2.06	8.41	5.23	-17.05	3.02	5.92
	SIG	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
	DFE	6509	6509	6509	6509	5226	5226	5226	5226	1279	1279	1279	1279
Steel	COEF	0.83	-0.20	0.31	-0.23	0.66	-0.21	0.35	-0.23	1.03	-0.18	0.25	-0.21
	SE	0.23	0.01	0.04	0.02	0.30	0.01	0.05	0.03	0.34	0.01	0.06	0.05
	T	3.61	-20.00	7.75	-11.50	2.22	-36.13	6.47	-8.64	3.05	-17.89	4.18	-4.48
	SIG	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DFE	2334	2334	2334	2334	1848	1848	1848	1848	482	482	482	482

Notes: * Index is the TN-Bituminous price index for asphalt mix (for all states). For all other commodities, index is the MO/IL-Fuel price index, except for TN which has its own fuel price index.

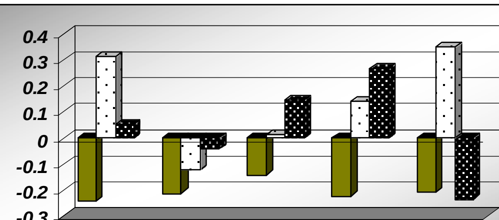
Exhibits 3-17, 3-18 and 3-19 show bar plots of the basic regression model coefficient estimates for all lettings, lettings with rising prices and lettings with falling prices, respectively. All quantity elasticity coefficients are negative and statistically significant. The magnitudes of the quantity elasticity coefficients fall in a narrow range from -0.24 to -0.14, with little variation across the three time periods. Hence, a 100 percent increase in the quantity requested results in a 14 to 24 percent reduction in the bid price per unit, depending on the pay item category.

Exhibit 3-17: Regression Coefficients for All Lettings



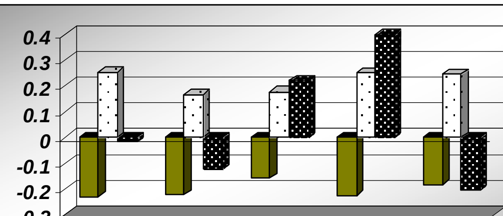
	Asphalt	Base Stone	Concrete	Grading	Steel
Quantity Elasticity	-0.24	-0.21	-0.14	-0.22	-0.2
Price Index Elasticity	0.23	0	0.08	0.17	0.31
Price Adjustment Clause Effect	0.04	-0.06	0.16	0.29	-0.23

Exhibit 3-18: Regression Coefficients for Periods of Rising Prices



	Asphalt	Base Stone	Concrete	Grading	Steel
Quantity Elasticity	-0.24	-0.21	-0.14	-0.22	-0.21
Price Index Elasticity	0.31	-0.12	0.01	0.14	0.35
Price Adjustment Clause Effect	0.05	-0.04	0.15	0.27	-0.23

Exhibit 3-19: Regression Coefficients for Periods of Falling Prices



	Asphalt	Base Stone	Concrete	Grading	Steel
Quantity Elasticity	-0.23	-0.22	-0.16	-0.22	-0.18
Price Index Elasticity	0.25	0.17	0.18	0.25	0.25
Price Adjustment Clause Effect	-0.02	-0.12	0.22	0.41	-0.21

All but one price index elasticity coefficient is positive, and many of these are statistically significant, but not as consistently as with the quantity elasticity coefficients. The bituminous price index elasticity is positive and significant for asphalt, ranging from +0.23 to +0.31, depending on the time period. A 100 percent increase in the bituminous price index results in an increase of 23 to 31 percent in the asphalt mix unit bid price. The fuel price index elasticity is significant for grading and steel, but base stone and concrete show no statistically significant fuel price index elasticity. The price elasticity coefficients show a larger degree of variation across the three time periods, but show no consistent pattern of variation.

The PAC coefficients are also variable with no consistent pattern. The price clause coefficients are negative for base stone but not statistically significant. The price clause coefficients are negative and statistically significant only for steel. The price clause coefficients are positive for asphalt mix, cement and grading. For cement and grading, the positive price clause coefficients are also statistically significant. From this model it is not possible to conclude whether PACs have a generally positive or negative effect on bid prices.

3.4 Comparisons of Pay Item Bids in Individual States with the Control States

In the second round of the regression analysis, each state with a PAC for a given pay item category was compared individually to the group of four control states. The regression equation is the same as discussed above, only the number of states entering the regression changes. There are three states with asphalt mix indices, four states with fuel indices, and two states with steel indices (see Exhibit 3-10). Although Oregon has a steel index, no pay items were identified for this category, leaving only one state (Illinois) to analyze for steel. The effects of the fuel index are analyzed for all five pay item categories. The asphalt mix index applies only to pay items in the asphalt category, and the steel index applies only to pay items in the steel category.

Exhibit 3-20 shows the basic regression model coefficients for the individual states. There are four parts to the table, the quantity elasticity coefficients, price index elasticity coefficients, the PAC effect, and the constant term. Each part of the table contains the coefficient estimates for each pay item category with a PAC in effect in that state. Note that the actual index used in the regression may be a surrogate index from another state for that pay item category (see Exhibit 3-10).

Exhibit 3-20: Basic Regression Model Coefficients by State, Pay Item Category and Index Type for All Lettings, Lettings during Rising Prices, and Lettings during Falling Prices

			Quantity Elasticity						Price Index Elasticity					
	Category	Index**	Falling Prices		All Lettings		Rising Prices		Falling Prices		All Lettings		Rising Prices	
Illinois	Asphalt	Fuel	-0.29		-0.27		-0.27		0.15	*	0.06	*	0.00	*
	Base Stone	Fuel	-0.23		-0.23		-0.23		0.14	*	-0.08	*	-0.21	*
	Concrete	Fuel	-0.15		-0.13		-0.12		0.18	*	0.08	*	0.01	*
	Grading	Fuel	-0.22		-0.22		-0.22		0.20		0.14		0.12	*
	Steel	Fuel	-0.19		-0.21		-0.21		0.19		0.26		0.29	
	Steel	Steel	-0.19		-0.21		-0.21		1.29		-0.86		-2.00	
Missouri	Asphalt	Fuel	-0.25		-0.27		-0.27		0.26		0.11		0.04	*
	Asphalt	Bitumin	-0.25		-0.27		-0.27		0.40		0.32		0.37	
	Base Stone	Fuel	-0.22		-0.23		-0.23		0.19	*	-0.03	*	-0.19	*
	Concrete	Fuel	-0.16		-0.12		-0.11		0.28		0.12	*	0.00	*
	Grading	Fuel	-0.23		-0.22		-0.22		0.22		0.18		0.18	
	Steel	Fuel	-0.20		-0.22		-0.22		0.32		0.39		0.43	
Oregon	Asphalt	Fuel	-0.25		-0.27		-0.27		0.30		0.16		0.06	*
	Asphalt	Bitumin	-0.25		-0.27		-0.27		0.45	*	0.19		0.23	*
	Base Stone	Fuel	-0.23		-0.23		-0.23		0.19	*	-0.07	*	-0.25	*
	Concrete	Fuel	-0.16		-0.12		-0.11		0.28		0.13	*	0.00	*
	Grading	Fuel	-0.23		-0.23		-0.23		0.22		0.18		0.20	
	Steel	Fuel	-0.22		-0.24		-0.24		0.28		0.38		0.43	
Tennessee	Asphalt	Fuel	-0.27		-0.27		-0.27		0.22		0.10		0.05	*
	Asphalt	Bitumin	-0.28		-0.27		-0.27		0.37		0.33		0.43	
	Base Stone	Fuel	-0.22		-0.21		-0.21		0.14	*	-0.06	*	-0.17	*
	Concrete	Fuel	-0.15		-0.12		-0.11		0.25		0.10	*	0.00	*
	Grading	Fuel	-0.22		-0.22		-0.22		0.23		0.22		0.23	
	Steel	Fuel	-0.21		-0.23		-0.23		0.29		0.35		0.39	
			Price Adjustment Clause Effect						**Constant Term**					
Illinois	Asphalt	Fuel	-0.01	*	0.08		0.10		5.50		5.79		6.06	
	Base Stone	Fuel	0.32	*	0.35		0.35		3.73		4.89		5.58	
	Concrete	Fuel	0.29		0.28		0.28		5.94		6.40		6.79	
	Grading	Fuel	0.68		0.51		0.48		2.66		3.15		3.26	
	Steel	Fuel	-0.11		-0.11		-0.12		1.39		1.18		1.03	
	Steel	Steel	-0.12		-0.11		-0.12		-2.27	*	5.65		9.74	
Missouri	Asphalt	Fuel	0.07	*	-0.01		-0.03	*	4.66		5.51		5.88	
	Asphalt	Bitumin	0.05	*	-0.01		-0.03	*	3.59		4.19		3.93	
	Base Stone	Fuel	-0.72		-0.70		-0.68		3.32		4.58		5.48	
	Concrete	Fuel	-0.22	*	-0.21		-0.22		5.45		6.17		6.82	
	Grading	Fuel	0.14	*	0.05		0.03	*	2.68		2.96		2.95	
	Steel	Fuel	-0.38		-0.40		-0.40		0.83	*	0.52	*	0.31	*
Oregon	Asphalt	Fuel	-1.77		-0.70		-0.52		4.45		5.22		5.81	
	Asphalt	Bitumin	-1.79		-0.71		-0.53		3.23	*	4.98		4.78	
	Base Stone	Fuel	0.00		0.24		0.24	*	3.39		4.82		5.80	
	Concrete	Fuel							5.41		6.12		6.80	
	Grading	Fuel	0.58		0.50		0.48		2.64		2.93		2.89	
	Steel	Fuel							1.18	*	0.78	*	0.53	*
Tennessee	Asphalt	Fuel	0.15	*	0.14		0.13		5.05		5.58		5.83	
	Asphalt	Bitumin	0.14	*	0.13		0.13		3.93		4.18		3.58	
	Base Stone	Fuel	0.36		0.28		0.27		3.56		4.62		5.17	
	Concrete	Fuel	0.05	*	-0.07		-0.09	*	5.58		6.24		6.75	
	Grading	Fuel	0.07	*	0.03		0.02	*	2.56		2.71		2.71	
	Steel	Fuel	-0.55		-0.56		-0.55		1.11	*	0.84		0.68	*

Notes:
* Indicates the coefficient is not significantly different from zero (p level >0.05).
** Asphalt index is the TN-Bituminous price index for asphalt mix (for all states). For all commodities, the fuel index is the MO/IL-Fuel price index, except for TN which has its own fuel price index. The steel index is the IL-Steel index.

All quantity elasticity coefficients in Exhibit 3-20 are negative, ranging from -0.11 to -0.46. The estimates show a remarkable degree of consistency across states, pay items, and letting dates. The price index elasticity coefficients are generally positive, but not as consistently as with the quantity elasticity coefficients. The exceptions occur for base stone in several states, and asphalt mix in Oregon and Tennessee. The fuel price index elasticities are always positive for steel, grading and concrete in all states, and the steel price index elasticities are positive for steel in Illinois.

Overall, the PAC coefficients again show an inconsistent picture for most states and commodities, with a similar number of positive and negative signs. One exception is the state of Missouri, where almost all of the coefficients are negative, indicating that the presence of the price adjustment clause leads to lower bids. Note that Missouri is the only modeled PAC state with both zero trigger values for all commodities and an opt-in feature for all commodities. Steel in Illinois and Tennessee and asphalt mix in Oregon also show results indicating that the PAC program results in lower bid prices.

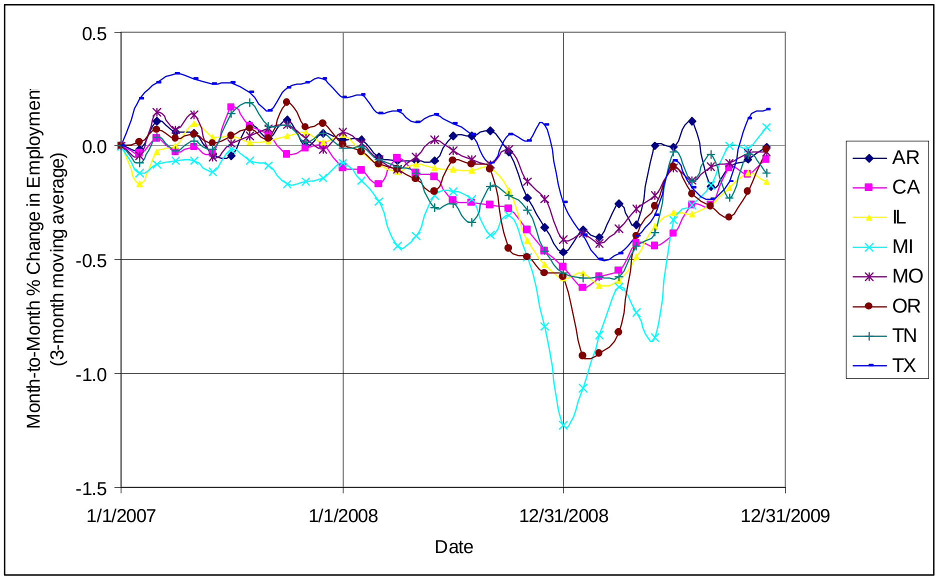
3.5 Analysis of the Average Number of Bids per Job

The final set of regressions examines the average number of bids per job. The thesis to be tested is that the presence of a price adjustment clause encourages more bids during times of escalating fuel prices. The data for these regressions consist of monthly averages of the number of bids for the four states with a price adjustment clause and the four control states. The states with PACs for each type of index were shown in Exhibit 3-10.

The basic regression model has the average number of bids as the dependent variable on the left of the equation and several explanatory variables on the right, including the average job size that month, the number of highway construction firms in the state as reported by the US Census of Manufactures, and the change in state employment.

Exhibit 3-21 shows the three-month moving average of the month-to-month percent changes in non-farm employment in the eight states as reported on the BLS website. The eight states follow much the same pattern, reflecting the same boom and bust pattern observed for the fuel, asphalt mix and steel price indices in Exhibit 3-12. Employment was stable to rising (percent changes near or slightly above 0), then falling, and then recovering to a more stable regime. Again, three sets of regressions were run, one for the average number of bids on all letting dates, one for lettings during periods of stable or positive employment, and a third for periods of falling employment. (For ease of comparisons, the same cut-off dates were used as for the fuel price indices.)

Exhibit 3-21: Three-Month Moving Average of Month-to-Month Percent Changes in Non-Farm Employment



Again, the basic model includes a "Clause" coefficient associated with the indicator variable for the four states with a PAC in effect during the study period. In this case the expected sign for the clause coefficient is positive, since the presence of a PAC in a state is expected to reduce risk and encourage more bids. In addition, trigger and Opt-in variables were later added to the basic regression model. Depending on the model, these additional variables introduced multicollinearities which resulted in unstable parameter estimates for the added variables and the PAC term.

Let aj,t represent the average number of bids per job in state j in month t. Let qj,t represent the average size of the jobs let in state j in month t. Let fj represent the number of construction firms in state j. Let wj,t represent the change in employment in state j in month t. The basic regression equation is

$$\text{Ln } a_{j,t} = a0 + c\, x_j + b \text{ Ln } f_j + d\, q_{j,t} + e\, w_{j,t} ,$$

where the notation Ln y denotes the natural logarithm of y. The regression coefficient a0 is a constant term. The "Clause" coefficient c is associated with an indicator variable xj which has the value 1 for states with a PAC in effect (IL, MO, OR and TN), and a value of 0 for the four control states (AR, CA, MI, and TX) with no PACs in effect during the study period. The coefficient a0 provides a measure of the average level of the average number of bids per job, while the PAC coefficient c adjusts this average price level for lettings in the indicated states. If there is an effect due to the PAC, the coefficient c is expected to be positive, indicating that on average more bids per job are received in the states with PACs.

The coefficient b measures the effect of the number of construction firms in the state. This coefficient is expected to be positive, since states with more firms are expected to have more bids submitted. The coefficient d measures the effect of the average size of the jobs bid that month.

The coefficient e measures the effect of changes in economic conditions in the state. This coefficient is expected to be negative. When economic conditions are poor, as indicated by falling employment, the average number of bids per job is expected to increase, and vice versa.

3.6 Group Comparisons of the Average Number of Bids per Job

In the first set of the average number of bids regressions, the group of four states with a PAC of any type was compared to the control group of the four states with no PAC. Exhibit 3-22 shows the results of the of regression analyses comparing the two groups of states. There are three sets of regressions, for lettings on all dates; lettings during the two time periods of rising prices and stable employment; and a third for lettings during the period of falling prices and employment. The exhibit contains three sets of regression results. The basic model shown at the top of each table includes estimates for the constant term, the average job size, the number of firms, the change in employment and the PAC effect. The middle set of regressions includes the Opt-in variable, while the lower set of regressions includes both the Opt-in and the trigger variable.

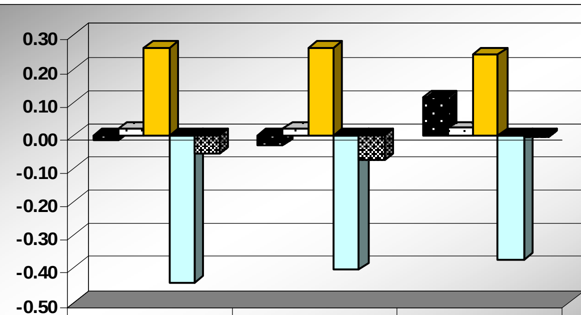
Exhibit 3-22: Regression Results for the Average Number of Bids per Job

	Time Period	Constant	Average Job Size	Number of Firms	Change in Employment	Opt-in	Trigger	Price Adjustment Clause Effect
Basic Model	**All Dates**	-0.01	0.02	0.26	-0.44			-0.06
	Significance	0.94	0.00	0.00	0.00			0.15
	Rising Prices	-0.03	0.02	0.26	-0.40			-0.07
	Significance	0.89	0.00	0.00	0.00			0.10
	Falling Prices	0.11	0.02	0.24	-0.37			-0.01
	Significance	0.82	0.31	0.00	0.00			0.94
With Opt-in Variable	**All Dates**	-0.10	0.02	0.27	-0.44	-0.03		-0.04
	Significance	0.65	0.00	0.00	0.00	0.33		0.37
	Rising Prices	-0.15	0.02	0.28	-0.41	-0.05		-0.05
	Significance	0.54	0.00	0.00	0.00	0.22		0.31
	Falling Prices	0.13	0.02	0.24	-0.38	0.01		-0.01
	Significance	0.81	0.31	0.01	0.01	0.93		0.92
With Trigger and Opt-in Variables	**All Dates**	-1.81	0.02	0.30	-0.40	0.02	1.59	1.40
	Significance	0.00	0.01	0.00	0.00	0.48	0.00	0.00
	Rising Prices	-1.47	0.02	0.30	-0.38	0.00	1.22	1.05
	Significance	0.00	0.01	0.00	0.00	0.97	0.00	0.00
	Falling Prices	-3.00	0.01	0.28	-0.21	0.09	2.97	2.70
	Significance	0.00	0.52	0.00	0.06	0.14	0.00	0.00

The model with the Opt-in variable in Exhibit 3-22 has average job size, number of firms and employment coefficients which are very similar to those for the basic model. However, the PAC coefficients for the Opt-in model are higher than those for the basic model when the Opt-in coefficient estimate is negative. This pattern again shows the multicollinearity effect on the PAC coefficient due to the addition of the Opt-in variable. Addition of the trigger variable shows more dramatic effects on the PAC coefficient. In this case, the two variables have a high positive correlation of 0.98.

