The Benefits Of Competition & A Balanced Paving Program:
A Business Case for a Two-Pavement System

JAMES W. MACK

CEMEX USA

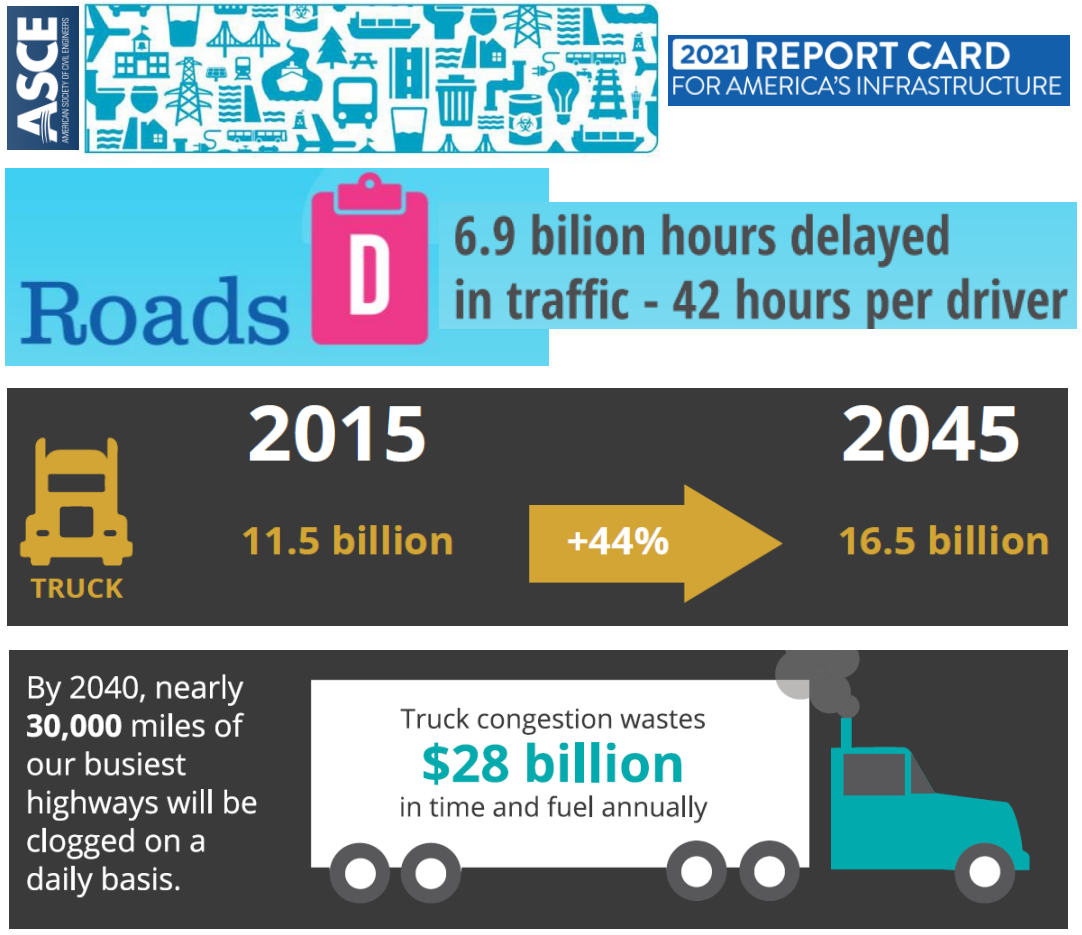
Acknowledgements to:
R. Kirchain, J. Gregory, T.R. Miller, F. Guo (MIT CSHub); O. Swei (Univ of British Columbia);

L Wathne (CPTech Center), A. Gieraltowski, E. Ferrebee (ACPA), M. Speakmon (CEMEX)

HIGHWAY NEEDS ARE AT AN ALL TIME HIGH

IIJA Increases Infrastructure Spending by $550 billion over 5 years … but it's Not Enough

- Road system earned a "D grade" from the American Society of Civil Engineers
- 43% of U.S. roadways are in a poor/mediocre condition
- Estimated backlog of:
  - $435B for highway road repair
  - $120B for system expansion
  - $105B for system enhancement
- Road conditions cost an additional $130 billion in extra vehicle repairs and operating costs
  - Over $1,000 / motorist / year.



In Addition, Highway Construction Material Inflation has increased 20-40%% in the Past Year

https://www.constructiondive.com/news/inflation-saps-infrastructure-act-iija-buying-power/639518/

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2023 Iowa Roads = B- (an increase from 2019)

2015 fuel tax increase helped improve pavement conditions statewide

25 % of roads are in poor/mediocre condition vs. 29% in 2019

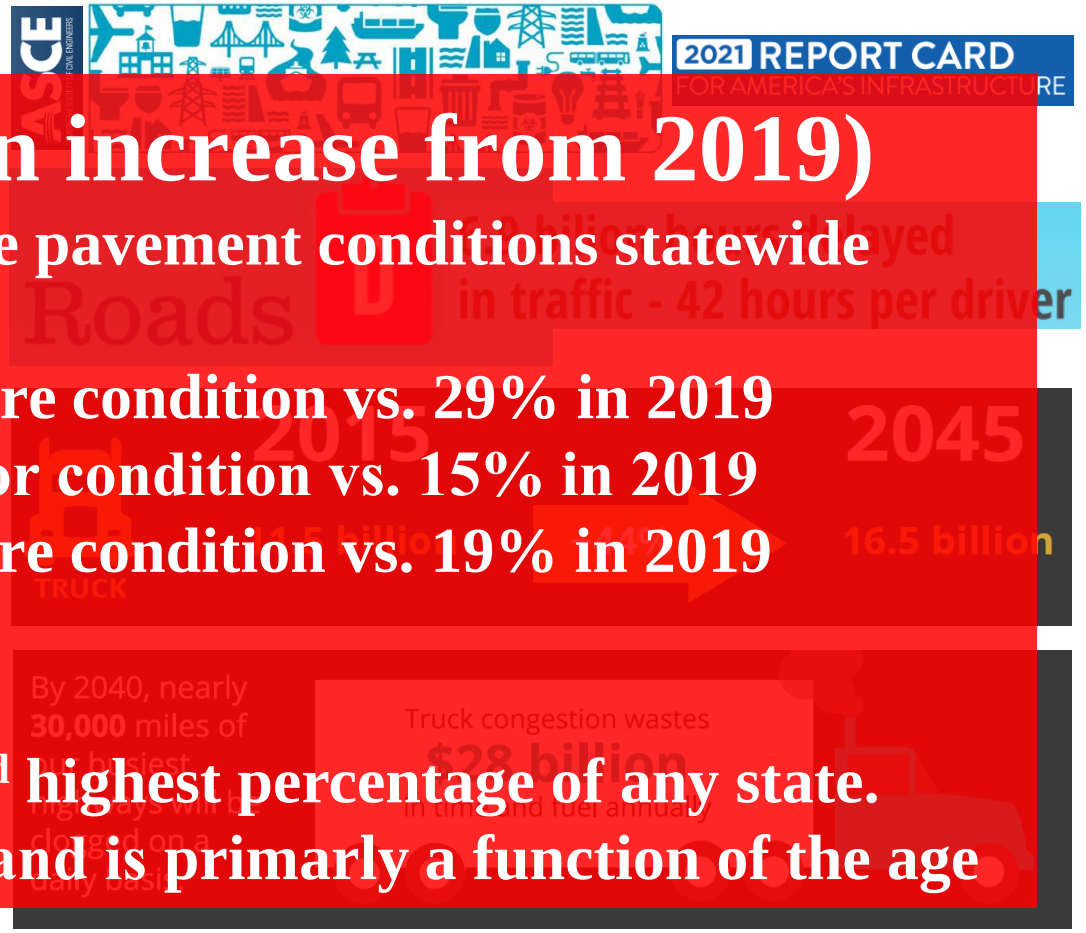
6% Iowa's rural roads are in poor condition vs. 15% in 2019

14% of rural roads are in mediocre condition vs. 19% in 2019

Issues are

~19% of bridges are rated "poor" - 2nd highest percentage of any state.

Overall Infrastructure rating is a "C" and is primarly a function of the age



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The Theory of Competition

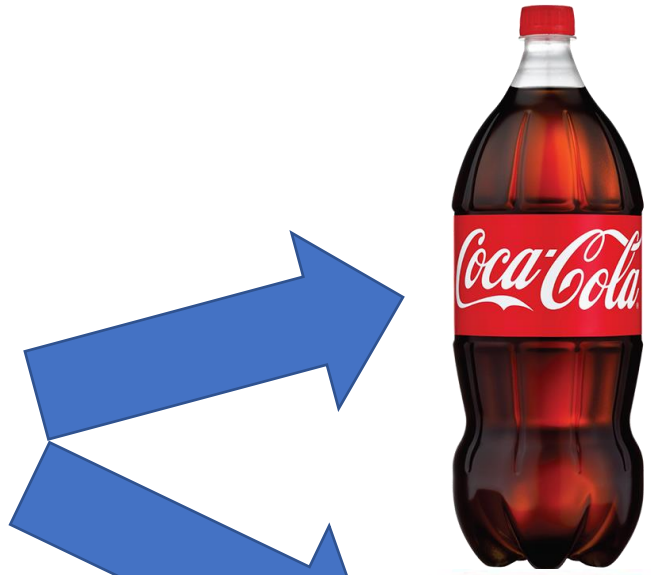
How Paving Competition can Lower Costs

How to Encourage Competition

Examples of Competition Impact

ECONOMIC THEORY STATES COMPETITION BETWEEN SUBSTITUTES REDUCES COSTS

Substitute: A product or service that satisfies the need that another product or service also fulfills



Bottles & Aluminum Cans are Substitutes that both can deliver Coca-Cola

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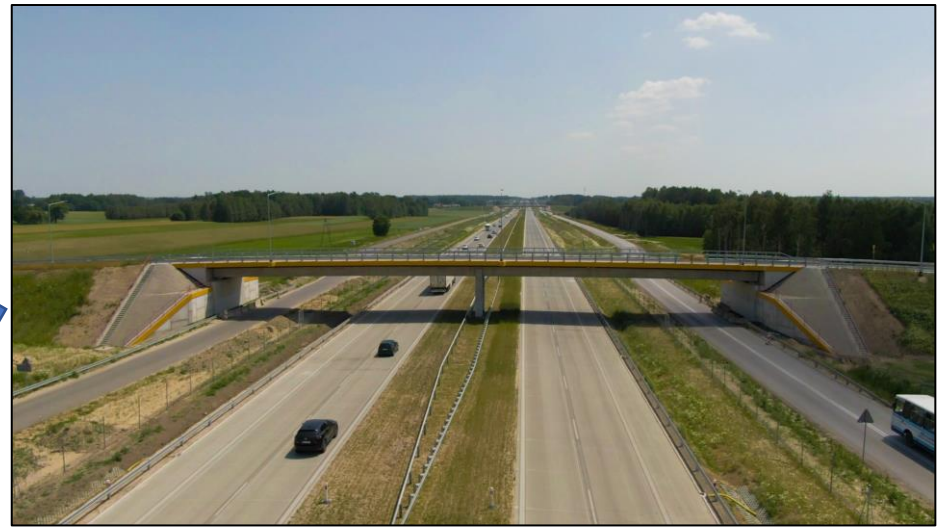

Concrete & Asphalt Pavements are Substitutes that Can (and Should) have the Opportunity to Compete