Exhibit 3-23 shows bar plots of the basic regression model coefficient estimates for all lettings, lettings with rising prices and lettings with falling prices, respectively. As expected, all coefficients for the number of firms are positive and statistically significant, all coefficients for the change in employment are negative and statistically significant and all coefficients for the number of firms are positive (and statistically significant). Also as expected, the coefficients for the average job size are all positive and, except for the period of falling prices, are statistically significant. Unfortunately, the three PAC coefficients are negative rather than positive. However, they are also extremely small and are not statistically different from 0. Therefore, no conclusion can be reached on whether the PAC programs affect the number of bids.

Exhibit 3-23: Regression Coefficients for the Average Number of Bids per Job



	All Dates	Rising Prices	Falling Prices
Constant	-0.01	-0.03	0.11
Average Job Size	0.02	0.02	0.02
Number of Firms	0.26	0.26	0.24
Change in Employment	-0.44	-0.40	-0.37
Price Adjustment Clause Effect	-0.06	-0.07	-0.01

3.7 Conclusion

A variety of statistics and statistical models were developed to examine the potential contribution of PAC programs to the reduction of bid prices and increase in the number of bids. In assessing the results of these models, it should be noted that PAC programs are very small relative to the total highway construction market, at approximately one-half of one percent. The effects of price adjustment clauses could have a much greater affect on contractors however, particularly smaller contractors and/or those specializing in fuel-intensive activities such as asphalt paving and excavation. In addition, there are a variety of market factors that influence bid prices and are difficult to account and control for. On the one hand, the models that were constructed did provide consistent and expected results for a wide variety of variables, especially measures of contract size, prices of fuel inputs and general economic indicators. Unfortunately, the variables measuring the existence of a PAC program and the specifics of the programs, such as trigger value and opt-in mechanisms, did not provide consistent results. Bid prices were highly correlated with bid quantities and fuel prices. However, the results for the price adjustment clauses were mixed. In some cases, such as for the state of Missouri, the model did show a consistent pattern in which the PAC program led to lower bid prices. However, in all other cases the results were inconclusive.

Section II: Results

Chapter 4: Benefits and Risks of Price Adjustment Clauses

The purpose of this chapter is to assess the benefits and risks of agency use of price adjustment clauses. Surveys of both DOTs and contractors conducted as part of this study reveal that these organizations favor these clauses. There is a consensus that these clauses result in lower bid prices. Based on the survey results, the study estimates that the use of these clauses does not cost much either in terms of DOT net payouts or in terms of DOT and contractor administrative costs. They do not increase risk and in many ways may reduce risk, especially for individual contractors. Unfortunately, the statistical analysis conducted in this study cannot conclusively answer the central question of whether these clauses result in lower prices or increase the number of bidders.

The study design addresses a number of issues including:

- **Added Risk Pricing**: There is a concern that in the absence of these clauses contractors will add contingencies to their bids to cover the material price risk. The study attempted to examine the extent to which PACs had an influence on "added risk pricing," leading to a reduction in potential extra profits by contractors.

- **Market Stability**: One of the potential benefits of PACs is their ability to increase stability in an otherwise unstable bid market. For example, PAC clauses can shield firms from large losses on individual contracts, thereby reducing the number of firms that exit the market and increasing the willingness to bid projects in periods when prices are escalating rapidly. The study examined whether the presence of PACs led to an increase in the number of bids.

- **Market Entry**: There is a question as to whether the existence of PACs and the reduced uncertainty would increase the desirability of the market resulting in new entries to the market and limiting the number of firms exiting the market.

- **Contract Default**: In the absence of PACs, rapidly rising prices may cause contractors to face large losses on a particular contract. This is a particular concern for high-risk commodities. This may lead to contractor defaults, non-performance on a particular contract and exit from the market.

- **Increased Competition**: The presence of PACs can potentially reduce risk, decrease the use of added risk pricing and increase bid competition. The consequent reductions of overall bid prices and increased numbers of bids per project can result in lower overall costs to DOTs.

The study has sought to answer the following questions:

- What price index/price adjustment clause strategies are available?
- In what states is each of the particular strategies in use?
- What are the theoretical underpinnings of price adjustment clauses, both economic and otherwise?
- What is the experience of state DOTs with price adjustment clause strategies?
- What are the administrative costs of price adjustment clauses?
- Do these strategies provide benefits in terms of number of bids, cost of construction and stability of the contractor pool?
- Does quantitative data indicate that price adjustment clauses provide benefits in terms of number of bids, cost of construction and stability of the contractor pool?
- How do the road builders view price adjustment clauses and strategies?
- In what situations and for what types of contracts are clauses effective?
- What attributes of the clauses make them effective?

To answer these questions, this chapter brings together the available strategies and economic theory with the information collected and presented in the earlier chapters of this report including the experience of state DOTs, the experience of road construction contractors, practices from other industries, and quantitative statistical analysis. The purpose is to describe not only what strategies are available but also why particular strategies may or may not be preferred under particular conditions.

The ultimate goal is to create guidance that will inform state DOTs not only as to why they should use indexes, but also as to what strategies will work in what situations and what characteristics or attributes of the indexes are most effective.

In order to describe the conclusions of the research in detail, the following sections describe:

1) The highway construction industry revenue and cost trends
2) Input price volatility
3) Price adjustment clauses as a cost control strategy
4) Price adjustment clauses and economic theory
5) Current PAC program practices and costs
6) Current PAC program benefits
7) PAC program risks and barriers to implementation
8) Future PAC program plans
9) Potential DOT strategies

4.1 The Highway Construction Industry and Construction Cost Trends

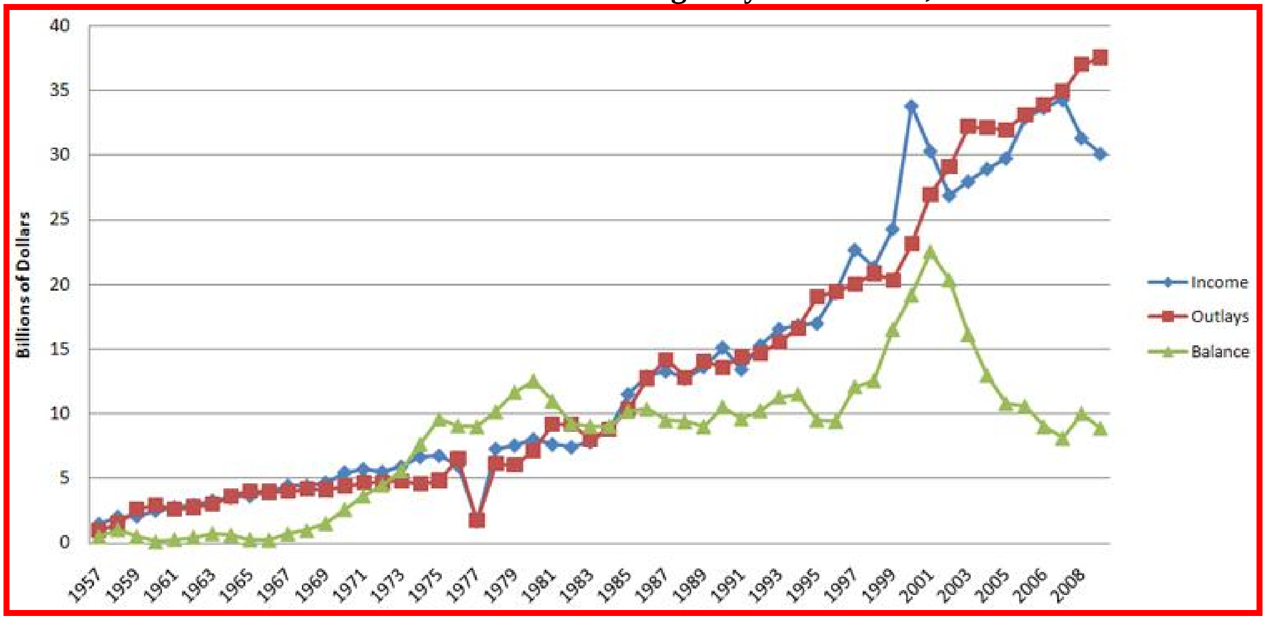
The U.S. transportation design and construction industry generates more than $380 billion in economic activity annually and sustains 3.4 million American jobs.[19] The latest government statistics for 2008, recorded $181 billion in disbursements for highways, with $136 billion spent for capital, maintenance and traffic services, while the remainder was spent on administration

[19] The American Road & Transportation Builders Association (ARTBA), http://www.artba.org/economics--research/

and research, highway law enforcement and safety, interest on debt and bond retirements. State agencies accounted for the bulk of this spending, disbursing $114 billion, with capital, maintenance and traffic services expenditures accounting for $88 billion.

In recent years, highway revenues, which are not adequate to keep pace with rapidly increasing costs, have created a difficult situation for state highway agencies. For example, Exhibit 4-1 depicts the status of the Federal Highway Trust Fund. Note that income to the fund has been relatively flat while increasing outlays have led to a declining fund balance. Although Congress is authorized to appropriate supplemental funds if the HTF falls too low, efforts to correct the imbalance between construction costs and available funding remain important.

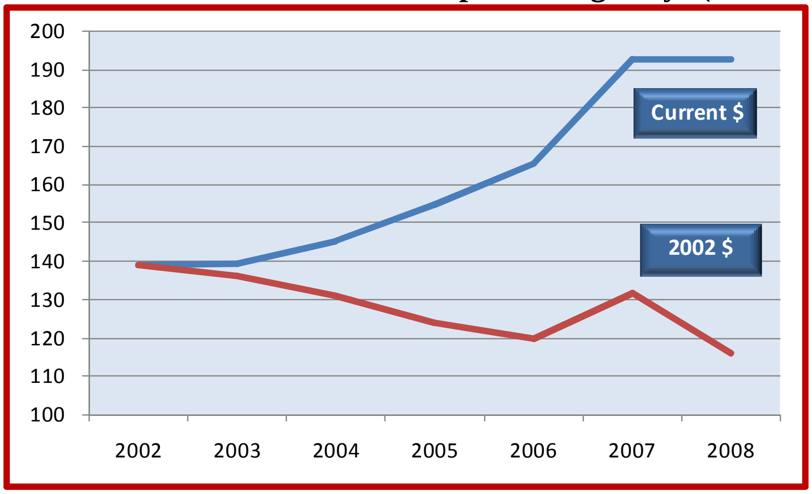
Exhibit 4-1: Status of the Federal Highway Trust Fund, 1957-2009



Source: Highway Statistics 2009, Federal Highway Administration, Office of Highway Policy Information, Status of the Federal Highway Trust Fund Chart FE-210C. October 2010. Available at: http://www.fhwa.dot.gov/policyinformation/statistics/2009/fe210c.cfm

Exhibit 4-2 depicts how receipts for highways have eroded in real terms in recent years. The upper line shows total receipts for highways by all units of government. Since 2002, receipts have climbed from approximately $140 billion to just over $190 billion in 2008. The lower line shows the same dollar amounts deflated based on the producer price index for Highway and Street Construction. In 2002 dollars, receipts have dropped from approximately $140 billion to just under $120 billion in 2008, representing only 83.4% of the 2002 purchasing power.

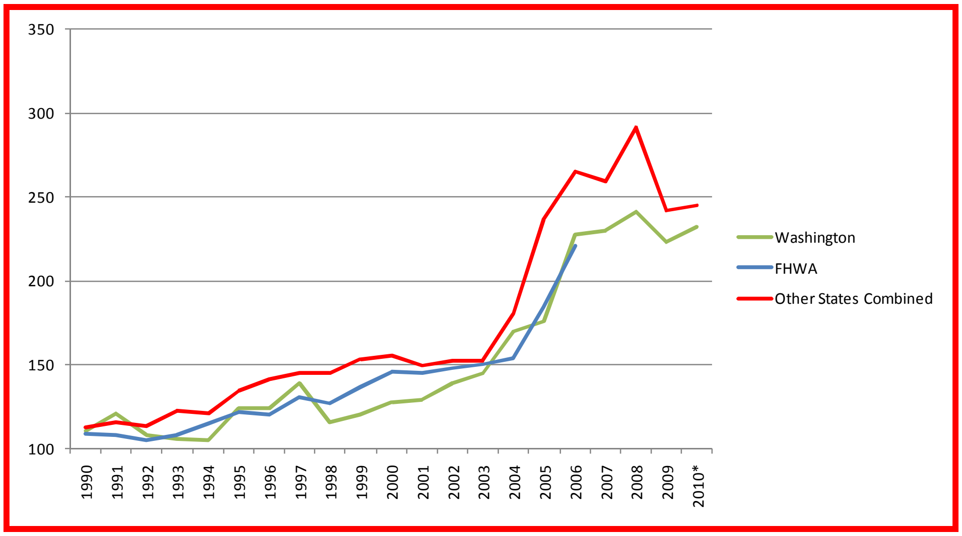
Exhibit 4-2: Current and Constant Dollar Receipts for Highways (In Billions of Dollars)



Sources: US Department of Labor, Bureau of Labor Statistics, Produce Price Indices Producer Price Index, Industry Data, Series ID: PCUBHWY—BHWY, Industry: Material and Supply Inputs to Highway and Street Construction http://data.bls.gov:8080/PDQ/servlet/SurveyOutputServlet;jsessionid=6230ab7c76766f537838 and Highway Statistics 2008, Federal Highway Administration, Office of Highway Policy Information, Total Receipts for Highways, By Governmental Unit - Chart REC-C, Available at: http://www.fhwa.dot.gov/policyinformation/statistics/2008/rec.cfm

Construction costs have increased rapidly. Exhibit 4-3 provides a graphic of various construction cost indices compiled by the Washington State Department of Transportation. These indices, with a base of 100 in the 1987 to 1990 time frame, increased by only 50 percent by 2003. In the next five years however, the indices had close to doubled.

Exhibit 4-3: Construction Cost Indices[20]

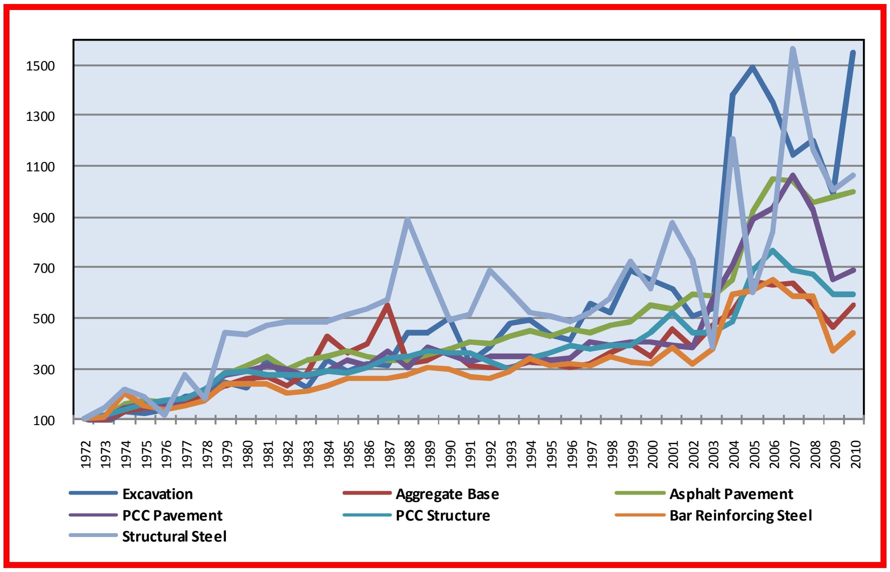


Source: http://www.wsdot.wa.gov/biz/construction/CostIndex/CostIndexPdf/CostIndexGraph.pdf

[20] The WSDOT index has a base of 1990 = 100, while the FHWA and Other States indexes have a base of 1987 = 100. The other states index is the average of the annual indices for California, Colorado, Oregon, South Dakota & Utah. The analysis adjusted 2003 and 2004 WSDOT CCI data points to correct for spiking bid prices on structural steel. WSDOT data is through 2010. California, Colorado and Utah data is through Q3 2010. Oregon data is through Q2. The FHWA discontinued its index in 2007.

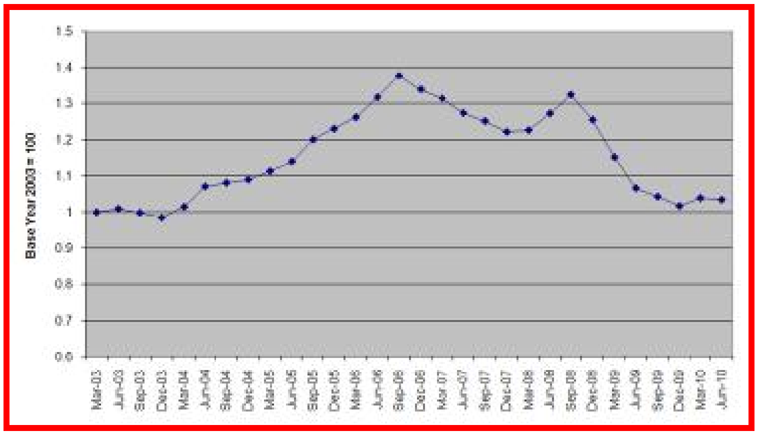
Exhibit 4-4 provides a more detailed examination of contract prices paid by the California Department of Transportation for individual components. Since 2003, prices have fluctuated much more rapidly than in the previous thirty years.

Exhibit 4-4: California DOT Average Highway Contract Prices (1972=100)[21]



Team member Oman Systems Inc. recently employed its Bid-Tabs database to aid in formulating the National Highway Construction Cost Index. This index contains large volumes of state-level records for pay items on successfully bid contracts. The NHCCI index graph shows escalating highway construction costs between late 2003 and the middle of 2006, as well as a second peak in the middle of 2008.[22]

Exhibit 4.5: National Highway Construction Cost Index



Source: http://www.fhwa.dot.gov/ohim/nhcci/pt1.cfm

[21] California Department of Transportation Average Highway Contract Prices. http://www.dot.ca.gov/hq/esc/oe/contract_progress/exhibitBM.pdf . 2010 data is through the third quarter.
[22] The Congressional Budget Office's recently released "Public Spending on Transportation and Water Infrastructure" provides helpful supplementary information on escalating construction costs, although the discussed data points terminate by 2007.

4.2 Input Price Volatility

Much of the escalation in highway construction costs is a direct result of increases in input prices. Therefore, price adjustment clauses are perhaps more necessary than ever. In particular, the price of petroleum products has fluctuated rapidly. Exhibit 4-5 provides data on the weekly retail gasoline prices. In the decade from 1994 to 2004, prices increased only 50 percent, from $1.00 to $1.50 per gallon. In the next four years, the price nearly tripled to almost $4.25, before dropping back to $1.50 for a brief time and then escalating rapidly back to $3.00 per gallon.

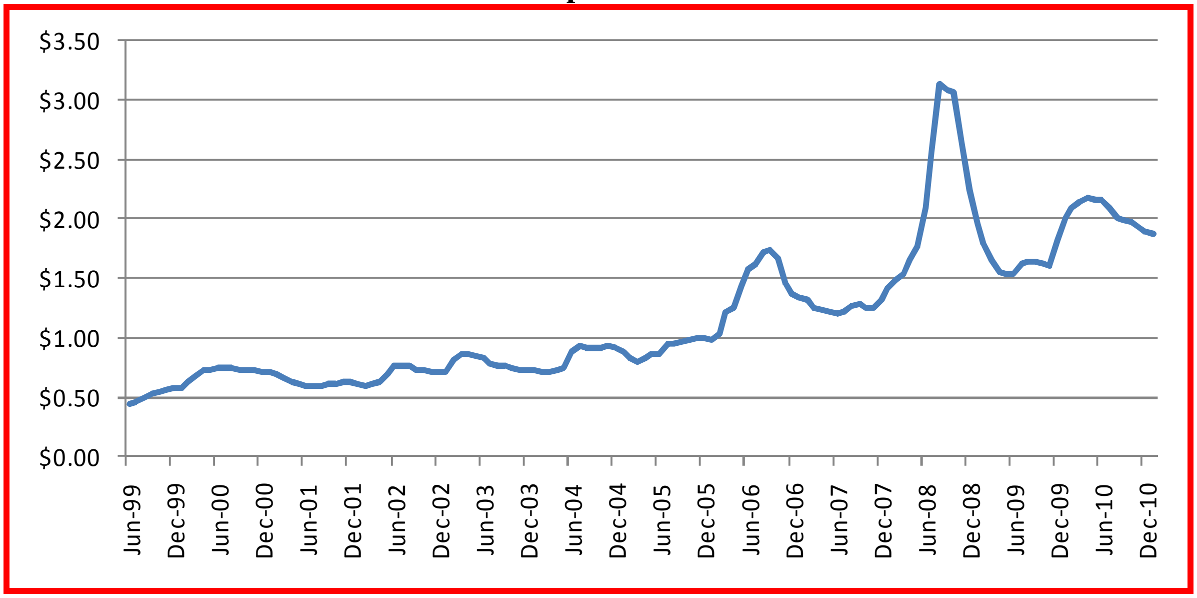
Exhibit 4-5: Retail Gasoline Prices

Exhibit 4-6 depicts a similar trend for retail diesel prices. In the case of diesel, prices increased to nearly $5.00 per gallon and fell to only $2.00 before jumping back to $3.00.

Exhibit 4-6: Retail Diesel Prices

Costs of materials and oil-based fuels significantly affect the overall price of bid items. With demand for construction in both domestic and international markets increasing through 2010, the prices of construction materials have also increased. Analysts have attributed this trend to a number of factors including limited capacity to produce materials, lack of competition, and energy pricing. In fact, the prices of some materials are in direct correspondence to the prices of oil-based fuels (e.g., asphalt mix) and energy in general. Exhibit 4-7 shows the increase in the price of asphalt cement from December 1999 to June 2010. The historical gasoline, diesel and asphalt cement prices show a concurrent drop in prices in 2006, followed by sharp increases through summer 2008, followed by declines in late 2008 and early 2009, and generally increasing prices through to the present.

Exhibit 4-7: Asphalt Cement Index



Source: ACAF, Asphalt Contractors Association of Florida, 2011,
http://www.dot.state.fl.us/Construction/fuel&bit/fuel&bit.htm#2004%20Fuel&Bit

4.3 Price Adjustment Clauses as a Cost Control Strategy

Facing this dilemma of construction costs that are rising more rapidly than budgets, the transportation community has examined strategies and techniques to control costs, including price adjustment clauses. A report by Damnjanovic, et al, of the Texas Transportation Institute summarized many of these efforts.[23]

To determine the extent of the problem, the American Association of State Highway and Transportation Officials (AASHTO) conducted a survey to identify the factors contributing to increases in construction costs. The results of this survey indicated that the most effective method to control construction cost is rejecting non-competitive bids and re-advertising.[24] While there are no specific data to support such a claim, surveys from the Kentucky and Missouri

[23] Ivan Damnjanovic, Stuart Anderson, Andrew Wimsatt, Kenneth F. Reinschmidt, and Devanshu Pandit, Evaluations of Ways and Procedures to Reduce Construction Costs and Increase Competition, Texas Transportation Institute, The Texas A&M University System, College Station, Texas, March 2008, Published January 2009, FHWA/TX-08/0-6011-1, URL: http://tti.tamu.edu/documents/0-6011-1.pdf

[24] Sanderson, V., "Current Strategies to Address Increasing Highway Construction Costs and Reduced Competition." Technical Agenda, AASHTO Subcommittee on Construction, Washington, D.C., 2006.

Departments of Transportation (DOTs) reported annual savings of $1.8 million and $5 million, respectively, using similar strategies.

In a similar effort, the Florida Department of Transportation (FDOT) developed a number of short-term and long-term strategies for cost control.[25] Short-term approaches included strategies such as encouraging bid options and bid alternatives, developing a more comprehensive price index for construction contracts to manage risk, optimizing night shift work, and redefining project scope. Long-term approaches considered additional fundamental changes in the bid letting process, as well as development of more accurate cost estimating tools.

Damnjanovic reported on similar efforts by several Departments of Transportation. WSDOT identified issues/factors that they can control, such as reduced cost through increased competition, while TxDOT proposed 50 cost-saving ideas related to maintenance, pavement design, alternative materials, aesthetics, competition, and others.

Damnjanovic postulated that very few studies, if any, have approached the problem from a rigorous methodological viewpoint. The focus was on *ad hoc* cost control methods without considering the role of the cost reduction methods in the project development process. His research attempted to fill this gap in the body of knowledge by reviewing the current practices of DOTs, conducting fact-finding workshops that involved design and construction engineers, conducting workshops involving contractors, collecting data using Delphi process, analyzing the collected data, and developing guidelines for implementation of cost reduction methods.

In order to develop a list of cost control strategies, representatives from the DOTs shared their experiences of cost increases and the strategies and methods employed to curb rising construction costs. The research team reviewed 108 methods identified during brainstorming sessions. The team consolidated similar methods while eliminating duplicate methods. The discussion during the third workshop on how to implement the cost reduction methods resulted in classification of the considered methods into two different categories: program-wide methods and project-based methods. A consolidation of the similar methods further resulted in a list of 56 methods. In order to assess and compare the effectiveness of methods, each method was ranked according to its perceived cost reduction effectiveness criteria ranging from 0 to 4 for a ‘no’ to ‘very high’ response, respectively. Exhibit 4-8 shows the ranking of the 21 methods having programmatic or program-wide applications, with price adjustment clauses ranked eighth with a relatively high score.

[25] Prasad, A., “Cost Estimation and Management,” FDOT State Estimate Office, FL, 2006.

Exhibit 4-8: Ranking and Scores for TTI Program-Based Methods

Rank	Method	Score (0-4)
1	Standardize methods and provide more design repetition.	2.21
2	Educate and train designers, consultants, and contractors.	2.21
3	Evaluate restrictions on imported materials.	2.04
4	Create material sources by TxDOT.	2.04
5	Evaluate local market condition for availability of resources to effectively plan construction lettings.	2.00
6	Implement formal risk identification and management program.	1.96
7	Utilize owner buying power.	1.92
8	**Add price adjustment clause to contracts.**	**1.83**
9	Cross-district sharing of lessons learned.	1.63
10	State-owned batch plants and crews for small and isolated jobs.	1.58
11	Develop selection tools for contracting methods based on past performance of alternative contracts.	1.54
12	Purchase commitment to suppliers by TxDOT with option for buying.	1.46
13	Improve design change procedure to increase responsiveness to change (fast and simple).	1.46
14	Reduce bond cost over project time.	1.42
15	Update design manuals.	1.42
16	Implement comprehensive approach to cost estimating.	1.21
17	Ease contracting requirements with TxDOT.	1.21
18	Relax prequalification requirements for certain projects.	1.17
19	Provide owner-controlled bonding for small contractors.	1.08
20	Contractor evaluation/grading.	1.04
21	Provide design-build lump-sum contract for traffic control.	0.88

Source: Ivan Damnjanovic, Stuart Anderson, Andrew Wimsatt, Kenneth F. Reinschmidt, and Devanshu Pandit, Evaluations of Ways and Procedures to Reduce Construction Costs and Increase Competition, Texas Transportation Institute, The Texas A&M University System, College Station, Texas, March 2008, Published January 2009, FHWA/TX-08/0-6011-1, URL: http://tti.tamu.edu/documents/0-6011-1.pdf

4.4 Price Adjustment Clauses and Economic Theory

An understanding of the economic underpinnings of contract price adjustment is essential to developing useful guidance on the use, structure and features of these clauses. Public policies, which are compatible with economic theory, are less prone to failure and unintended consequences.

In economics, the competitive market is the ideal against which the economist measures the circumstances in the real world. Policies that bring real world markets closer to the model of perfect competition are likely to improve efficiency. According to two professors of economics at Mercer University, "The theory of perfect competition sets the frame of reference for all presentations of economic theory, both microeconomic and macroeconomic. As such it serves as the efficiency benchmark when evaluating economic outcomes, both on the chalkboard and in the measurement of reality."[26]

[26] Scott A. Beaulier and Wm. Stewart Mounts, Jr., "Asymmetric Information about Perfect Competition: The Treatment of Perfect Information in Introductory Economics Textbooks," Stetson School of Business and Economics, Mercer University, Macon, GA, September 2008. www.scottbeaulier.com/Information_Version_2.doc

Numerous industries and markets have used price adjustment clauses where circumstances interfere with the ability to employ the natural competitive forces of the market. For example, airline companies use fuel surcharges. Industries such as natural gas, coal and petroleum coke employ price adjustment clauses, as high capital costs and immobile capital require long-term contracts. Most transportation industries such as shipping and trucking employ fuel adjustment clauses. Even residential electricity billing includes fuel adjustment factors.

This section explores the treatment of price adjustment in the economic literature. The first subsection reviews the attributes of competitive markets and compares this idealized theory to the highway construction market. The second subsection examines how the problem of imperfect information affects efficient outcomes. The third subsection explores the problem of input risk. The fourth subsection reviews literature on transaction-cost economics, a field of economics concerned with approximating efficiency in an environment of small-numbers bargaining, uncertainty, and immobile capital. The fifth and final subsection examines how risk allocation in markets characterized by imperfect information.

Competitive Markets

The basic economic theory behind price adjustment clauses is that the rapid fluctuation in input prices causes market imperfections that reduce the natural competitive balance of the highway construction market. In economics, the market structure of perfect competition requires five necessary assumptions, although the list varies depending on the particular source or textbook:

1. Firms sell a homogeneous product;
2. There are a large number of small firms;
3. Firms are price takers;
4. There are no barriers to entry and exit in the long-run; and
5. Firms and consumers have perfect information.[27]

In the short term, perfectly competitive markets are allocatively efficient, as output will always occur where marginal cost is equal to marginal revenue, and therefore where marginal cost equals average revenue. In the long term, such markets are both allocatively and productively efficient, as output will occur where marginal cost is equal to average cost. In simple terms, producers will have income equal to the amount it costs them to produce including a fair rate of return on invested capital.

The highway construction industry, while competitive, does not satisfy every aspect of perfect competition. For example, there are less than an infinite number of buyers, new entrants to the market can face substantial barriers, information is not perfect, and the quality of service provided varies substantially from contractor to contractor.

The highway construction industry is to a certain extent a monopsony, as it has less than an infinite number of buyers. In economics, a monopsony is a market form in which only one buyer

[27] Scott A. Beaulier and Wm. Stewart Mounts, Jr., "Asymmetric Information about Perfect Competition: The Treatment of Perfect Information in Introductory Economics Textbooks," Stetson School of Business and Economics, Mercer University, Macon, GA, September 2008. www.scottbeaulier.com/Information_Version_2.doc

faces many sellers. It is an example of imperfect competition, similar to a monopoly, in which only one seller faces many buyers. As the only purchaser of a good or service, the "monopsonist" may dictate terms to its suppliers in the same manner that a monopolist controls the market for its buyers. Note that the highway construction industry is certainly not completely a monopsony as there are local government agencies that buy highway construction and private industries that buy similar heavy construction. However, many contractors will work almost exclusively for their state DOT.

In the highway construction industry, the lower prices caused by monopsony power has two distinct effects on economic welfare. First, it redistributes welfare away from suppliers and to the DOTs. Secondly, it reduces the aggregate (or social) welfare enjoyed by both groups taken together; as the net gain realized by the DOT is smaller than the loss inflicted on the suppliers.

Perhaps the most salient aspect of the highway construction industry is that monopsony power may keep profit margins lower than normal. Note also that some other forms of risk, such as collections problems are low, as government entities are likely to pay their suppliers.

Imperfect Information

Price adjustment clauses primarily address the problem of imperfect information. If contractors possessed perfect knowledge of the future prices of fuel, as well as additional construction inputs, they could incorporate those prices.

Many economists have emphasized the important role of information in competitive markets. For example, Edwin Mansfield, a professor of economics at the University of Pennsylvania's Wharton School, noted that, "Perfect Competition requires that consumers, firms, and resource owners have perfect knowledge of the relevant economic and technological data. Consumers must be aware of all prices. Laborers and owners of capital must be aware of how much their resources will bring in all possible uses. Firms must know the prices of all inputs and the characteristics of all relevant technologies. Moreover, in its purest sense, perfect competition requires that all of these economic decision-making units have an accurate knowledge of the future together with the past and present."[28]

Beaulier and Mounts assert that, "Without an assumption about information, well-informed decisions cannot be made. We cannot even begin to understand a firm's decisions without making some kind of assumption about the knowledge available in the industry. Without perfect information, the decision to enter or exit an industry is not apparent to the profit seeker: the firm owner does not even know the shape of relevant cost curves; the owner also lacks information about future costs and prices. In fact, in the absence of perfect information, producers are not even sure whether their output levels are the profit maximizing points of production. It seems

[28] Edwin Mansfield Ph.D., University of Pennsylvania, "Microeconomics Theory and Practice," W.W. Norton & Company, New York, 2nd Edition, 1975.

clear, then, that the theory of perfect competition requires the perfect information assumption for there to be consistent logic in presentation."[29]

Economic Risk, Factors and Imperfect Information

The importance of imperfect information, such as knowledge of future fuel prices, is higher where the proportion of inputs contributed by the producer is low and producers face a variety of production risks.

Highway construction contractors face a large number of risks. In addition to rapidly fluctuating prices for fuel and other commodities, there are a number of other risks. For example, during persistent bad weather, contractors may still have to pay crew to show-up. In addition, they still have to pay for equipment and overhead items from office staff to land and facilities. Other forms of risk relate to uncertainties in estimates. These can include unforeseen obstacles such as buried rock or utility issues. In order to be profitable, the contractor must accurately estimate the amount of work to as well as the cost to perform each task. In addition, as federal economist Dr. Laurence Crane has noted, "the economic climate has changed accompanied by increasing non-production risks—marketing, financial, environmental, legal, etc."[30]

Crane has also pointed out that improved technology affects the returns to production by reducing the proportion of inputs contributed by the producer. Increased technology inputs in the production process reduces the amount of producer owned and supplied inputs. As a producer's share of labor and other inputs decline, so does their share of the earnings. The profit earned (economic rent) is returned to the provider of the input. Thus, profit margins narrow and the importance of controlling the risk associated with the other inputs rises.[31]

"Improved technology affects the returns to production in another important way. Not only does it help stabilize prices at a lower level by increasing production, it reduces the proportion of inputs contributed by the (producer). Increased technology inputs in the production process reduces the amount of (producer) owned and supplied inputs. As a producer's share of labor and other inputs decline, so does their share of the earnings. The profit earned (economic rent) is returned to the provider of the input. Thus, profit margins are narrowed and the importance of controlling the risk associated with the other inputs is enhanced."[32]

Construction firms submit bid prices in advance of performing the work. At that time, they possess imperfect information as to future prices of fuel and other inputs. Price adjustment clauses should aid in rectifying this problem by allowing contractors to realize revenues that are closer to their actual costs at time of delivery. This allows contractors to earn reasonable returns

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[29] Scott A. Beaulier and Wm. Stewart Mounts, Jr., "Asymmetric Information about Perfect Competition: The Treatment of Perfect Information in Introductory Economics Textbooks," Stetson School of Business and Economics, Mercer University, Macon, GA, September 2008. www.scottbeaulier.com/Information_Version_2.doc

[30] Production Risks: Alive and Well, Dr. Laurence Crane, National Crop Insurance Services, Overland Park, Kansas, May 17, 2004. Available at: http://www.ag-risk.org/NCISPUBS/LAIPPUB/Artic15.htm

[31] Ibid.

[32] Ibid.

and will reduce added risk pricing, lessen defaults, limit exit of firms from the market, enhance competition, and lower prices.

Transaction Cost Economics

While the model of perfect competition presents an ideal that provides the greatest efficiency, in the real world all of the conditions seldom exist. Consider several examples.