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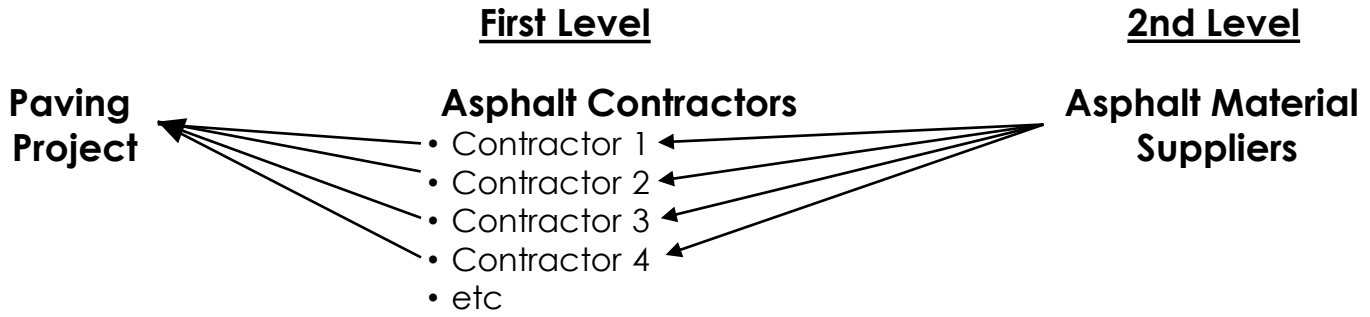
THERE ARE TWO FORMS OF COMPETITION

Inter-industry Competition Brings Another Level of Competition to the Supply Chain

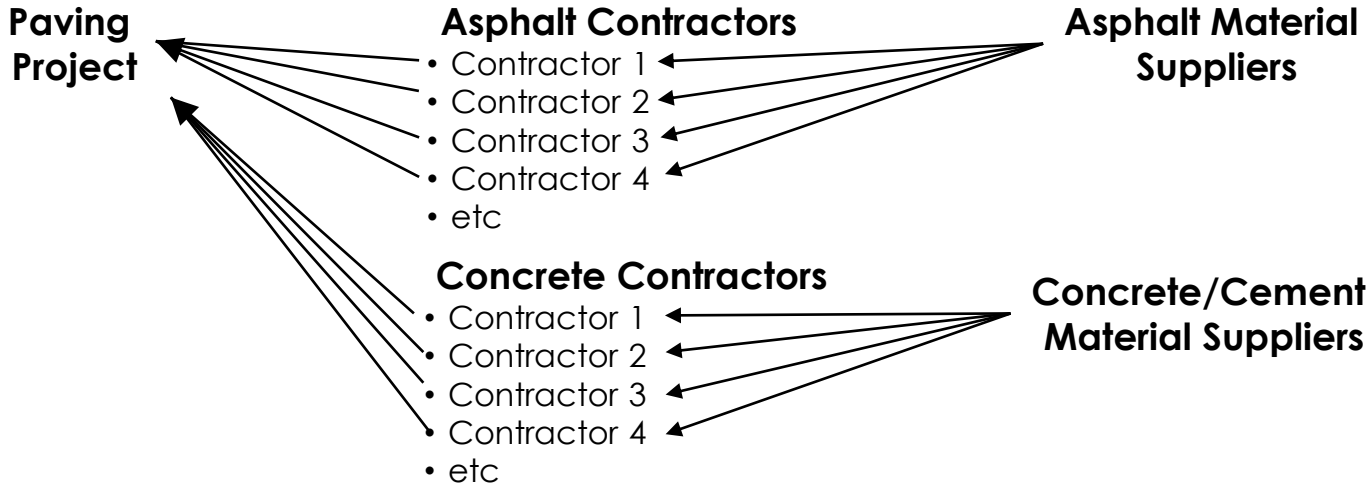
Intra-Industry (Contractor) Competition

Competition Between firms that pave with the same material



Inter-Industry (Industry) Competition

Competition between firms that pave with different material substitutes



Contractor competition does not assure competition takes place at all levels of the supply chain

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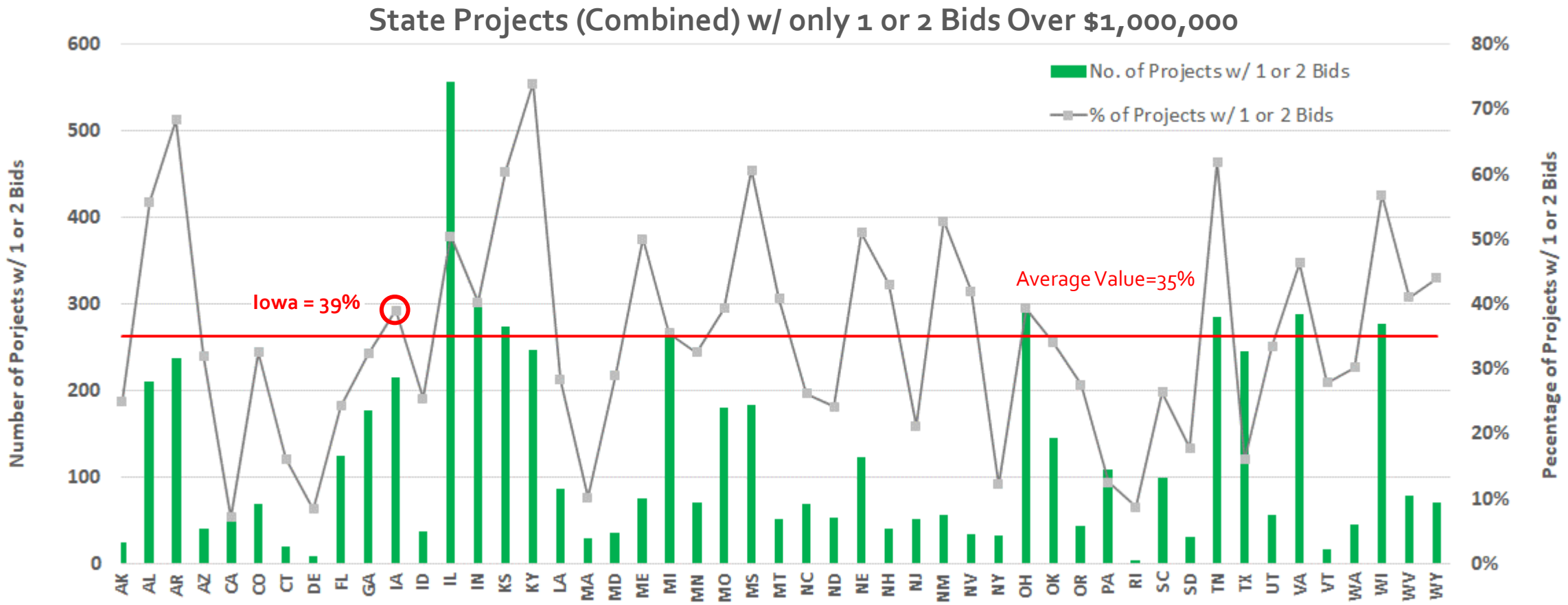
OFTEN THERE IS A LIMITED INTRA-INDUSTRY (CONTRACTOR) COMPETITION

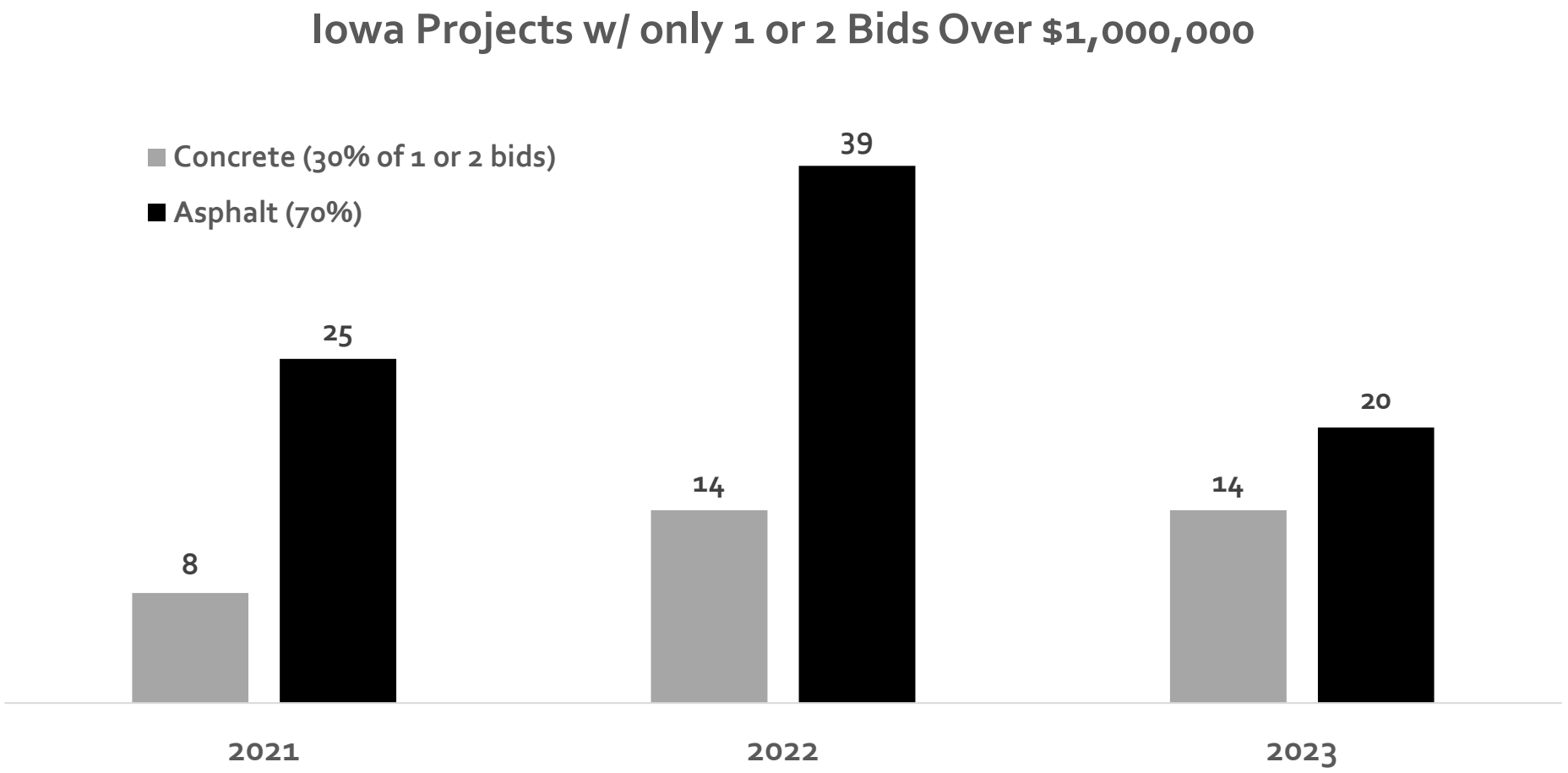
Number of 1 and 2 Bid Contracts Over $1 Million (2020-2022)



* Source: Oman Systems, Inc Bid Tabulation. Alaska, Hawaii, & New Jersey are not included

IOWA BIDX INTRA-INDUSTRY (CONTRACTOR) COMPETITION

Number of 1 and 2 Bid Contracts Over $1 Million (2021-2023)



* Source: Bidx (Concrete Call Order 100-149 and Asphalt Call Order is 150-199).