In the natural gas industry, short-term agreements are prone to frequent and costly renegotiations between producers and buyers. In addition, producers can be hard-pressed to find alternative means of sale if their arrangements with pipeline owners prove to be less than ideal.[33]
In the coal mining industry, the availability of alternative customers and suppliers diminishes as the contracted quantity of coal increases. Contract durations tend to be longer, often by a decade or more, if relationship-specific investments (on-site electric generators for isolated mines with fewer transportation alternatives and longer distances for example) are important.[34]
In the petroleum coke industry, prohibitive storage costs necessitate rapid processing and efficient shipping. In response, shippers have incentives to locate near petroleum coke suppliers and to attempt to limit the availability of alternative shipping options.[35]
The government negotiates long-term shipping contracts for the Department of Defense. The carriers face the risk of changes in bunkering fuel costs and currency exchange rates.[36]

In these examples, the competitive market is unable to function and provide for efficient outcomes due to uncertainty, immobile capital and small numbers of firms. One solution is long-term contracts that often have price adjustment clauses. The study of these markets falls under the term "Transaction-Cost Economics." For example, two authors note that, "A small literature has developed that explains various forms of organization that depart from repeated auction-market transactions between individual buyers and sellers as efficient responses to this 'hold-up' problem rather than as monopolistic behavior." They also opine that, "…the hypothesis that long-term contracting is a means of approximating efficiency in an environment of small-numbers bargaining, uncertainty, and immobile capital is difficult to reject because the transactions cost model is often quite general and not formalized."[37]

For example, in the highway construction industry, the problem of fuel price adjustments would not exist if contractors could bid on each day's work in the morning of each day. However, this would not be practical, because the cost of mobilizing every day would be too high, thus, the term transaction cost. Note that in the above quote the authors explain that these forms of

[33] Hubbard, R. Glenn and Robert Weiner. "Efficient Contracting and Market Power: Evidence from the U.S. Natural Gas Industry." *Journal of Law and Economics*, 1991.
[34] Crocker, Keith and Scott Masten. "Regulation and Administered Contracts Revisited: Lessons from Transaction-Cost Economics for Public Utility Regulation." *Journal of Regulatory Economics*, 1996.
[35] Goldberg, Victor and John Erickson. "Quantity and Price Adjustment in Long-Term Contracts: A Case Study of Petroleum Coke." *Journal of Law and Economics*, 1987.
[36] U. S. Department of Transportation, Volpe National Transportation Systems Center, "Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts," July 2009.
[37] Hubbard, R. Glenn and Robert Weiner. "Efficient Contracting and Market Power: Evidence from the U.S. Natural Gas Industry." *Journal of Law and Economics*, 1991.

organization such as long-term contracts and price adjustment clauses are thought of as efficient responses, rather than undesirable or monopolistic behavior. As one paper noted, "Incorporating some type of price adjustment mechanism into a long-term contract thus appears to be an important element in the design decision."[38]

Risk Allocation

Price adjustment clauses reduce risk to the individual or organization that receives the adjustment. An important policy question is which of the parties in a long-term transaction should bear the risk of changing prices. The Volpe National Transportation Systems Center examined this question in their analysis of DOD shipping contracts. Their report noted that "Because the BAF (Bunker Fuel Adjustment Factor) is a mechanism for shifting the risk of fuel price volatility, the decision should be explicitly made as to how much of the risk each party should bear."[39] The Volpe report reached the following conclusions:

- "If a carrier is better placed to manage this risk, through hedging or other means, then it should bear more of the risk."
- "If carriers are in the best position to forecast risk and take appropriate actions to minimize the impacts, then they should bear the risk directly."
- "If the risk is largely out of anyone's control (or any of the relevant parties), and shippers (USTRANSCOM) can absorb the uncertainty of not knowing actual costs until the time of delivery, then shippers can bear the risk.[40]

Their conclusion was that since neither part could accurately forecast fuel prices that it made sense for the government to bear the risk. In the end, DOD paid the price that the fuel cost when the carriers actually delivered and used the fuel. This is exactly the case with highway construction PACs. The state DOT compensates the contractor as if they were able to delay bidding and purchasing of the fuel to when it is actually used.

4.5 Evaluation of Current PAC Program Practices and Costs

This section and the four that follow summarize the results of the data collection phase of this research study including findings from the literature reviews, surveys and statistical analyses. This section reviews findings on current practices including program design, program size and program costs. Section 4.6 reviews potential program benefits including lower bid prices, more bids per project, fewer bid retractions, greater market stability, and supply chain effects. Section 4.7 evaluates potential PAC risks and barriers to implementation. Section 4.8 surveys future PAC

[38] Keith J. Crocker and Scott E. Masten, "Regulation and Administered Contracts Revisited: Lessons from Transaction-Cost Economics for Public Utility Regulation," Journal of Regulatory Economics, 1996.
[39] U. S. Department of Transportation, Volpe National Transportation Systems Center, "Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts," July 2009.
[40] U. S. Department of Transportation, Volpe National Transportation Systems Center, "Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts," July 2009.

plans. Section 4.9 evaluates potential DOT actions and strategies for improving or amplifying their PAC programs.

The current AASHTO survey and the findings of the two surveys conducted as part of this study provide a wealth of information on the design of the specific programs in place, the size of the programs in terms of disbursements and returns and the labor and other costs associated with administrating the programs. The following subsections summarize the findings from these surveys.

PAC Program Design

The vast majority of state DOTs currently employ price adjustment clauses, although each state has a unique policy that varies in coverage and features. As of the latest AASHTO survey conducted in the fall of 2009, 47 out of the 50 state DOTs used a price adjustment clause. For the states that do have PACs, nearly all use them for fuel (41 states) and liquid asphalt (40 states), with smaller numbers using them for steel (15 states) and cement (4 states).

Just as states apply PACs only to specific pay items, they often also exclude them for projects below a minimum pay item quantity, a small project size, or a project of short duration. Shorter, larger projects would be more resistant to vacillating prices than longer and smaller projects, although this cannot be quantified.

Trigger points are most often set between 5.0 and 7.5 percent, but range from an immediate (zero) trigger to a trigger of over 20 percent. Trigger points vary within states by commodity and, in general, liquid asphalt PAC trigger points are lower than those used for fuel PACs. Higher trigger values would reduce the administrative load for DOTs. At the same time, contractors might retain concerns about risk and factor this into their estimates. Lower trigger values would lower the risk premium while adding to administrative cost. Most of the additional expense would come from increasing numbers of payouts, although the accuracy of the system could cut both ways and increase returns from contractors during times of falling commodity prices. The statistical analysis conducted on Missouri, the only test state that has a zero value trigger clause, showed consistently lower average bid prices.

The program design for some states utilizes an opt-in policy, which allows contractors to decide whether to be subject to a PAC for an individual contract. Of the 41 states with fuel PACs, 13 have an opt-in feature. For the 40 states with liquid asphalt PACs, six have an opt-in feature. Five of the 15 states with a steel PAC have an opt-in feature, while none of the four states with cement PAC programs have such a feature. Contractors could opt-out when they have adequate storage or fixed prices from suppliers, decreasing DOT costs and risk.

Three quarters of the responding states reported that they use the fuel use per unit method to calculate fuel usage and PAC payments. This method is reliable and predictable: the sole variable input when using this method is the quantity of work performed during a pay period. The main criticism of this method is the lack of updated fuel factors. Remaining states use a variety of methods for fuel PACs. Of these alternative methods, the percent of cost method can be useful when a contract includes many lump sum items, although the fuel/indexed material use per unit is still preferable.

PAC Program Size

The PAC programs tend to be relatively small in comparison to overall state highway spending, based on the 18 states that reported disbursements and returns. Average net disbursements over the 2006 to 2009 period under the PAC program represent less than 1.5 percent of each state's direct highway spending (see Exhibit 1-11). For two-thirds of the states reporting data, the PAC program payments represent less than two-thirds of one percent of direct highway spending.

Prior to 2009, program payments to contractors greatly exceeded returns to DOTs. However, with falling fuel prices in 2009, reporting states actually had returns that exceeded disbursements.

PAC Program Costs

Administrative burden is the most highly cited barrier to using and /or implementing a PAC program. Of the 30 states to respond with cost information, the average number of person-hours per month spent on administering these clauses is 86 hours or approximately 1,000 hours per year. While states were not asked to provide hourly costs, at a per hour cost of $50, the yearly cost would total $50,000. A per hour cost of $100 would imply a yearly cost of $100,000 per state. Additional cited costs include an average monthly subscription cost of $291 for the 26 states that responded, or approximately $3,500 a year. Two states cite initial programming costs as ranging between $5,000 and $50,000. Using the higher end of the labor hour cost of $100 but assuming this estimate subsumes subscription and amortized initial and recurring programming costs, would result in a total program cost or roughly $5 million across the 50 states.

On average, contractors reported spending approximately 10 person-hours per month administrating the PAC program for their firm, the equivalent of approximately 120 hours per year. Assuming a lower end estimate of cost at $50 per hour, cost would total $6,000 annually. Since these costs would apply mainly to prime contractors and only to those in PAC states that indexed the types of items they bid a conservative estimate is 2,500 firms or $15 million across the 50 states.

Total administrative costs for DOTs and contractors are therefore approximately $20 million per year. The average annual disbursements for the 18 states that reported were $277 million. Assuming full reporting by all 47 states with a PAC program would inflate that total to $500 million per year; administrative costs would be about four percent.

4.6 Evaluation of PAC Program Benefits

There is a variety of potential benefits from the implementation of PAC programs. This section reviews evidence from the surveys and statistical analysis concerning several of these potential benefits including lower bid prices, more bids per project, fewer bid retractions, greater market stability, and supply chain effects.

Lower Bid Prices

One potential benefit of PAC programs is lower bid prices. Among state DOT respondents, 78 percent reported a moderate or large benefit from PACs in terms of better pricing, while only 4 percent reported no benefits. Contractors agreed, with 58 percent responding that the presence of PACs led to moderately or significantly lower bid prices, while only 13 percent responded that they led to moderately or significantly higher bid prices.[41] When PACs are not in place, almost all responding contractors claim they add contingencies to their bids to cover the material price risk.

The statistical analysis, on the other hand, was not able to prove conclusively that states with PACs benefitted from lower prices. There is some indication that mean bids are lower, at least for several items, in states with price adjustment clauses. However, these differences may reflect differences between states in the average sizes of projects bid as well as other factors. The multistate regression model, which controlled for factors such as project size and material prices, provided a mix of positive and negative coefficients for the PAC variable, many of which were not statistically significant. In some cases, such as for the state of Missouri, the single state model did show a consistent pattern in which the PAC program led to lower bid prices. However, for some of the other single state models the results were inconclusive.

Increased Number of Bids and Fewer Bid Retractions

A second potential benefit of PAC programs is an increase in the number of bids received per project. Among state DOT respondents, only 24 percent reported a moderate or large benefit from PACs in terms of increased number of bids, 40 percent a small benefit and 35 percent no benefit at all. State DOTs clearly did not see this to be as important a benefit as lower prices. Approximately 30 percent of contractors thought that both the number of projects they bid and the number of bidders on a project would be moderately or significantly higher, while less than six percent, in both cases, thought there would be a decline.

The consensus is that there would be little change in the number of bids, and the statistical analysis again did not provide evidence that PAC programs increase the number of bidders. One confounding factor is that the economy generally performs poorly during periods of rapidly increasing fuel prices and this tends to increase the number of bids as contractors become more desperate for sales.

Related to the number of bids is the potential for contractors to retract a bid, refuse to complete the work or simply fail in the face of sharply higher material prices. While several sources had cited anecdotal information on such cases, respondents did not generally report these possibilities as a major concern. Contractor default, therefore, does not appear to happen often, although when it does it may garner significant attention and cause significant disruption.

[41] The survey conducted by the study team resulted in responses from 100 contractors representing 31 states.

Market Stability

Anecdotal evidence from state DOTs and construction contractors conveys their sentiment that PACs lead to greater overall stability in the highway construction market. When asked how the presence of PACs affects contractor stability, 55 percent of responding DOTs believe that there is a moderate to large benefit, whereas only 22 percent believe there is no benefit. In addition, 60 to 80 percent of responding DOTs perceive a moderate to large benefit from PACs to all stakeholders in the market – DOTs, prime contractors, subcontractors and suppliers. Only 4 to 7 percent of DOTs perceive no benefit from PACs to themselves, prime or subcontractors. These responses indicate that contractor stability afforded by PAC programs provide a significant benefit.

In total, 58 percent of responding contractors believe overall market stability is moderately to significantly higher with the presence of PACs, whereas only 6 percent believe stability is lower. The majority of responding contractors also believe the levels of risk to prime contractors, subcontractors and suppliers are moderately to significantly lower, whereas only between 12 and 16 percent believe levels of risk are higher. Contractor perceptions of the level of risk to DOTs are more even across categories, but approximately 58 percent still responded that the level of risk is either lower or unchanged.

In addition, the consensus among DOTs and contractors is that PACs remove added risk contingencies and lead to lower bid prices. The removal of such contingencies represents a reduction in uncertainty for DOTs and an increase in contractor confidence that the DOTs will cover their cost increases for covered items. As explained in the section above on lower bid prices, over three quarters of responding DOTs perceive a moderate to large benefit from PACs to pricing and the majority of contractors agree that the presence of PACs leads to lower priced bids. This decrease in uncertainty and increase in bidder confidence is a key explanation as to how PACs can increase the overall stability of the market.

Supply Chain Benefits

The major inputs to highway construction move through a supply chain from suppliers to contactors to state DOTs. The use of price adjustment clauses in highway construction contracts alters the relationships between these parties, affecting the risk each party faces and the ultimate profitability and stability of each level in the chain.

The introduction of PACs alters the relationships in the supply chain, causing alterations in benefits and risks to the various parties. This is not necessarily a zero-sum game as it is possible for all parties to benefit. For example, both DOT and contractor respondents generally believed that all of the parties benefitted from the PAC programs. Respondents to the DOT survey perceived moderate or large benefits for DOTs (61 percent), prime contractors (81 percent), subcontractors (70 percent), and suppliers (60 percent). For every group except suppliers, less than seven percent of respondents perceived no benefit. Two respondents wrote in that they perceived a significant benefit to taxpayers. Respondents to the contractor survey perceived moderate or large benefits for DOTs (82 percent), prime contractors (83 percent), subcontractors (84 percent), and suppliers (78 percent).

In the absence of PACs, contractors will have to bear the increased costs of material inputs unless the contractors negotiate price commitments with suppliers or buy and store the commodity from the contract bid date. In contrast, with a PAC in place, contractors merely pass on the price of the commodity to DOTs, with the exception of residuals due to trigger values or inaccurate or mistimed adjustments. The contractor survey queried contactors as to the common problems experienced on projects without PAC programs. Obtaining fixed prices from suppliers is a major problem for most contractors, with 73 percent indicating this issue as either a moderate or a major problem. Most contractors also believe suppliers honoring price and quantity commitments is a significant issue, with 61 percent indicating this issue as either a moderate or a major problem. The issue of costs for carrying inventory when contracts lack a PAC is less agreed upon with 43 percent indicating this issue as either a moderate or a major problem.

Suppliers will face risk to the extent they offer price commitments beyond their ability to carry product in inventory. However, as indicted above, suppliers are unlikely to offer fixed prices or to honor price and quantity commitments. When asked whether supplier price relationships change with the introduction of a PAC program, the majority of contractors say no. For those pricing relationships that do change with the introduction of a PAC, most contractors explain that the supplier prices float with the index. It is unclear whether this drop in lock-in prices increases or decreases supplier risk and profit.

The available evidence suggests that DOTs with PAC programs benefit from reduced bid prices, increased number of bids and a more stable contractor workforce. In years of declining prices, such as 2009, they may actually get returns from contractors. However, in most years they will pay contractors adjustments based on increased input prices and face moderate administrative and other costs.

4.7 PAC Program Risks and Barriers to Implementation

Several potential problems exist when attempting to implement a PAC program, particularly when considering expanding PAC programs to materials beyond fuel and liquid asphalt.

Availability and Reliability of an Index

Easy access to reliable index data is necessary for the operations of a successful PAC program. Indexes for fuel and asphalt cement are readily available and are generally reliable. However, access to reliable indices for other materials is often more limited. Cement indices can be found through the Bureau of Labor Statistics and other sources. However, since cement is an input to concrete, the correlation between index prices and eventual construction cost is less precise. Contractors utilize disparate types of manufactured steel and pipe depending on project demands, making effective indexing an unwieldy exercise.

Method for Measuring Quantities Used

The difficulty in accounting for measuring method differs according to the material under consideration. Stone/aggregate and pipe are almost uniformly measured in tons and linear feet respectively. Liquid asphalt is often bid as a separate item. In cases where it's not, the mix component proportions can be gleaned from mix specifications. On the other hand, concrete (of which cement is a major input) is used in a variety of ways on site and standardization of measure cannot be guaranteed. Miscellaneous types of steel may be bid in different units or included in other items.

Impact of Changing Prices

The risk associated with fluctuating material pricing is one of the main justifications for including PAC programs for fuel, liquid asphalt and steel. However, materials such as cement, pipe and stone/aggregate are historically more immune to price volatility. The minimal anticipated pay outs may not be justified when weighed against the startup and administrative costs of a PAC program. State DOTs seem reticent to investigate the expansion of PAC programs to these items. Contractors seem more amenable to the idea, perhaps because they don't have to account for additional program costs.

Contractor's Ability to Control Price

This category refers to a contractor's ability to stockpile a particular construction material and is related to the previous category. As a stand-alone item and as a component of liquid asphalt, fuel is a commodity material subject to substantial price fluctuation. While fuel can be stockpiled by contractors, the costs to construct storage tanks and other infrastructure may be prohibitively expensive. PAC programs for such materials are useful as a risk mitigation measure. For other materials contractors can more effectively predict and control pricing, bringing the necessity of a PAC program into question. Materials such as steel (structural or otherwise), stone/aggregate and pipe can be stored for longer periods. Additionally, suppliers are more willing to lock in the prices of these materials due to the historically more stable markets for them.

Administrative Burden

The cost of government programs will always be a significant issue and when queried as to the barriers to implementing and using PACs, 42 percent of state DOT respondents cited administrative burden. This may point to the desirability of developing a PAC program, perhaps centrally funded, that is easy to implement and maintain. The more automated the program, the more advantageous. Tying the program calculations to data that states already collect (i.e. progress payments) and creating a system that will automatically compute PAC payments would be a good foundation to build a program on. A centralized system that entered the index data or derived it from a purchased index or federally collected data could reduce administrative burden and cost. The "fuel/indexed material use per unit" method is especially suited to such a system.

Additional Concerns

The second largest barrier to implementation, according to state DOT respondents, was contractor resistance. The most interesting aspect of this assertion is that the reason most often cited for having the PAC programs is that contractors demanded them.

As presented in Exhibit 1-22, political and policy considerations can be a barrier to creating PACs as well. However, state DOTs rarely cited state laws and regulations (3 percent), DOT leadership (7 percent), or legislature/political (3 percent) as barriers. On the other hand, 29 percent of respondents cited creating policy at the DOT as a barrier. This may be associated with administrative burden and lack of time and/or resources to create PAC specifications.

State DOTs raised data availability as a significant issue. For example, 23 percent of state DOT respondents cited availability of fuel usage factors as a barrier and two “other” comments revolved around the availability of good price indexes or market costs for commodities.

Several respondents questioned the cost effectiveness of PAC policies, with 23 percent of respondents indicating that the cost of payments do not justify benefits and one “other” commenter noting that there was “very little benefit for most contracts.”

Exhibit 4-9: Summary of Potential Risks and Benefits

Potential Benefits	Potential Risks
Lower bid prices	Administrative costs
Increased number of bidders	Costs of purchasing indexes
Market stability	Costs of setting up procedures (programming, software, etc.)
Less firms exited market	Contractor PAC disbursements
Fewer contractors default/bid retractions	Policy formation and political barriers
More equitable profits on each contract	Contractor resistance
Contractor PAC receipts	Inaccuracies due to indexes, usage factors, timing, etc.

4.8 Future PAC Program Plans

DOTs could make several potential changes to the designs of their PAC programs. This section reviews potential program design elements, barriers to implementation or expansion of PAC programs and plans by DOTs to alter or expand current programs in the future.

Many of the survey questions elicited perceptions on the effectiveness of PAC program design. The questions queried DOTs and contractors as to what changes they would like to the fuel use per unit method, which is the method most used and most preferred. The majority of DOTs and contractors believe that updated fuel usage factors and additional fuel usage factors would improve fuel PACs. These responses show that even for the most commonly used price adjustment clause there is still a need for additional technical information.