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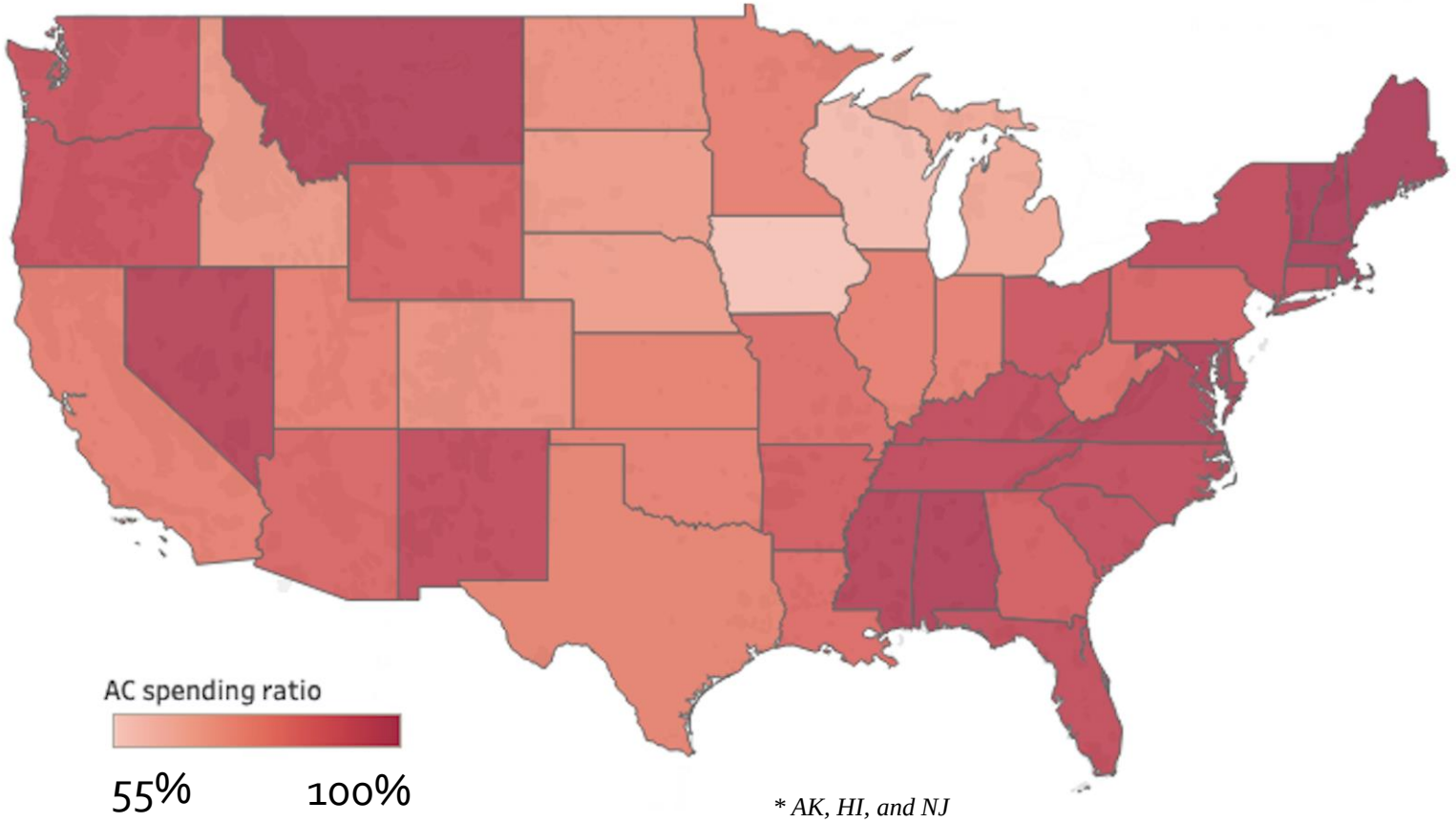
THERE IS LIMITED INTER-INDUSTRY COMPETITION IN MANY STATES

Competition between Asphalt & Concrete

Most State DOTs spend most of their paving expenditures on Asphalt

Iowa is one of the exceptions

Average Percent Spending on AC (2005-2018)



** AK, HI, and NJ do not input pay item details.*

MIT 2020, https://cshub.mit.edu/sites/default/files/images/0315%20New%20Competition%20Summary.pdf

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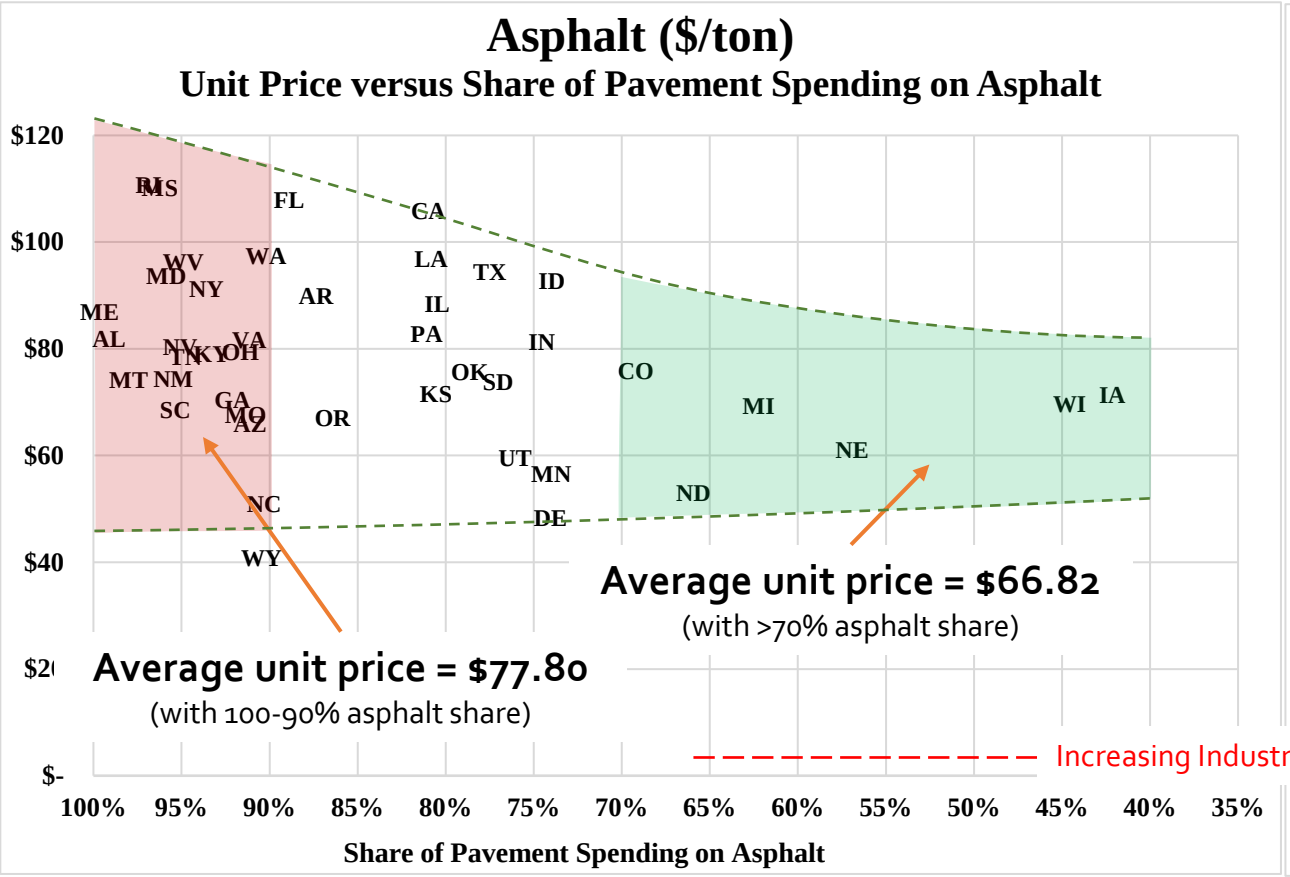
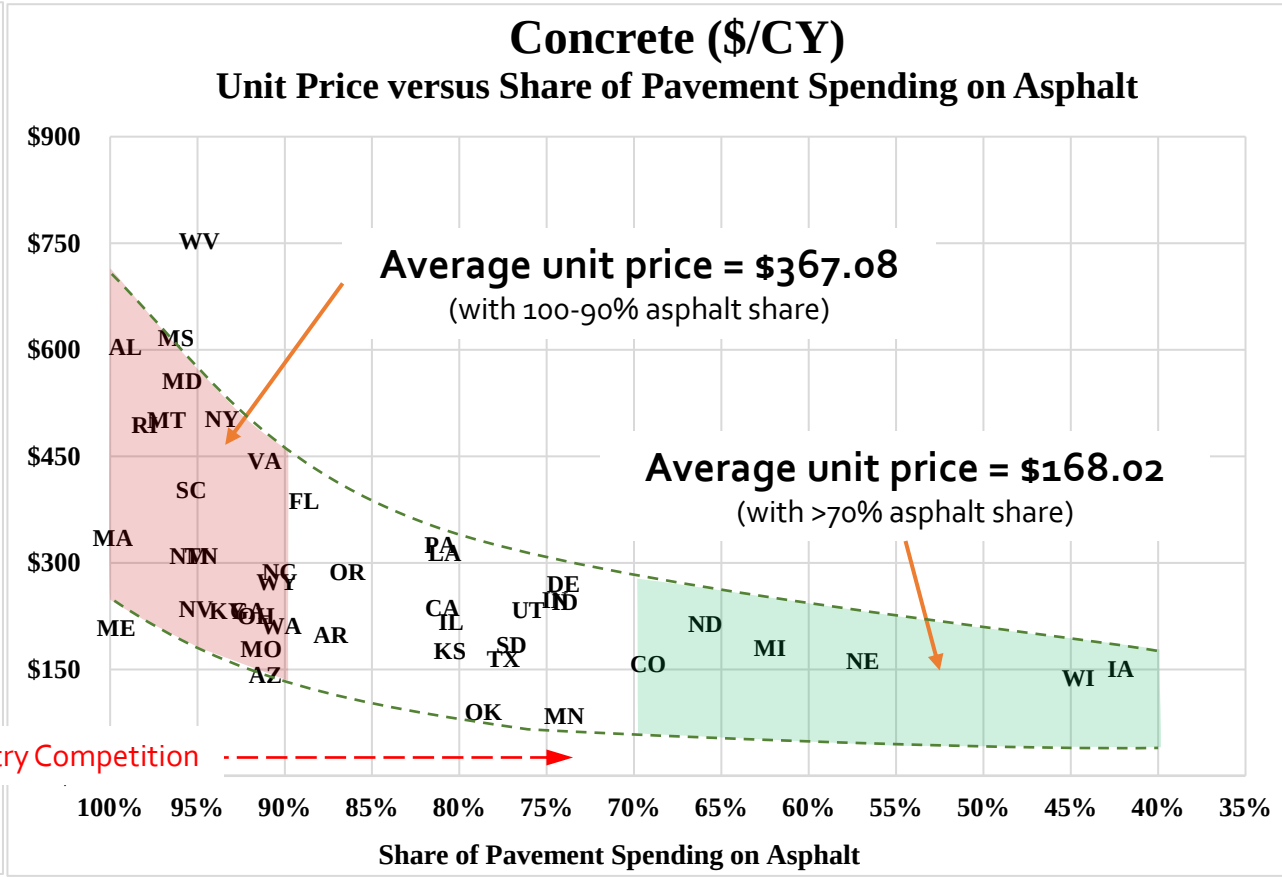
2014-2018





Increasing Industry Competition

While insightful, it does not consider other explanatory items or provide an indication to how much increased opportunities to compete could lower paving material unit costs

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2. Oman Systems, Inc Bid Tabulation Data. Retrieved from http://www.omansystems.com

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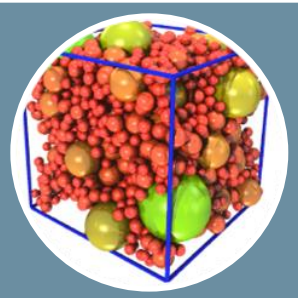
MIT CONCRETE SUSTAINABILITY HUB (CSHub)

Multi-year Project to Develop Breakthroughs that will Lead to More Sustainable and Durable Pavements and Buildings



Concrete Science

Mechanical & chemical models across length scales

Engineering

Improving the design process for pavements & buildings

Economics

Assessing financial risk of pavement & building investments

Environment

Assessing the environmental impact of pavements & buildings

Research approach holistic and multidisciplinary

The Goal of the research to lead to improved decision making

(1) providing scientific basis for informed decisions; (2) demonstrating the benefits of a life-cycle view; and (3) transferring research into practice.