To determine how DOTs can improve PACs and make them more efficient, the survey asks contractors about problems when PACs are in place. One issue regarding PACs is the timing on invoices versus the index payment calculations. This problem involves a discrepancy in the date contractors purchased the materials and the index date used by DOTs. The majority of contractors at 50 percent do not believe this is a problem for the PAC program and 36 percent perceive a slight problem. A high trigger value for index payments is also a complaint of some contractors. Three quarters of contractors believe trigger values are either a non-issue or a slight problem and the remaining contractors believe it is a moderate problem. Incorrect index values in PAC contracts was also believed to be not a problem by many contractors, as only 22 percent find it to be a moderate to major issue.

The survey also asked if increased material costs are still a problem when a PAC program is in place. The desired consequence of PAC programs is to mitigate this issue. In total, 50 percent of contractors do not believe increased material costs are a problem when PACs are in place, and 27 percent perceive it as a slight problem. For projects without PAC programs, 42 percent of contractors cited increased material costs as a major problem when PACs are absent. Only 9 percent of contractors believe it is not an issue when PACs are absent. These discrepancies show that contractors believe that PACs do in fact mitigate the consequences of increased material costs.

The surveys conducted for this study queried DOTs and contractors on their plans for the future of their PAC programs. When asked which if any items DOTs planned to add, 15 of the 27 responding DOTs stated they are not planning to add any items. In total, eight DOTs plan to add steel, five are planning to add fuel, five are planning to add cement, one is planning to add asphalt mix, and no DOTs are planning to add liquid asphalt. The reason the number of DOTs that plan to add fuel and liquid asphalt is so low is that the vast majority already index them, at 41 and 40 states respectively. One DOT plans to add asphalt mix and no DOTs plan to add concrete. A potential explanation for the small number of DOTs planning to add these items is the overall lack in industry interest to index them. Eight states cite steel, currently indexed by 15 states, as an item they plan to add in the future. Five states cite cement, currently indexed by only four states, as an item that they plan to add in the future. These are high response rates compared to the number of states currently indexing these items. Therefore, steel and cement appear to be the items DOTs are most likely to introduce to PAC programs, although the historically less volatile markets for these items may lead DOTs to question including them.

The survey queried contractors as to which items their state currently indexes and which items they would like added to their state's PAC program. For fuel and liquid asphalt, the sentiment was similar to that of DOTs, a small desire to add the items due to so many states already indexing them. In total, 56 contractors responded that they are subject to fuel PACs and 11 would like to see them added. Similarly, 66 contractors responded that they are subject to liquid asphalt PACs and five would like them added. Contractors also had similar opinions as DOTs on steel and cement. Seven contractors responded that they are subject to cement PACs and 33 would like cement added. In total, 31 contractors responded that they are subject to steel PACs and 51 would like steel added. When asked what other items contractors would prefer to have indexed, a contractor from Mississippi cited pre-stressed concrete beams, a Tennessee contractor cited stone and pipe materials, an Illinois contractor indicated aggregates, and a Pennsylvania contractor would like to see aluminum and copper added. This analysis can help DOTs focus resources on implementing PACs for items that contractors prefer. Contractor demand for asphalt mix and concrete PACs appeared higher than that of DOTs. In total, 17 contractors responded that they are currently subject to asphalt mix PACs and 18 would like asphalt mix added. Only two contractors cite their states as using concrete PACs, but 29 would like their states to add them.

4.9 Evaluation of Potential DOT Strategies

The project team has developed a series of strategies and arrayed the various information collected about each strategy in order to assess the benefits, costs, risks and institutional barriers for each strategy. Exhibit 4-9 below provides this array.

Exhibit 4-10: Strategy Evaluation Array

Strategy	Economic Benefits and Theory	State DOT Experience	Contractor Experience	Statistical Evidence	DOT Risk	Institutional Barriers	Administrative and Other Costs
Start New Program	Reduces input factor risk	Positive	Positive	Mixed	Medium	Significant	Significant startup and admin costs & PAC payments
Add Additional Commodities	Reduces input factor risk	Positive	Positive	Mixed	Low	Medium	Minimal administrative costs, significant PAC payments
Lower Trigger Values	Reduces input factor risk	Positive	Positive	Positive	Low	Medium	Significant PAC payments
Add Opt-in Clause	Allows for lower bids during price de-escalation	Positive	Positive	Not available	Low	Low	Minimal administrative costs
Update Fuel Usage Factors	Reduces input factor risk	Positive	Positive	Not available	Low	Low	Minimal administrative costs
Change Method	Depends on method	Mixed	Mixed	Not available	Medium	Significant	Significant startup costs
Reduce Project Exclusions	Reduces input factor risk except short duration projects	Positive	Positive	Not available	Low	Low	Minimal administrative costs
Create National PAC Tool	Eliminates redundant costs	Positive	Unknown	Not applicable	Low	Low	Eliminates redundant costs
Switch to Insurance	Private market alternative to DOT self-insurance	Unknown	Unknown	Not applicable	High	Significant	Significant administrative cost
Switch to Stockpiling	Self-insurance but high carrying costs	Unknown	Negative	Not applicable	High	Significant	High commodity cost/risk

The array lists ten potential strategies. The following bullets describe each of these strategies in more detail. They include:

- **<u>Start a New Program:</u>** At present, three states DOTs do not have a PAC program and could add such a program. Local government entities could also add a program. In general, DOTs and contractors favor these programs and the risks inherent in these programs are low or average. However, start-up and administrative costs can be significant and DOTs could face substantial payouts. At the same time, DOTs may realize savings due to lower levels of added risk pricing, more competition and a more stable market.

- **<u>Add Additional Commodities</u>**: Several DOTs are considering adding new commodities to their PAC programs. The vast majority of states already employ PACs for fuel and liquid asphalt. States could develop PACs for commodities such as steel and stone/aggregate, although the smaller magnitude of price fluctuations may not justify the associated start-up and administrative costs of such a program. Many contractors suggested adding additional commodities. The benefits and risks are similar to adding a new program, however, startup costs will be low and the increase in ongoing administrative costs will be minor.

- **Lower Trigger Values**: Trigger values range from zero to over 20 percent. DOTs could lower higher trigger values. High trigger values may reduce the effectiveness of PAC programs, as contractors may still need to add a risk factor in pricing. For example, two states have fuel trigger values of 20 percent or more. If fuel prices were $3 per gallon a 20 percent rise would equal 60 cents. With average excavation prices in Tennessee at approximately $3.30 per cubic yard over the last two years, and approximately half a gallon used per cubic yard, contractors would face almost a ten percent increase in costs before reaching the trigger point. It is worth noting that the statistical model for Missouri showed that the price adjustment clause lowered average bid prices. Missouri was the only state tested that has a zero trigger value and the only state for which the statistical model provided consistently positive results for the price adjustment clause.

- **Add Opt-in Clause**: Opt-in clauses are available in about a third of the states. Additional states could add these policies. These clauses may allow contractors to decide when they need to participate. Where they have adequate storage or guaranteed prices from suppliers they could opt-out, reducing DOT costs and risk. Although not by any means likely, contractors could manipulate the system by opting-in during periods of rising prices and opting-out during periods of falling prices. With this in mind, the language of concerning the timing of the opt-in clause must be clear. Additionally, the accuracy of the opt-in clause may not be ideal if the opt-in occurs at project award rather than execution.

- **Update Fuel Usage Factors**: A current NCHRP study is developing updated fuel usage factors. States may choose to use new factors or add more factors. Many DOTs and contractors suggested developing updated fuel factors and adding more items. The more accurate the fuel usage factors, the more likely that the price adjustment clauses will fulfill their intended purpose.

- **Change Method**: Three quarters of responding states use fuel use per unit method. States can switch to or from this method. The fuel use per unit is likely to be easier to apply, thus reducing administrative cost. The availability of updated, more accurate fuel usage factors that cover more items would increase the desirability of using the fuel use per unit method. Alternatives to the fuel use per unit method are discussed in greater detail in the guidelines section.

- **Reduce Project Exclusions**: States exclude projects from their PAC programs for a variety of reasons including specific pay items, minimum pay item quantities, dollar thresholds, and short durations. These exclusions can be modified to include additional projects where warranted. Several contractors have suggested excluding less projects. Excluding projects can result in contractors adding contingencies to bids reducing the effectiveness of the PAC program.

- **Create National PAC Tool**: Several states have suggested the development of an FHWA tool or a tool with automated calculations and more nationally available indexes (see Exhibit 1-23). A national organization could create a national PAC tool and update it with indexes. This could reduce administrative costs at the state level and encourage the wider use of PAC programs.

- **Switch to Insurance**: A national, state or private insurance mechanism that reimbursed contractors for increases in materials costs could replace state DOT administered PAC programs. For funding, the insurance mechanism could charge a fee per unit of material used. The development of such a program would face substantial institutional barriers and isn't under consideration by any organization known to the project team.

- **Switch to Stockpiling**: States or contractors could purchase materials in advance to guarantee prices. Stockpiling of liquid asphalt is cost-intensive. Heated storage is required and rarely lasts beyond a month. Storage facilities, inventory carrying costs and environmental concerns (environmental regulations regarding fuel for example) can be significant issues. For the DOTs, quality assurance might become an issue as well.

State DOTs and highway construction contractors generally favor price adjustment clauses and generally believe that these clauses improve the stability of the market while reducing risk and providing benefits in terms of reduced prices and greater competition. State DOTs should carefully evaluate the opportunities to enhance and extend their programs. The results of this study can help DOTs in evaluating the options open to them. Available indices by commodity are offered in the guidelines section.

Conclusions

The most beneficial aspects of a PAC program include bid pricing and market stability. Both the contractor and DOT surveys confirm that PAC programs lead to lower and often more accurate bids by contractors. The statistical analysis performed on bid prices in Missouri corroborates these beliefs. Missouri is the only state analyzed by the study team that utilizes a zero trigger value and the only state to display a definitive correlation between contract payouts and lower prices. While this evidence from one state cannot constitute a broader conclusion, neither does it refute the possibility that zero trigger values lead to PAC improvements. PACs assuage contractor uncertainty in material pricing, leading to bidding confidence and improved stability in the market. On the other hand, factors such as administrative costs and political barriers may hinder PAC development.

Fuel and liquid asphalt PACs are utilized by more than 80 percent of states nationwide and are the most responsive to fluctuating prices. The widespread availability of price indices, the inability for contractors to control price, and the infeasibility of long-term storage further bolster the case for these PACs. Cement, steel and stone/aggregate PACs are less widely used. Although many of the contractors surveyed would support their inclusion, few DOTs are considering adding them. Justifications include historically stable prices of these materials and the ability to stockpile many of them for extended periods of time.

Approximately 75% of states utilize the fuel/indexed material use per unit method of PAC administration. This method is straightforward and largely nullifies the ability of concerned parties to manipulate the adjustment process. However, this method would benefit from updated fuel use factors. Other methods such as percent of cost and the invoice method are used sparingly, although the percent of cost method can be effective when a contract includes many lump sum items.

The study team in general recommends the use of price adjustment clauses as a cooperative means of improving construction estimating accuracy and lowering contractor risk. There is already substantial support for these programs among contractors and a majority of state DOTs employ PACs for fuel and asphalt cement. The majority of contractors surveyed believe that PACs provide added stability to the market while lowering risks for themselves, their subcontractors, and their suppliers. Likewise, a majority of state DOT respondents believe that PACs benefit both contractors and DOTs. Although more quantitative evidence from the bid item analysis would have benefited the study, in light of rising construction costs and volatile material pricing, initiation and efficient administration of these programs will have a net positive effect on the industry.

Section III: Guidelines

Guidelines for DOT Use of Indexing or Cost Escalation Clauses

The purpose of this document is to provide explicit guidelines DOTs may use to determine when conditions may warrant the use of price indexing or cost escalation clauses and to describe the key factors DOTs should consider and the decision-making process an agency might use. These guidelines also describe each of the attributes of these clauses and provide guidance as to where and when each attribute is effective and at what level to set them.

This guidance will include tools such as the "strategy evaluation array" that will allow the user to understand each strategy, its characteristics and its perceived and measured benefits and costs. The guidelines will also provide the decision-making process an agency might use to determine whether to use price indexing or cost escalation clauses for a particular project or program. The project team will identify best practices and highlight them.

The guidelines include six main sections:

- **Criteria for Implementing a PAC Program**: This section summarizes the benefits and risks of implementing a PAC program. This section also explores alternative strategies.

- **Criteria for Selecting Materials to Include in a PAC Program**: This section will assess the benefits and risks for each type of available material.

- **Criteria for Selecting PAC Program Method**: This section will assess the different PAC program methods that are available.

- **Criteria for Selecting the Attributes of a PAC Program**: Based on the selected materials, this section will outline the different attributes of each material item and the recommended options for each attribute (i.e. opt-in strategies, trigger values, project selection).

- **Best Practices and Recommendations**: This section will summarize the findings in the previous sections and make recommendations based on those findings.

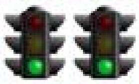
- **Sample PAC Program Specifications** The last section includes example specifications for the three PAC program methods that are currently in use by different state departments of transportation.

As a reference to the above method of developing guidelines, the documents from the 2009 International Supply Management Conference and the Bureau of Labor Statistics outline similar processes for developing price adjustment clauses.[42]

Criteria for Implementing a PAC Program

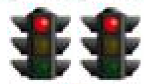
The first step an agency should undertake in the process of determining whether to implement a PAC program involves the analysis of the benefits and risks associated with implementation. Listed below are the factors that an agency needs to consider. Each item includes a rating indicating whether the factor is a benefit (Green Light) or a risk (Red Light). If the classification of the item depends on the circumstances, the guidelines rate it as a Yellow Light. The number of lights indicates the level of the benefit or risk.

 Large Benefit

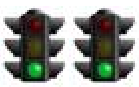
 Moderate Benefit

 Small Benefit

 Large Risk

 Moderate Risk

 Small Risk



<u>Bid Prices</u> –The results from both the DOT and Contractor surveys indicate a consistent belief that prices are lower when a PAC program is included in the contract. The statistical analysis for Missouri, which includes a zero-value trigger clause, indicated a consistent pattern of lower prices when a PAC program is utilized. The statistical results couldn't be replicated in states with non-zero trigger clauses. Lower bid prices will result in a direct savings to the project owner.

<u>Numbers of Bidders</u> –The survey results indicate a consistent belief that including a PAC program in a contract will result in an increase in the number of responsive bidders. Economic theory also indicates that the reduction in risk associated with the lack of "perfect information" will move the market toward the conditions required for "perfect competition."

<u>Bid Retractions</u> - Related to the number of bids is the potential for contractors to retract a bid, refuse to complete the work or simply fail in the face of sharply higher material prices. While several sources had cited anecdotal information on such cases, respondents did not generally report these possibilities as a major concern. Contractor default, therefore, does not appear to happen often, although when it does it may garner significant

[42] These documents can be found at http://www.ism.ws/files/Pubs/Proceedings/09ProcFD-Bendorf.pdf and http://www.bls.gov/ppi/ppiescalation.htm respectively.

attention and cause significant disruption.

Market Stability - Anecdotal evidence from state DOTs and construction contractors conveys their sentiment that PACs lead to greater overall stability in the market. Over three quarters of responding DOTs perceive a moderate to large benefit with PACs. A majority of contractors agree that the presence of PACs leads to lower priced bids. This decrease in uncertainty and increase in bidder confidence is a key explanation as to how PACs can increase the overall stability of the market.

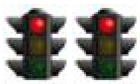
Supply Chain - Contractor - The use of PAC programs alters the relationships between these parties, affecting the risk each party faces and the ultimate profitability and stability of each level in the chain. In the absence of PACs, contractors will have to bear the increased costs of material inputs unless the contractors negotiate price commitments with suppliers or buy and store the commodity from the contract bid date. In contrast, with a PAC in place, contractors merely pass on the price increase of the commodity to DOTs. One exception is the case of residuals due to trigger values or inaccurate or mistimed adjustments.

Direct Cost – Periods of Price Fluctuations – The direct cost of a PAC program (as defined as the actual PAC payments to or receipts from the contractor) is a function of the price trends for different materials during the course of the contract. As would be expected, the direction of the material price changes will determine whether this is a positive or negative amount. Rising prices would increase pay outs to contractors, while falling prices would mean that the contractors would have to refund the DOT. Program design can also have an effect on the direct costs of the program (i.e. trigger values). If the PAC program does include an opt-out clause, the direct cost of the program can be affected if this clause is implemented.

Supply Chain - Supplier – The market power of the supplier can have an impact on the effectiveness of a PAC program. In cases where the supplier has a large amount of market power or little competition, the presence of a PAC program may lead to increased costs on indexed projects. Agencies may need to monitor material prices for indexed projects and non-indexed projects to ensure proper pricing.

Start Up Costs - Administrative burden is the most highly cited barrier to using and /or implementing a PAC program. However, according to survey results, the initial costs of implementing a program are relatively small in relation to program payments. They include the cost of purchasing indexes, setting up resources and procedures, and developing computer programs.

Administrative Costs - As with the start up costs, the survey results indicate that ongoing administrative costs of a PAC program are also relatively small from both the DOT and contractor side. Just as with the program costs, the administrative costs of maintaining the program are a function of program design. An agency can reduce administrative costs by tightening project eligibility and increasing trigger values. This reduces the number of projects and the frequency of payments and therefore reduces the number of person-hours required to maintain the program. Such changes, however, may have a negative impact on the overall plan effectiveness.



Political Barriers - Political and policy considerations can be a significant barrier in developing and implementing new policies and programs. However, the DOT survey did not indicate that this is a significant barrier. As each state has a unique set of rules and laws that govern the implementation of new specifications, each state will need to study the appropriate rules and limitations.

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Conclusion: An agency should consider each of the above factors when evaluating the benefits and costs of implementing a PAC program. The table below provides a framework for the analysis of the costs (weight) of each of the factors, which can vary depending on market and competitive conditions as well as the PAC program parameters. A completed table is shown in the Summary and Recommendations section beginning on page 110.

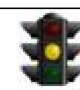
Benefit/Risk	Plus/Minus	Comments	Weight (1-10)
Bid Prices			
Number of Bidders			
Market Stability			
Bid Retractions			
Supply Chain			
Direct Costs			
Start-Up Costs			
Administrative Costs			
Political Barriers			

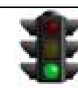
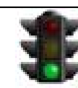
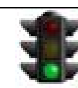
Once completed with data based on the user's unique situation, the above table will provide useful direction on implementing a PAC program. If an agency decides to move forward on the implementation of a PAC program, the remaining section of this report will provide guidelines on the materials to include as well as the attributes of the PAC program.

Criteria for Selecting Materials to Include in a PAC Program

Once an agency has made the determination to implement a PAC program, the next step involves selecting the materials to include in the program. Currently, the two most common materials included in PAC programs are fuel (41 states) and liquid asphalt (40 states). This section also considers cement, steel (structural), steel (other), stone (aggregate) and pipe. A separate table below for each commodity lists the criteria that agencies should consider in the decision to implement a PAC program for that material.