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QUESTION: DOES MORE OPPORTUNITIES FOR INDUSTRIES TO COMPETE CREATE SAVINGS IN PAVING?

MIT Analyzed 10 Years (2005-2014) of Pavement & Materials Pricing Data

- Represented ~ 30,000 jobs.
  - Filtered to include only asphalt or concrete material pay items
  - Excluded activities that were not asphalt or concrete paving items (e.g., curbs, drainage, etc.)
    - 73% of the asphalt pay items (94% of the asphalt pavement spending)
    - 57% of the concrete pay items (88% of the concrete pavement spending)
- Developed statistical models to determine what factors had significant influence on paving costs:
  - Quantity / Project Size
  - Annual spending
  - Number of bidders
  - Share/number of AC and PCC bids
  - Price Adjustment Clauses
  - Share of spending on AC vs. PCC **Proxy for inter-industry competition**

Slide Courtesy of MIT,
Source: Oman Systems, Inc Bid Tabulation Data. Retrieved from http://www.omansystems.com

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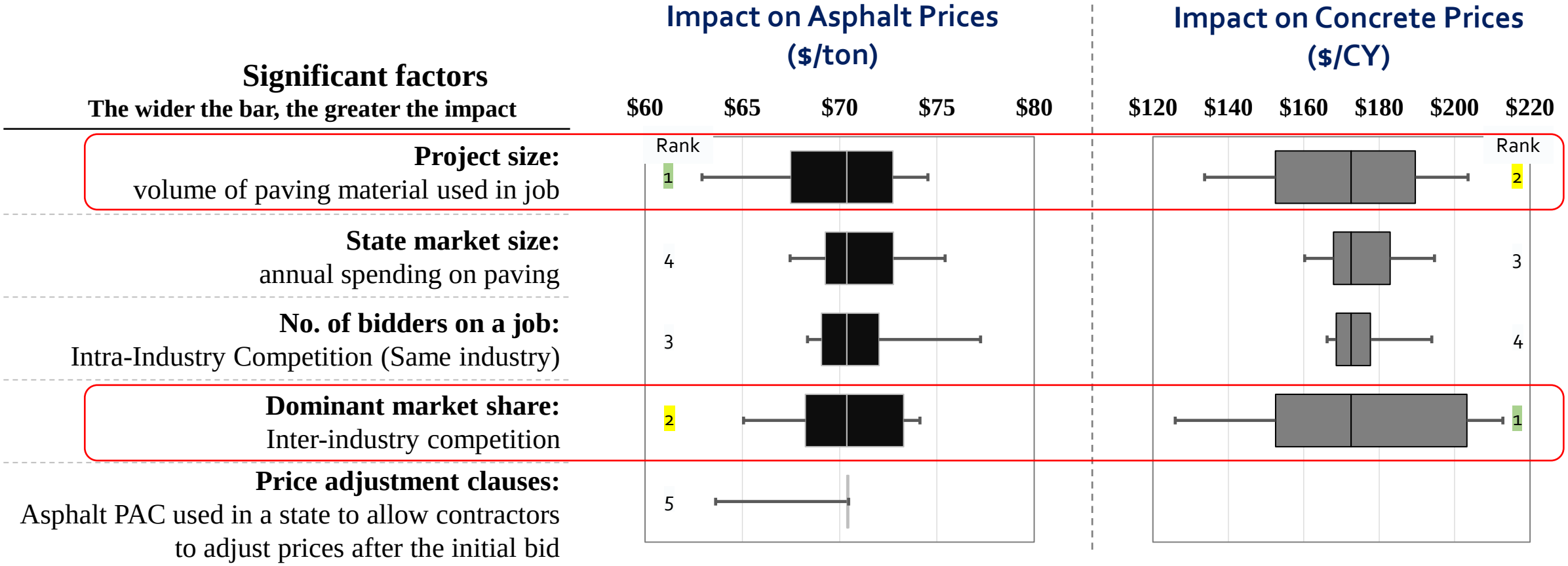
INTER-INDUSTRY COMPETITION IMPACT IS LARGE

1st and 2nd Most Important Factor on Unit Costs for Concrete and Asphalt Paving



Competition between material industries has a larger impact than competition between multiple contractors

Slide Courtesy of MIT,

1 Indicates highest impact factor in paving costs

2 Indicates 2nd highest impact factor on paving costs

https://cshub.mit.edu/sites/default/files/images/0315%20New%20Competition%20Summary.pdf