<table>
<tr><th>FUEL (Gas and Diesel)</th><th>Overall Rating</th><th></th></tr>
<tr><td>Availability of an Index</td><td>Indexes for fuel are readily available from many different sources inside and outside the industry. The ability to index by state and region is also available. Many state DOT’s currently publish fuel indexes as shown below:
<table>
<tr><td>Georgia</td><td>Georgia DOT Fuel Price Index
http://www.dot.state.ga.us/doingbusiness/materials/Pages/asphaltcementindex.aspx</td></tr>
<tr><td>North Dakota</td><td>North Dakota DOT Fuel Price Index
http://www.dot.nd.gov/roadreport/construction/rollingcost.pdf</td></tr>
<tr><td>Oregon</td><td>Oregon DOT Asphalt and Fuel Prices
http://www.oregon.gov/ODOT/HWY/ESTIMATING/asphalt_fuel.shtml</td></tr>
<tr><td>New York</td><td>NYSDOT Average Posted Prices for Fuel
https://www.nysdot.gov/main/business-center/contractors/construction-division/fuel-asphalt-steel-price-adjustments</td></tr>
<tr><td>General Price Index (AAA)</td><td>AAA National Average Price
http://www.fuelgaugereport.com/</td></tr>
<tr><td>U S Energy Information Admin</td><td>Gasoline and Diesel Fuel Update
http://www.eia.doe.gov/oog/info/gdu/gasdiesel.asp</td></tr>
<tr><td>Bureau of Labor Statistics</td><td>Producer Price Index, Commodities (Series WPU057303)
http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU057303&data_tool=XGtable</td></tr>
</table>
</td><td></td></tr>
<tr><td>Validity of the Selected Index</td><td>The widespread use of fuel and price data provides a large level of confidence in the values used in the indexing system.</td><td></td></tr>
</table>

Method for Measuring Quantities Used	Since fuel is not a contract item within most DOT contracts (there are a few exceptions), the agency must designate a method to calculate the quantities of fuel consumed during each adjustment period.	
Impact of Changing Prices	On highway construction projects, the operational cost of equipment is a large percentage of the overall cost of a project. Consequently, changes in fuel prices have a large impact to overall costs. The volatility of prices, especially over the last 2 years as shown in the graph, increases the risks to the contractors which increases the risk factors applied to prices. 	
Contractor's Ability to Control Price	Given the commodity nature of fuel, many users do not have the ability to control the prices paid for fuel except in the very short term. In addition, the ability to stockpile fuel for long periods becomes costly due to both infrastructure and inventory costs.	
Program Setup and Administration	The cost of implementing and maintaining a program is relatively small and agencies can automate much of the process by linking to the progress payment system. Tying more contract items to the fuel index will increase initial set-up costs, but once installed, the administrative cost differences should be minimal.	

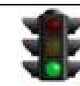
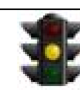
<table>
<tr><td>LIQUID ASPHALT</td><td>Overall Rating</td><td></td></tr>
<tr><td>Availability of an Index</td><td>Indexes for liquid asphalt, although not as prevalent as fuel, are available from many different sources. Many state DOT's currently publish asphalt indexes, for example:
<table>
<tr><td>North Carolina</td><td>http://www.ncdot.org/doh/operations/dp_chief_eng/constructionunit/paveconst/Asphalt_Mgmt/acprices/</td></tr>
<tr><td>Tennessee</td><td>http://www.tdot.state.tn.us/construction/indices/bituminousindex.pdf</td></tr>
<tr><td>Washington</td><td>http://www.wsdot.wa.gov/biz/construction/pdf/referencecosts.pdf</td></tr>
<tr><td>Bureau of Labor Statics</td><td>Producer Price Index, Commodities (Series WPU05810112)
http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU058&data_tool=XGtable</td></tr>
</table></td><td></td></tr>
<tr><td>Validity of the Selected Index</td><td>The overall consumption of liquid asphalt is linked more closely to the state highway construction program than fuel consumption. Consequently the validity of indexes must be more closely monitored than fuel indexes.</td><td></td></tr>
<tr><td>Method for Measuring Quantities Used</td><td>In most cases, the identification of the quantities used of liquid asphalt is easily obtainable from contract quantities. Some states separate the liquid amounts from the aggregate amounts to make this identification easier. Even with "mix" prices that include both liquid and aggregate, the component breakdown is relatively easily determined from mix designs and specifications.</td><td></td></tr>
<tr><td>Impact of Changing Prices</td><td>The most variable component of asphalt mix is the liquid asphalt component. All the other costs of the mix (aggregates and plant costs) are much less likely to change substantially during the course of a contract. The large price changes of petroleum products in 2008 and 2009 had a very large impact on the cost of producing asphalt mix for construction projects.</td><td></td></tr>
<tr><td>Contractor's Ability to Control Price</td><td>As with fuel, liquid asphalt is subject to the price fluctuation of all petroleum products. Also many users do not have the ability to control the prices paid for liquid asphalt except in the very short term and the ability to stockpile for long periods either becomes too costly or not feasible.</td><td></td></tr>
<tr><td>Cost of Administering Program</td><td>The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "indexed material use per unit" method.</td><td></td></tr>
</table>

CEMENT	**Overall Rating**	
Availability of an Index	Although less prevalent than fuel, there are indexes available for cement. Bureau of Labor Statistics: Producer Price Index, Commodities (Series WPU1322) http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU1322&data_tool=XGtable Connecticut DOT: http://www.ct.gov/dot/lib/dot/documents/dconstruction/cement_hist.pdf	
Validity of the Selected Index	The direct correlation of cement price indexes and the cost of concrete on highway construction projects is more difficult to make since cement is an indirect material (an input to the manufacturing of concrete).	
Method for Measuring Quantities Used	Concrete (the primary use of cement in a project) is incorporated into many different items within a highway contract. The quantity measurement for these items have many different units of measure (square feet of sidewalk, linear feet of concrete pipe, cubic yard of bridge concrete, square foot of retaining wall). The varying units of measure and class of concrete make measurement difficult.	
Impact of Changing Prices	Concrete is the main component of many items on a highway project (bridges, pipe, curb, and sidewalk). The impact of rising cement prices will increase the concrete price and ultimately have an impact on project cost. However, the variability of concrete prices has been much lower than other materials (especially during the 2008-2009 period of rapid price changes of other materials). 	
Contractor's Ability to Control Price	Due to the nature of the material, concrete cannot be stockpiled and the contractor is typically not the consumer of cement, they purchase the cement from the supplier as part of the concrete. Other than locking in the price of concrete from the supplier, the contractor has no method of reducing the risk of rising prices.	
Cost of Administering Program	The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "indexed material use per unit" method.	

<table>
<tr><td>STEEL - Structural</td><td>Overall Rating</td><td></td></tr>
<tr><td>Availability of an Index</td><td>Indexes for steel consumed on highway construction projects are less available than for other items such as fuel or liquid asphalt. The table below lists links to generic steel price indexes.
<table>
<tr><td>Bureau of Labor Statistics</td><td>Producer Price Index, Commodities (Series WPU1017)
http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU1017&data_tool=XGtable</td></tr>
<tr><td>Bureau of Labor Statistics</td><td>Producer Price Index, Commodities (Series WPU107)
http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU107&data_tool=XGtable</td></tr>
<tr><td>MEPS</td><td>North American Carbon Steel Price Index (With Individual Product Forecasts)
http://www.meps.co.uk/N.Amer%20Index.htm</td></tr>
</table></td><td></td></tr>
<tr><td>Validity of the Selected Index</td><td>The relationship of available steel indexes and the cost of steel on highway contracts is less direct than for other indexes. Steel is used in a very large variety of industries and in a large variety of types and grades.</td><td></td></tr>
<tr><td>Method for Measuring Quantities Used</td><td>The method of measurement of steel varies from state to state. Some states bid bridge structures or structural steel as a lump sum, linear foot, or pounds. Alternative PAC programs such as the "invoice method" may be required in certain cases such as when items are bid using lump sum.</td><td></td></tr>
<tr><td>Impact of Changing Prices</td><td>Structural steel is a large input cost for bridges. Changes in steel prices will have a large impact on the overall cost of the project.</td><td></td></tr>
<tr><td>Contractor's Ability to Control Price</td><td>Unlike other products where it is not practical to stockpile, steel can be stockpiled on projects. In many cases, prices for steel can be locked in with the supplier at the time the project is awarded.</td><td></td></tr>
<tr><td>Cost of Administering Program</td><td>The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "index material use per unit" method.</td><td></td></tr>
</table>

STEEL - Other	**Overall Rating**	
Availability of an Index	Indexes for steel consumed on highway construction projects are less available than for other items such as fuel or liquid asphalt. The previous section contains a table that lists links to generic steel price indexes.	
Validity of the Selected Index	The relationship of available steel indexes and the cost of steel on highway contracts are less direct than for other indexes. Steel is used in a very large variety of industries and in a large variety of types and grades.	
Method for Measuring Quantities Used	The method of measurement of steel (other than structural steel) varies from state to state. Some states bid steel by the pound (steel reinforcing bar) or by the linear foot (guardrail). In other cases the cost of steel is include in other items such as steel reinforced concrete pipe. With most steel purchases based on the pounds, there is some difficulty applying index values in some states.	
Impact of Changing Prices	Although price changes will have a direct consequence to overall project cost, the variability of prices for steel is less than other materials. In recent years contractors have encountered steel shortages causing prices to change rapidly and project schedules to be delayed.	
Contractor's Ability to Control Price	Unlike other products where it is not practical to stockpile, steel can be stockpiled on projects. In many cases, prices for steel can be locked in with the supplier at the time the project is awarded.	
Cost of Administering Program	The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "indexed material use per unit" method.	

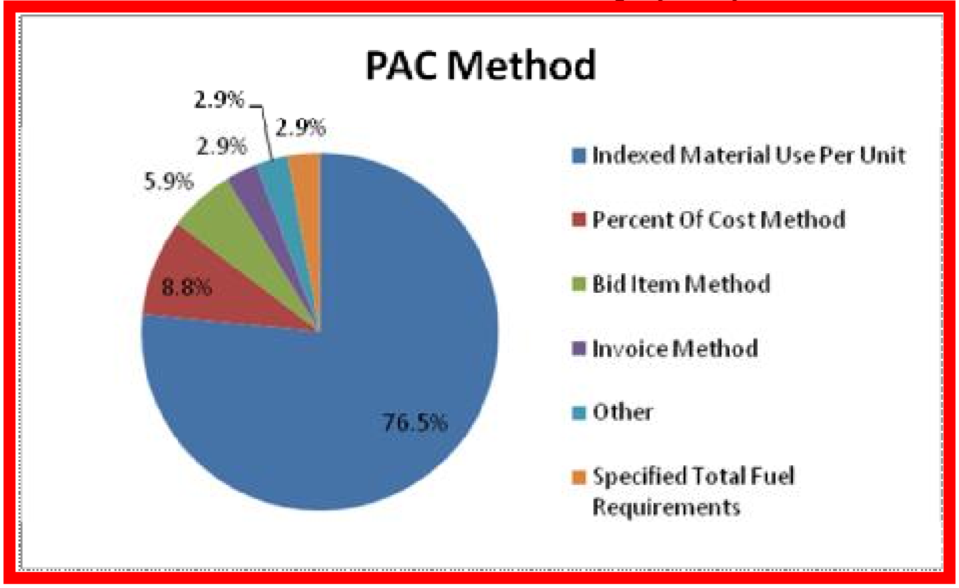
STONE (AGGREGATE)	**Overall Rating**	
Availability of an Index	The cost of stone will vary greatly from location to location. The differing material types also increase the difficulty in creating and maintaining an index. Bureau of Labor Statistics — Producer Price Index, Commodities (Series WPU1321) http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?series_id=WPU1321&data_tool=XGtable	
Validity of the Selected Index	Once an index is selected, it would be difficult to determine the relationship of the index to the actual costs on a project. Variables such as haul distance and material type vary greatly.	
Method for Measuring Quantities Used	The measurement of quantities used on a project is easily determined since most stone items are contract items and paid on a per ton basis. A simple conversion from tons to cubic yards can be quickly performed by states that bid these items in cubic yards.	
Impact of Changing Prices	Although price changes will have a direct consequence to overall project cost, the variability of prices for stone is relatively small compared to other materials.	
Contractor's Ability to Control Price	Stone can be stockpiled (and paid) on projects therefore allowing the contractor to minimize the risk of price changes until the material is used. In many cases, prices for stone can be locked in with the supplier at the time the project is awarded.	
Cost of Administering Program	The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "fuel use per unit" method.	

PIPE	**Overall Rating**	
Availability of an Index	The ability to obtain an index for pipe is compounded by the many sizes, classes and types of pipe.	
Validity of the Selected Index	Once an index is selected, it would be difficult to determine the relationship of the index to the actual costs on a project. Variables such as pipe type, size and raw material costs as well as material type vary greatly.	
Method for Measuring Quantities used	The measurement of quantities used on a project is easily determined since most pipe items are contract items and paid on a per linear foot basis.	
Impact of Changing Prices	Fluctuation in the price of pipe is small compared to other construction items. Price changes will have a direct affect on project cost.	
Contractor's Ability to Control Price	Pipe can be stockpiled (and paid) on projects therefore allowing the contractor to minimize the risk of price changes until the material is used. In most cases prices for pipe can be locked in with the supplier at the time of project is awarded.	
Cost of Administering Program	The cost of implementing and maintaining a program is relatively small and much of the process can be automated by linking to the progress payment system, which is based on the quantities of work performed during the pay period. This same quantity is used to calculate PAC payments for PAC programs utilizing the "fuel use per unit" method.	

Criteria for Selecting a PAC Program Method

Once the decision to implement a PAC program has been made and the materials to include have been determined, the next decision to be made is to select the type of program to implement. There are a number of different programs to choose from, but as the graph below indicates, the "Indexed Material Use per Unit" method is by far the most common method currently in use.

Guidelines Exhibit 1.1: PAC Methods Employed by State DOTs



Indexed Material Use per Unit
This method for calculating price adjustments is by far the most common method used by DOTs (over 75% of current programs use this method). This method is also difficult to manipulate to the advantage of one party or the other. The only variable input is the quantity of work performed in a pay period. All the other factors are outlined in the specifications.

The limitation of this method is the fuel use factors specified in the contract documents. Over 75% of the DOT respondents and 60% of the contractor respondents desire updated fuel use factors.

Price adjustments are determined by the quantity of work performed on various bid items as outlined in the specifications. Fuel-intensive bid items are assigned a "fuel use factor." The fuel use factor is specified in gallons per unit of payment (example: gallons per cubic yard of excavation). An example of calculating the payment is shown in Appendix C. For other indexed materials, the measurement will be directly to the bid item (example, pounds of steel, tons of asphalt or cubic yards of stone).

The Tennessee provision for fuel use per unit is provided in Appendix C as an example of how such systems are implemented.

Percent of Cost Method
In states that utilize a number of lump sum items, the percentage of cost method is an alternative to the "Indexed Material Use Per Unit" method. There are a number of states that utilize lump sum bidding for many structure items.

Contractors are required to complete an affidavit in order to establish the appropriate fuel or material cost percentage. This opens up the possibility of manipulation. One state (CT) specifies the value of fuel cost as a percentage of the contract amount (1.5%). Specifying the percentage eliminates the need for a contractor supplied affidavit that some states require. However, the problem with specifying the percentage is that the material cost for a project will change depending on the mix of work within a project. For example, a project with large amounts of grading will have a much larger percentage of fuel cost than a project with a large dollar value of structures.

Once the percentage is determined, the formula applied is similar to the formula shown in the Tennessee DOT fuel use per unit provision on page 20. North Dakota utilizes a percent of cost price adjustment as well. Their fuel cost adjustment formula is provided below. Their specifications list the following formula (FCA= fuel cost adjustment):

FCA = Fuel Ratio x Estimate x (Cost Change +/- 0.10)

The above formula shows a 10% trigger value. The cost change can only be applied if the change in fuel cost exceeds ten percent. The percentage is determined by the state DOTs or by a contractor supplied affidavit.

The method of measurement of this method is simply a matter of multiplying the current pay estimate value by the predetermined percent of cost. This value is then compared to the index values. Appendix C gives an example of this computation.

The Connecticut provision for implementation of the percent of cost method is provided in Appendix C.

Invoice Method
Just as with the "Percent of Cost" method, states that utilize a number of lump sum items, the "Invoice Method" is also an alternative to the "Indexed Material Use Per Unit" method. There are a number of states that utilize lump sum bidding for many structure items.

In order to establish the appropriate material used on a project, this method requires the submission of actual purchase invoices for the material which can lead to contractor manipulation of the system. In addition, proper controls would need to be implemented to ensure the invoiced material is actually used on the indicated project.

The method of measurement for the invoice method relates directly to the invoice amounts supplied by the contractor for the time period invoiced.

NOTE: Although two respondents indicated they use this method, further research of the specifications show that both these states (CT and WY) actually use the "Percentage of Cost" method so no current examples of specifications are available for this method. Additionally, the New York price adjustment for iron and steel was considered as an example of an invoice method for price adjustment. Their methodology is very similar to their fuel and liquid asphalt adjustment clauses. There is an index value that is monitored and only paid when the index changes by more than a specified percentage (in this case 5%) from the bid index. The formula used in all three specifications is the same. It appears that the term “invoiced” as used in the specifications connotes determining the quantity of steel used that will be input into the price adjustment calculation.

Bid Item Method

This method is used by creating a bid item for fuel cost for the project and the bidder enters a value from zero up to the maximum amount designated by the owner.

This option is currently used by the Alabama DOT on specified projects. The benefit of this method is the low administrative costs associated with maintaining the program as well as the flexibility of the system for the contractor to determine their participation level by changing the price they bid on the item.

This method does require the DOT establish a maximum bid price for each project, so a method of calculating the maximum bid amount must be developed and this amount should vary depending on the project work mix.

NOTE: Although two respondents indicated they use this method, further research of the specifications show that one (NV) uses the “Indexed Material Use Per Unit” and the other (UT) uses the “Percentage of Cost” method. The one “Other” respondent (AL) actually uses this method.

The method of measurement for the bid item method is similar to the percent of cost method. The percentage paid on the bid item is equal to the percent completion of the project for the current estimate period. Appendix C gives an example of this computation.

The Alabama DOT bid item method specifications are provided in Appendix C.

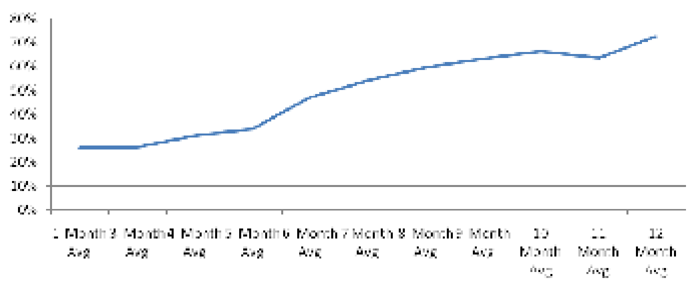
Specified Total Fuel

In this method, the state DOT will set an amount of fuel to be used on a project. A fuel allocation schedule is then created that details the estimated amount of fuel used at each point of the construction process. The percent of fuel used to date is then applied to the total estimated fuel needed after the completion of each increment of work. This method is not currently used by any DOT’s. Although one respondent indicated they use this method, further research of the specifications show that they (CO) actually use the “Indexed Material Use Per Unit” method.

Criteria for Selecting the Attributes of a PAC Program

The next step in implementing a PAC program is for the agency to determine program attributes or specifications. According to economic theory, “perfect information” is one of the conditions required for “perfect competition.” While it is virtually impossible to predict future commodity prices, the PAC program mimics the spot market for a commodity by adjusting prices to reflect current conditions. From this perspective, it would be preferable to have zero trigger values, no opt-in/opt-out clauses, or exclusions based on project duration or size. However, agencies must temper economic theory related to perfect competition with the realities of start-up and administrative costs. A small trigger value, preferably 5 percent or less, can reduce the risk to contractors associated with escalating prices. Opt-in/opt-out provisions can increase flexibility in cases where contractors are willing to assume risk. Excluding small projects or projects with short duration can reduce number of payments while still protecting contractors.

Recommendations for PAC Provisions

PAC Provision	**Additional Information**	**Recommended Values/Actions**
Trigger Value	Trigger values in existing programs range from zero to over 20 percent. Lower trigger values will increase the costs of administrating the program as well as the actual program costs. With lower trigger values, the likelihood of program payment increases. However, lower trigger values also will decrease any risk premium that may be included in the pricing. Conversely, higher trigger values may reduce the effectiveness of PAC programs, as contractors may still need to add a risk factor in pricing. It is worth noting that the statistical model for Missouri showed that the price adjustment clause lowered average bid prices. Missouri was the only state tested that has a zero trigger value and the only state for which the statistical model provided consistently positive results for the price adjustment clause.	0% - 10% (plus or minus)
Opt In / Opt Out Provisions	Opt-in clauses are available in about a third of existing programs. These clauses may allow contractors to decide when they need to participate. Where they have adequate storage or guaranteed prices from suppliers they could opt-out, reducing DOT costs and risk.	Exclude
Project Duration	Shorter duration projects pose less of a risk of changing material prices and therefore benefit less than projects longer in duration. In most cases, material prices can be locked in for terms of 6 months or less. The longer the project duration, the less likely the contractor has the ability to lock in prices. In addition, the cost to administer a PAC program will increase for shorter duration projects in that the start-up costs have a larger impact. The following chart shows the likelihood of experiencing a 5% or greater variation in index prices by length of contract.  (Source data: TN DOT Liquid Asphalt Index Jan 2000 to Aug 2010).	6 Months or Longer
Project Size	Although there is some correlation to project size and project duration, the impact of price changes is more related to duration than size. A relatively small contract that extends over a longer period of time is much more at risk of price change impact than a large, short duration project. Therefore an attribute based on project size may not be valid.	No recommendation

Summary and Recommendations

This last section summarizes the findings in the previous sections and makes recommendations for implementing a PAC program. The actual criteria for a specific state will vary depending on many factors within each agency, but general recommendations can be made.

PAC Program Risk Benefit Analysis

Based on the analysis conducted as part of this study, the project team recommends the use of Price Adjustment Clauses (PAC) programs as a general policy. Circumstances within an agency may alter the conclusions in the table shown below. Individual agencies may wish to reassess the benefits and risks of each of the following items based on their own unique circumstances.

Item	Comments	Weight (1-10)	Effect
Bid Prices	One of the more important considerations in the study. Although there is little statistical evidence to corroborate the link between a PAC program and bid prices, there is substantial anecdotal and economic evidence as outlined in the study.	+9	Strongly Positive
Number of Bidders	In periods of large material price fluctuations, the use of a PAC program can have an impact on the number of bids; however, in normal market conditions this impact would be minimal.	+2	Moderately Positive
Market Stability	As with bid prices, the market stability aspect of a PAC program is a large reason for implementing a program. Both owners and contractors responded that this is a large benefit of PAC programs.	+8	Strongly Positive
Bid Retractions	There is little evidence to support the concept of bids being retracted due to not having a PAC program. Other than extreme examples of material price fluctuations,	0	Neutral

	normal market conditions would imply that this is a "non-issue."		
Supply Chain	The supply chain benefit in many cases will have a minimal impact on the overall effectiveness of a PAC program.	+2	Moderately Positive
Direct Costs	The direct cost analysis varies greatly based on the movement of material prices during the program period. In periods of rising prices, the direct cost of the program far outweighs all the other costs of the program. During periods of falling prices this item can have a slight to moderate benefit.	-5	Negative
Start-Up Costs	Although there are costs to start up a PAC program, these are typically relatively small and "one time" costs.	-2	Slightly Negative
Administrative Costs	The administrative costs of implementing a system are relatively low.	-3	Slightly Negative
Political Barriers	Given the general acceptance of PAC programs in many states, barriers to implementing a PAC program should be low in most cases.	-1	Slightly Negative
TOTAL		**+10**	**Moderately Positive**

Materials to Include

Individual agencies will need to select materials for which they will provide a price adjustment clause along with a discussion of the underlying rationale. The recommendations assume that there are contract provisions to pay for stockpiled materials. If this provision is not available, then some of the recommendations may change, specifically the recommendations for steel.

Material	Comments	Include
Fuel	The relative broad availability of indexes, the widespread use by many agencies make the implementation of a PAC program for fuel an effective tool. In addition, the commodity pricing and lack of ability to lock in or stockpile fuels adds to the need for the PAC program.	YES
Liquid Asphalt	As with fuel, the commodity pricing and lack of ability to lock in or stockpile liquid asphalt creates a need for the PAC program. Although many indexes are available, the development of a local index is important to the success of the program.	YES
Cement	Although a commodity similar to fuel and liquid asphalt, the pricing of cement is historically much more stable than the others. The ability to stockpile concrete, of which cement is a major ingredient, doesn't exist. There still seems to be a large percentage of contacts where the price can be locked in reducing the need for a PAC program.	NO
Steel - Structural	Even in agencies that bid structural steel in easily tracked units of measure (e.g. pounds), the contracting methods used by contractors reduce the effectiveness of a PAC program for steel. In addition the ability to stockpile materials reduces the need for a PAC program.	NO
Steel - Other	The many methods of measuring quantities of steel along with the contracting methods used by contractors reduce the effectiveness of a PAC program for steel.	NO
Stone	The ability to create an index that would reflect the very location driven markets for stone make the implementation of a PAC program difficult. In addition, the contracting methods used by contractors and the ability to stockpile materials make the benefit of a PAC program minimal.	NO
Pipe	Lack of accurate indexing and the relatively small impact of changing prices reduce the effectiveness of a PAC program for pipe. In addition, as with stone, the contracting methods and the ability to stockpile materials make the benefit of a PAC program minimal.	NO

PAC Program Methods and Attributes

Individual agencies opting to have a PAC program will need to select the methods and attributes of that program. These methods and attributes will determine how adjustments are calculated, the value of the adjustment and the contracts to which they will apply.

PAC Method	Comments	Recommended
Indexed Material Use Per Unit	This method is the most commonly implemented system. It establishes the indexing method, use factors and attributes in the contract. Also, there is little ability to manipulate the system. This method is recommended where possible.	YES/ Unit Bid Items
Percent of Cost	Where there exist many lump sum items in a contract, the use of a percent of cost method is the second best alternative. It is not recommended where the "Indexed Material Use per Unit" method can be applied.	YES/ Lump Sum Items
Index for Fuel	Fuel, being a commodity, has a large market area for prices. However, there are regional fluctuations that can cause short term price fluctuations in certain areas. Developing an index linked to the Bureau of Labor Statistics is a starting point, but developing a state or regional index should be the goal of the PAC program.	YES
Index for Liquid Asphalt	Liquid asphalt is similar to fuel in that it is a readily available commodity. However the regional variations in price are much more pronounced than for fuel so developing a statewide index is needed.	YES
Trigger Value	The lower the trigger value, the more effective the index is for stabilizing the market as well as the increased likelihood of reduced bid prices. The drawbacks of a zero trigger value are increased administrative burdens and direct costs.	NO
Opt In/Opt Out	In periods of decreasing prices, the	NO

	likelihood of opting out of the program is much greater than in period of rising prices. This makes the cost of the program higher in that there are fewer periods where contract dollars are returned to the owner.	
Project Duration	Based on the low percentage of projects that have durations of six (6) months or less where the material prices change significantly, the overall program and administrative costs can be reduced by eliminating short duration projects.	6 Months and Longer
Project Size Limits	Although there is some correlation to project size and project duration, the impact of price changes is more related to duration than size.	NO
Percent of Cost	When using the percent of cost method, there are two methods to calculate the percent to use within the contract: DOT specified and Contractor affidavit of fuel cost. The DOT specified method requires the internal estimate of fuel consumption either on a statewide basis or a contract basis, both requiring detailed processes to calculate.	AFFIDAVIT

Appendix A: State DOT Survey Questions

National Cooperative Highway Research Program - State DOT

1. General Information

* **Please enter your contact Information:**

* **Does your DOT use Price Adjustment clauses?**

- ◯ Yes
- ◯ No

National Cooperative Highway Research Program - State DOT

2. Current Program

* **Approximately what percent of contracts include price adjustment clauses?**

* **On what basis can projects be excluded from the price adjustment clause?**

- ☐ Only Designated Projects
- ☐ All Projects

Please explain

* **Please check the items for which your state currently utilizes price adjustment clauses:**

- ☐ None
- ☐ Fuel
- ☐ Liquid Asphalt

National Cooperative Highway Research Program - State DOT

3. Current Program Costs

Approximately how many man-hours per MONTH does the DOT spend on administrating the price adjustment clause program?

Please list any other costs and dollar amounts associated with implementing and maintaining the price adjustment clause program? (examples: subscription costs ($500 /month), publications ($750/month)):

What are the contract payments (and returns) from price adjustment clauses for each year?

These Numbers are:

National Cooperative Highway Research Program - State DOT

4. Fuel Price Adjustment Clause

What Method of FUEL price adjustment clause does your DOT use?

Would the availability of UPDATED fuel usage factors improve your fuel price adjustment clause program?

- ◯ Yes
- ◯ No

Would the availability of ADDITIONAL fuel usage factors improve your fuel price adjustment clause program?

- ◯ Yes
- ◯ No

National Cooperative Highway Research Program - State DOT

5. Perceptions

* Please select the level of **BENEFIT** from implementing a price adjustment clause program for each of the following categories:

	No Benefit	Small Benefit	Moderate Benefit	Large Benefit
Increased Number of Bidders	○	○	○	○
[illegible]	○	○	○	○
Better Pricing	○	○	○	○
[illegible]	○	○	○	○
[illegible]	○	○	○	○

Other Benefits (please list)

* **Has your opinion changed as to the NEED for price adjustment clauses since the large price fluctuations in 2004 (steel, cement and apshalt) and 2008 (fuel and asphalt)?**

- ○ No Change
- ○ More Need
- ○ Less Need

Please Explain

* **Has your opinion changed as to the BENEFITS of price adjustment clauses since the large price fluctuations in 2004 and 2008?**

- ○ No Change
- ○ More Benefits
- ○ Less Benefits

Please Explain

National Cooperative Highway Research Program - State DOT

* **Please rate the level of BENEFIT of your states price adjustment clause program for each of the commodities listed below:**

	No Change	No Benefit	Small Benefit	Moderate Benefit	Large Benefit
Fuel	○	○	○	○	○
Liquid Asphalt	○	○	○	○	○
[illegible]	○	○	○	○	○
Steel	○	○	○	○	○

* **Please rate the level of BENEFIT for each of the groups listed below:**

	No Benefit	Small Benefit	Moderate Benefit	Large Benefit
[illegible]	○	○	○	○
Prime Contractors	○	○	○	○
Subcontractors	○	○	○	○
[illegible]	○	○	○	○
[illegible]	○	○	○	○

Others that Benefit

National Cooperative Highway Research Program - State DOT

6. Future Plans and Changes

Please check the items that your state is considering adding price adjustment clauses to in the future:

- ☐ Fuel
- ☐ [illegible]
- ☐ [illegible]
- ☐ Steel - Structure
- ☐ Steel - Other
- ☐ [illegible]
- ☐ Concrete
- ☐ Other (please list and explain)

Please check the items that you perceive are BARRIERS to implementing and using a price adjustment clause program (check any/all that apply):

- ☐ Administrative burden
- ☐ Cost of payments don't justify benefits
- ☐ Crediting policy (DOT)
- ☐ State Laws/Regulations
- ☐ DOT Leadership
- ☐ Contractor Resistance to Price Adjustment Clauses
- ☐ Availability of fuel usage factors
- ☐ Legislature (Political)
- ☐ Other (please list and explain)

National Cooperative Highway Research Program - State DOT

If your state does NOT utilize price adjustment clauses for specific items, please explain why:

Fuel

Liquid Asphalt

Cement

Steel

* **Are there any improvements that can be made to the current price adjustment clause program?**

- ○ No
- ○ Yes, Please Explain

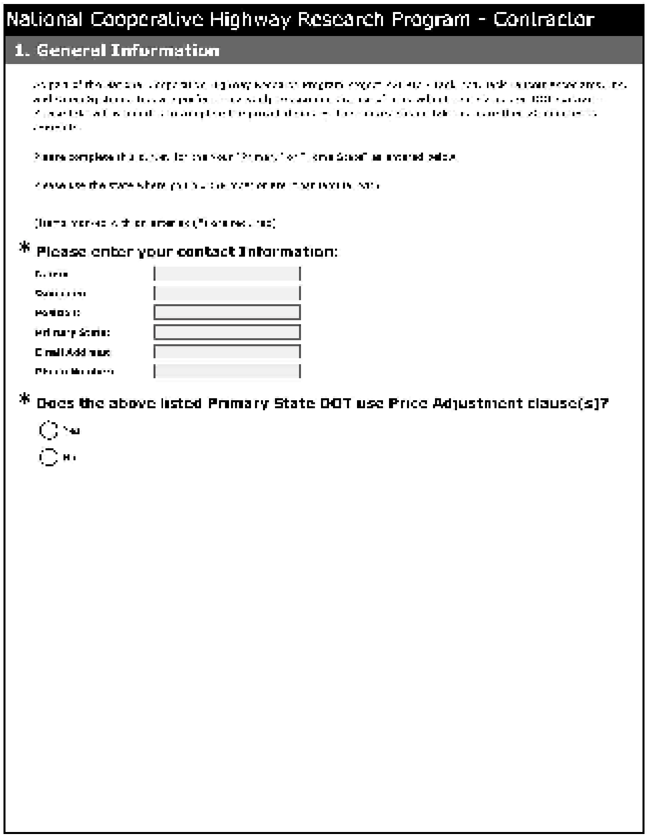
7. Conclusion

Is there any other information you would like to provide about Price Adjustment Clauses?

* **I am interested in participating in a more detailed interview regarding my responses.**

- ○ Yes
- ○ No

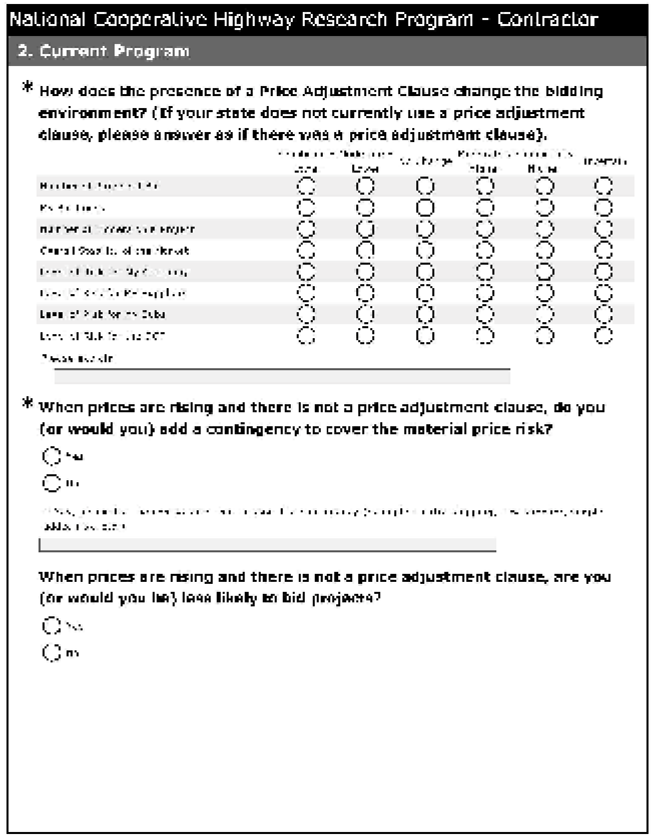
Appendix B: Contractor Survey Questions


National Cooperative Highway Research Program - Contractor

1. General Information

* Please enter your contact information:

* Does the above listed Primary State DOT use Price Adjustment clause(s)?

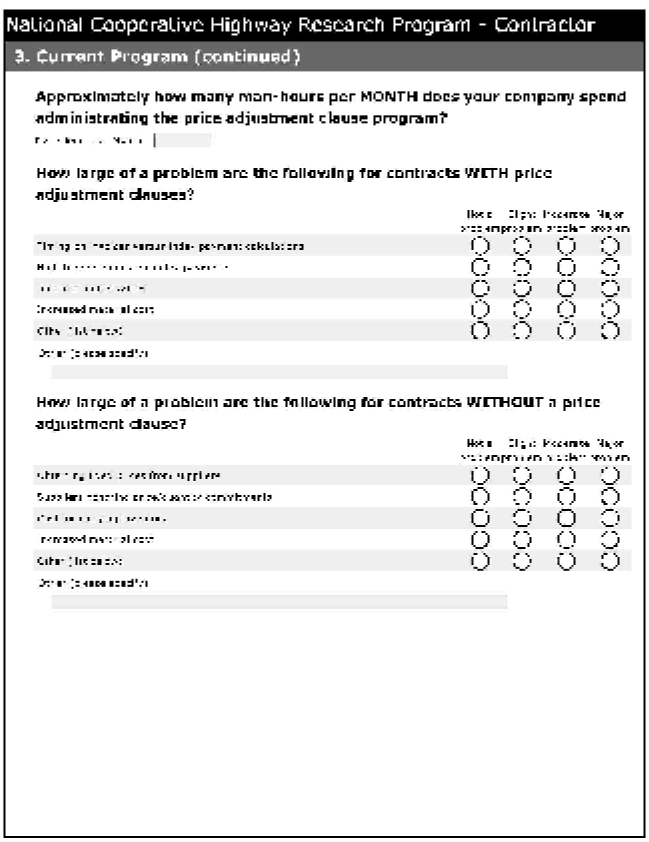

National Cooperative Highway Research Program - Contractor

2. Current Program

* How does the presence of a Price Adjustment Clause change the bidding environment? (If your state does not currently use a price adjustment clause, please answer as if there was a price adjustment clause).

* When prices are rising and there is not a price adjustment clause, do you (or would you) add a contingency to cover the material price risk?

When prices are rising and there is not a price adjustment clause, are you (or would you be) less likely to bid projects?

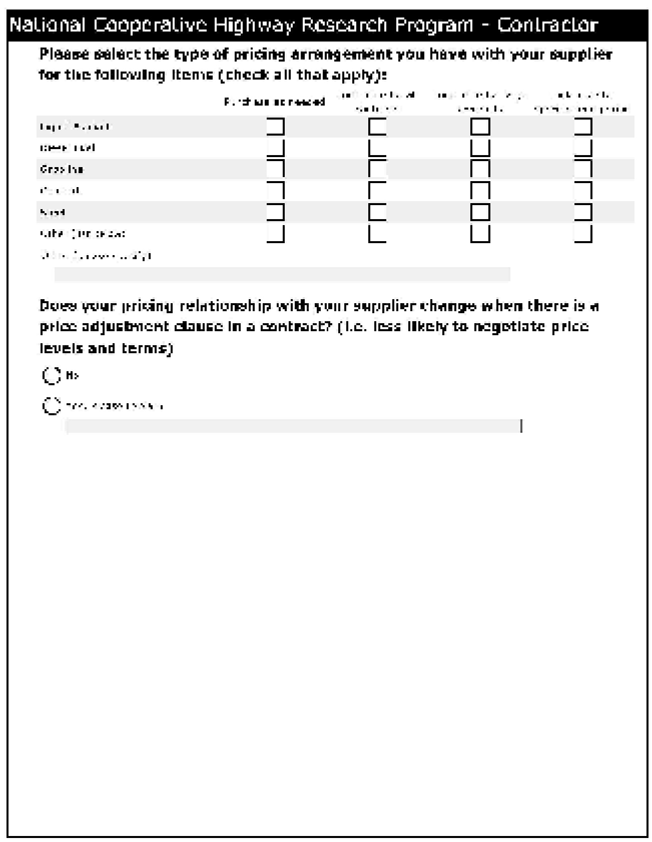

National Cooperative Highway Research Program - Contractor

3. Current Program (continued)

Approximately how many man-hours per MONTH does your company spend administrating the price adjustment clause program?

How large of a problem are the following for contracts WITH price adjustment clauses?

How large of a problem are the following for contracts WITHOUT a price adjustment clause?


National Cooperative Highway Research Program - Contractor

Please select the type of pricing arrangement you have with your supplier for the following items (check all that apply):

Does your pricing relationship with your supplier change when there is a price adjustment clause in a contract? (i.e. less likely to negotiate price levels and terms)

National Cooperative Highway Research Program - Contractor

4. Fuel Price Adjustment Clause

What method of FUEL price adjustment clause does your DOT use and which do you prefer?

	Fuel Use Per Unit	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	○	○	○	○	○
[illegible]	○	○	○	○	○

If your state uses the "Fuel Use Per Unit" option, what changes to this method would you like to see (please check all that apply):

- [ ] [illegible]
- [ ] [illegible]
- [ ] [illegible]
- [ ] [illegible]
- [ ] Other (please specify)

National Cooperative Highway Research Program - Contractor

5. Perceptions

* **Has your opinion changed as to the NEED for price adjustment clauses since the large price fluctuations in 2004 (steel, cement and apshalt) and 2008 (fuel and asphalt)?**

- ○ No Change
- ○ More Need
- ○ Less Need

Please Explain

* **Has your opinion changed as to the BENEFITS of price adjustment clauses since the large price fluctuations in 2004 and 2008?**

- ○ No Change
- ○ More Benefits
- ○ Less Benefits

Please Explain

* **Please rate the level of BENEFIT of an adjustment clause program for each of the commodities listed below:**

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fuel	○	○	○	○	○
Liquid Asphalt	○	○	○	○	○
Cement	○	○	○	○	○
Steel	○	○	○	○	○

National Cooperative Highway Research Program - Contractor

* **Please rate the level of BENEFIT of an adjustment clause program for each of the groups listed below:**

	No Benefit	Small Benefit	Moderate Benefit	Large Benefit
[illegible]	○	○	○	○
[illegible]	○	○	○	○
Subcontractors	○	○	○	○
Suppliers	○	○	○	○
Other (specify below)	○	○	○	○

[illegible]

6. Future Plans and Changes

Please check the items for which your state currently uses a price adjustment clause and check the items for which you would like to see a price adjustment clause added:

	[illegible]	[illegible]
Fuel	○	○
Liquid Asphalt	○	○
Cement	○	○
[illegible]	○	○
Steel - [illegible]	○	○
[illegible]	○	○
Concrete	○	○
Other (specify)	○	○

[illegible]

If you are NOT in favor of price adjustment clauses, please explain why:

Fuel

Liquid Asphalt

Cement

Steel

* **Are there any improvements that can be made to the current price adjustment clause program?**

- ○ No
- ○ Yes, Please Explain

National Cooperative Highway Research Program - Contractor

7. Conclusion

Is there any other information you would like to provide about Price Adjustment Clauses?

* **I am interested in participating in a more detailed interview regarding my responses.**

- ○ Yes
- ○ No

OMAN SYSTEMS, INC.

Jack Faucett Associates

Appendix C: Sample PAC Programs

The next few pages outline three different sample PAC program specifications.

EXAMPLE #1 – Fuel/Indexed Material Use per Unit Method
The first example is from the Tennessee DOT which utilizes the "Fuel/Indexed Material Use per Unit" method for specified pay items and a 5% trigger value.

EXAMPLE #2 - Bid Item Method
The second example is from the Alabama DOT which utilizes the "Bid Item" method where the DOT creates a pay item in the contract for the fuel used on the project with a maximum bid amount. The contractor can "Opt Out" of this program by bidding the pay item at zero.

EXAMPLE #3 - Percent of Cost Method
The last option is from the Connecticut DOT which utilizes the "Percent of Cost" method. In this example, the DOT specifies the percentage of the contract amount that will be used to calculate the fuel cost (in this case 1.5%). The fuel cost is then compared to the index value and a 5% trigger value is used.

EXAMPLE #1 - Fuel Use per Unit Method

SP109A **SP109A**

Sheet 1 of 4

STATE OF TENNESSEE

(Rev. 10-01-06) March 1, 2006
(Rev. 11-03-08)

SPECIAL PROVISION

REGARDING

PAYMENT ADJUSTMENT FOR FUEL

This special provision covers the method of payment adjustment for fuel price increases or decreases. Payment adjustments will be made in monthly increments based on the estimated fuel consumed on major items of work, the estimated price per gallon of fuel at the time of letting, and the percentage change of the Producer Price Index for Light fuel oils, Series ID Number WPU0573, published by the U.S. Department of Labor, Bureau of Labor Statistics.

The estimated price per gallon of fuel for this contract is $ 1.47 .

The May, 2009 Price Index (Ib) for light fuel oils shall be used for this contract. Adjustments will be based on the price index in effect for the month in which the item was installed.

Fuel consumption for payment adjustment shall be based on the following:

Item Number	Description of Work	Gallons per unit	Unit of measure
203	Any Road and Drainage Excavation	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.36	Cubic Yard
203	Any Borrow Excavation (Other than Solid Rock)	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.16	Ton
203	Any Borrow Excavation (Other than Solid Rock)	0.11	Ton
203-05	Undercutting	0.25	Cubic Yard
203	Any Embankment (in-place)	0.25	Cubic Yard
303, 309, 312	Any Aggregate Base	0.79	Ton
313, 501	Treated Permeable Base or Lean Concrete Base	0.10	Square Yard
307	Any Bituminous Plant Mix Base (HM)	2.98	Ton
411	Any Bituminous Concrete Surface (HM)	2.98	Ton
501	Any Portland Cement Concrete Pavement		
	≤ 10 in. thickness	0.25	Square Yard
	> 10 in. thickness	0.30	Square Yard

No payment adjustment for fuel shall be made on any item of work which is not listed above.

No payment adjustment for fuel shall be made unless the price index varies five percent or more from the index indicated in this Special Provision.

SP109A **SP109A**

Sheet 2 of 4

Where the price index varies five percent or more, the payment adjustment will be made as follows:

$$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$$

Where:

PA =Payment Adjustment (may be plus or minus)
Ic =Index for Current Month
Ib =Index for Bidding
Fe =Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [∑ (Pay quantity x Gallons per unit)= Fe]
Fp = Fuel Price for Bidding

Payment adjustment errors on items of work which have occurred because of quantity errors in previous months for which the time period in which the work was performed cannot be established will be rectified on a subsequent estimate according to the following formula:

$$Fa = \sum [(Fq \div Pq) \times Ea] - Ea$$

Where,

Fa = Final Adjustment (Item of work)
Fq = Final Quantity of work
Pq = Total Quantity of work on previous estimates
Ea = Total amount paid on previous estimates for Fuel Adjustment for this Item of work

The Project Engineer will compute the payment adjustment for fuel on work sheets similar to the ones attached and will furnish a copy of the calculations upon request to the prime contractor and approved subcontractors.

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Supplemental Agreement, all payment adjustments for fuel will discontinue, except that when the current price indexes are less than the price index for bidding, payment adjustments will continue to be made.

Payment Adjustment for fuel will be made under:

SP109A **SP109A**

Sheet 3 of 4

Monthly Payment Adjustment for Fuel Worksheet

Project No.______________________ Contract No.__________________

County___________________________

Fuel Price (Fp)__________Price Index Bidding (Ib)_________Current Price Index (Ic) _____

Estimate Period: Work Performed_______________Adjustment Paid________________
(Month/Yr)

Item	Unit	Quantity		Fuel Factor		Total Fuel
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________
_________	____	________	x	________	=	______________

Total Fuel for Month (Fe)____________________

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

SAMPLE SPREADSHEET TEMPLATE

Using the formulas in the above specifications, the following spreadsheet can easily be created to calculate the actual price index for each period. Once the project template has been created, then the only inputs to the table are the quantities of each item placed in the pay period.

Department Of Tranportation
Fuel Price Adjusment Clause

Project ID:	**CNJ298**
Description:	**WILLIAMSON COUNTY**
Letting Date:	**7/21/2010**
Pay Period:	**7/1/2010 to 7/31/2010**

Index (Bid Date)	**2.79**	
Index (Current Month)	**2.65**	
Trigger Value:	5.00%	
Actual Variance:	-5.02%	DEDUCTION

Totals Gallons:		**27,438**
Price Adjustment:	**$**	**(3,841.25)**

Pay Item	Description	Placed Quantity	Unit	Gal/Unit	Gallons
203-01	Unclassified Excavation	**5,000**	C.Y.	0.25	1,250
203-02	Borrow Excavation (Solid Rock)	**4,500**	C.Y.	0.36	1,620
303-01	Mineral Aggregate (Type A Base)	**12,000**	TONS	0.79	9,480
307-01.01	Bituminous Plant Mix Base	**5,000**	TONS	2.98	14,900
501-01	Portland Cement Concrete Pavement	**750**	S.Y.	0.25	188

EXAMPLE #2 - Bid Item Method

SECTION 698
CONSTRUCTION FUEL COST

698.01 Description.

This Section shall cover the cost of construction fuel for the equipment necessary for the performance of the required work except for the production of Hot Mix Asphalt (HMA).

698.02 Bidding and Cost Adjustment.

The bidder shall enter an amount from zero dollars up to the maximum dollar amount shown in the pay item description for fuel on the proposal form. The Contractor signifies that this amount represents a reasonable estimate of the fuel costs isolated from all other costs of completing the required work except for the production of HMA.

If a proposal contains an amount greater than the maximum amount shown in the pay item description, the amount bid for Construction Fuel will be assigned a value that is the maximum amount.

A cost adjustment will be made to the amount of compensation due for construction fuel on each estimate. This cost adjustment will be based on the cost of the fuel at the time of bid and the cost of fuel at the time of the estimate.

698.03 Method of Cost Adjustment.

The Department will determine and publish a monthly "Fuel Index" utilizing the average area terminal price reports for regular unleaded gasoline and No. 2 fuel of the "Platts Oilgram Price Report" published during the week in which the first day of the month occurs.

The Base Fuel Index (I_b) for the project will be the monthly fuel index published for the month in which the bids were opened for the project.

Before the expiration of contract time partial payments will be made on monthly estimates using the following formula:

6-113

698.03

$$P = (I_m / I_b) \times P_c$$

Where, P = Numerical portion of the lump sum bid amount, a number usually less than one. (Round to nearest thousandth.) May be expressed as a percentage of the lump sum by multiplying by 100 %.

I_m = Fuel Index for Current Monthly Estimate

I_b = Base Fuel Index

P_c = Percent of project completed during current estimate period, i.e., P_c = Percentage of project complete to date minus percent project complete at the time of previous estimate. Percentage of project complete will not include payment for stored materials. (Round percentage to nearest thousandth. Example: 21.71% = 0.217)

After the expiration of contract time (plus approved time extensions) two calculations of a potential partial payment will be made. The first calculation will be made using the current index and the base index as noted in the preceding formula. The second calculation will be made using the index during the month that contract time (plus approved time extensions) expired and the base index. The smallest amount of partial payment resulting from these two calculations will be made for the current estimate period.

698.04 Basis of Payment.

(a) UNIT PRICE COVERAGE.

The amount designated for construction fuel, shall be full compensation, after all applicable cost adjustments, for the furnishing of fuel for equipment used on the project, except for the fuel for the production of HMA, and for all materials, equipment, tools, labor, transportation and incidentals necessary for its use.

(b) PAYMENT WILL BE MADE UNDER ITEM NO.:

698-A Construction Fuel (max. bid limited to $_____) - per Lump Sum

SAMPLE SPREADSHEET TEMPLATE
Bid Item Method

Using the formulas in the above specifications, the following spreadsheet can easily be created to calculate the actual price index for each period. Once the project template has been created, then the only inputs to the table are the quantities of each item placed in the pay period.

Department Of Transportation		
Fuel Price Adjustment Clause		
Bid Item Method		
Project ID:	**20100528016**	
Description:	**MONTGOMERY COUNTY**	
Letting Date:	**5/28/2010**	
Bid Item Bid Price:	**$14,670**	
Contract Amount:	**$2,894,043.68**	
Index (Bid Date):	**2.79**	
Trigger Value:	0.00%	
INPUT VALUES		
Pay Period:	**8/1/2010 to 9/31/2010**	
Pay Period Amount:	**185,000.00**	
Index (Current Month):	**2.95**	
OUTPUT VALUES		
Actual Variance:	5.73%	ADDITION
Percent of Pay Item to Pay:	6.3924%	
Fuel Price Adjustment Payment:	53.78	ADDITION

EXAMPLE #3 - Percent of Contract Method

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ITEM #1600002A - FUEL COST ADJUSTMENT

The Fuel Price is available on the Department of Transportation web site at:
http://www.ct.gov/dot/matladj

This provision covers the method of price adjustment for increases and decreases associated with diesel fuel that is purchased and consumed in the performance of the contract work.

a) The number of gallons of diesel fuel represented in the calculation for the fuel cost adjustment will be equal to 1.5 percent (0.015) of the dollar amount of contract work

b) No other fuel types will be eligible for or used to determine fuel price adjustments for this contract

c) Fuel cost adjustments will be made upward or downward, only when the difference between the *Fuel Base Price* and *Fuel Period Price* is in excess of five percent (5%).

The Connecticut Department of Transportation will furnish the *Fuel Price* using the latest published selling price, in cents per gallon for "Diesel Fuel No. 2, Ultra Low Sulfur" as listed under Pad 1, City of New Haven - Rack Average by the Oil Price Information Service (OPIS).

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The *Fuel Base Price:* The price in cents per gallon which is posted by the Department of Transportation and is in effect that is 28 days prior to actual bid opening date.

The *Fuel Period Price:* The average calculated price representing the payment estimate period using the daily prices in cents per gallon posted by the Department of Transportation.

The dollar value representing payments for incentives or other payment adjustments such as liquidated damages, asphalt, fuel, reinforcing steel or cement adjustments, or sanctions will not be considered as part of the dollar amount of contract work completed for an estimate period (Q)

A fuel cost adjustment will be paid in accordance with the payment estimate schedule.

The "Factor" used in formula to determine the fuel cost adjustment is calculated as follows:

1. The *Fuel Period Price* is greater than the *Fuel Base Price*:

   Factor = (Period Price / Base Price) – 1.05

   If Factor is equal to or less than "0", then no cost adjustment applies.

   If Factor is greater than "0", then an adjustment applies using formula below.

92-618 BITUMINOUS PRICE ADJUSTMENT ADDENDUM NO. 1

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2. The *Fuel Period Price* is less than the *Fuel Base Price*:

   Factor = (Period Price / Base Price) – 0.95

   If Factor is equal to or greater than “0”, then no cost adjustment applies.

   If Factor is less than “0”, then an adjustment applies using formula below.

Formula: $\textbf{Factor} \times \textbf{0.015(Q)} \times \dfrac{\textbf{Base Price}}{\textbf{100}} = \$\_\_\_\_\_\_\_\_$

Where; Q = Dollar amount of work completed for an estimate period
* 0.015 = coefficient to convert dollar value of work (Q) to gallons

If adjustments are made in the contract quantities, the contractor shall accept any fuel adjustment as full compensation for increases or decreases in the price of fuel regardless of the amounts of overrun or under run.

No additional compensation will be made for any additional charges, costs, expenses, etc., which the contractor may have incurred since the time of bidding and which may be the result of any fluctuation in the base index price of diesel fuel.

Basis of Payment: The “Fuel Cost Adjustment” will be calculated using the formulas indicated above. A payment will be made for an increase in costs. A deduction from monies due the contractor will be made for a decrease in costs.

The sum of money shown on the estimate, and in the itemized proposal as “Estimated Cost”, for this item will be considered the bid price although payment will be made as described above. The estimated cost figure is not to be altered in any manner by the bidder. If the bidder should alter the amount shown, the altered figure will be disregarded and the original cost figure will be used to determine the amount of the bid for this Contract.

Pay Item	Pay Unit
Fuel Cost Adjustment	EST.

SAMPLE SPREADSHEET TEMPLATE
Percent of Cost Method

Using the formulas in the above specifications, the following spreadsheet can easily be created to calculate the actual price index for each period. Once the project template has been created, then the only inputs to the table are the quantities of each item placed in the pay period.

Department Of Transportation		
Fuel Price Adjustment Clause		
Percent of Cost		
Project ID:	**126-167**	
Description:	**FAIRFIELD COUNTY**	
Letting Date:	**5/19/2010**	
Percent of Cost:	**1.50%**	
Percent of Cost:	**$2,439,510**	
Index (Bid Date):	**2.79**	
Trigger Value:	6.00%	
INPUT VALUES		
Pay Period:	**8/1/2010 to 9/31/2010**	
Pay Period Amount:	**100,000.00**	
Index (Current Month)	**2.60**	
OUTPUT VALUES		
Actual Variance:	-6.81%	DEDUCTION
Fuel Percentage:	1,500.00	
Fuel Price Adjustment Payment:	(12.15)	DEDUCTION