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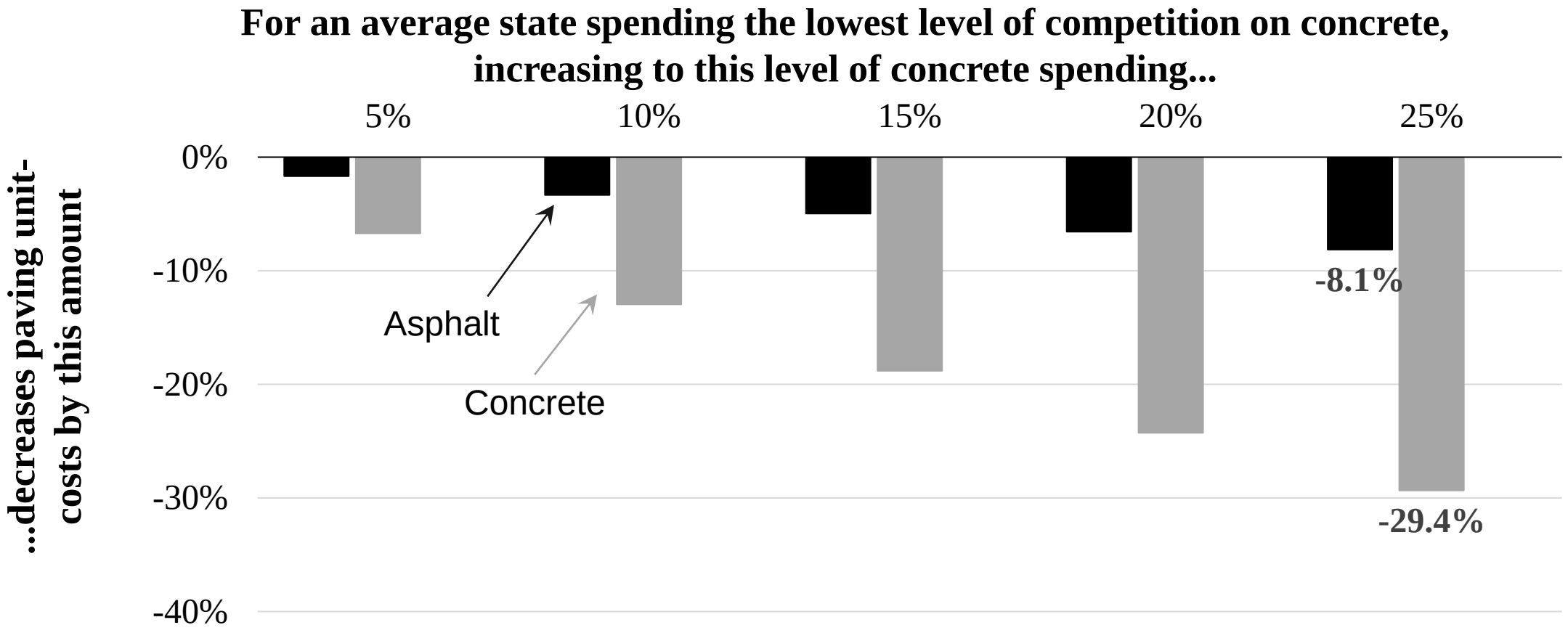
INTER-INDUSTRY COMPETITION LOWERS UNIT COSTS

Allows Highway Agencies to do More with their Budgets



States with high industry competition pay ~ 8% and 29% less for asphalt and concrete pavements respectively vs. states with the low competition (increasing competition between contractors only lowers cost ~ 5%)

Slide Courtesy of MIT,
https://cshub.mit.edu/sites/default/files/documents/CSHub%20Pavement%20Competition%20Topic%20Summary_Dec2017_FINAL.pdf

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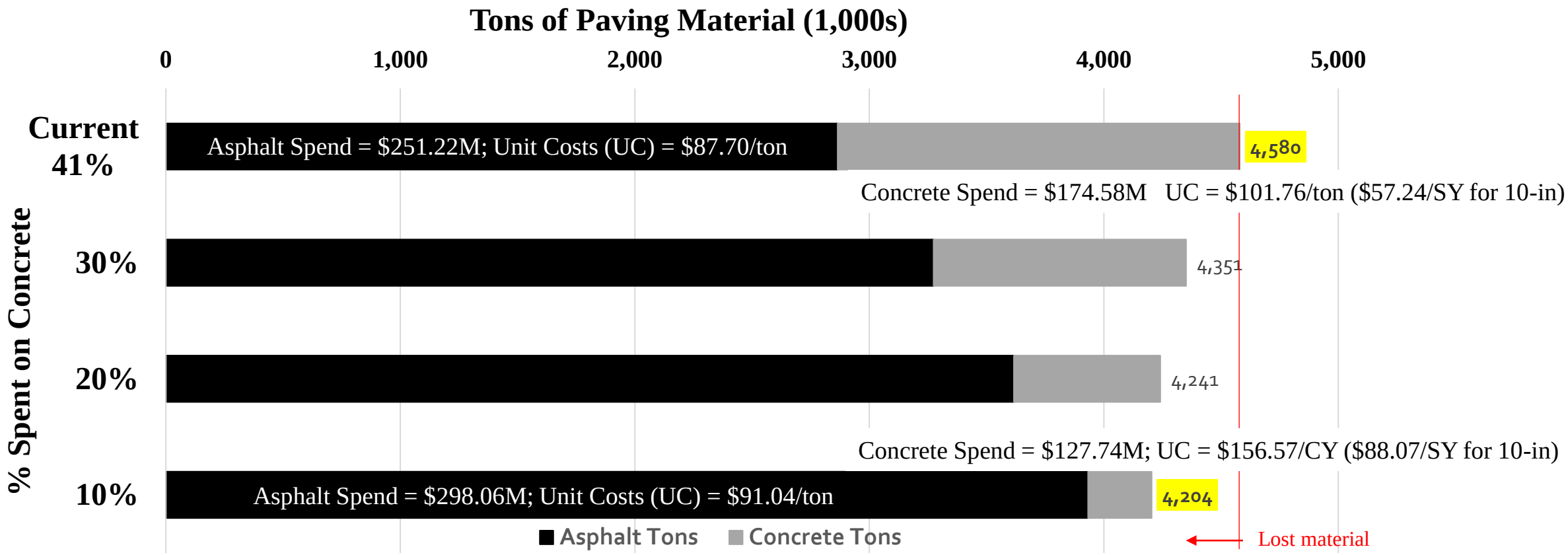
AGENCIES WITH A HEALTHY TWO-PAVEMENT SYSTEM CAN GET MORE "BANG FOR THE BUCK"

Long Term

Ex: IDOT Pavement Budget ≈ $426M (FY 22 – May 18 FY 23)



If IDOT decreased the purchases of concrete pavement to 10%, they would lose ~375,600 tons of paving materials (104 miles of 10-in pavement)

Prices based on 2021-2023 (7/20/21 – 4/18/2023) IDOT Historical Item Costs: Asphalt Items 101, 113, 114, 550, & 820
Concrete Items 100, 103, 108, 120,505, 515, 519, 820. Assumed unit weight of concrete = 150 lbs/ft^3

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TRANSPORTATION AGENCIES CAN CREATE OPPORTUNITIES FOR INDUSTRIES TO COMPETE

Transportation agencies often try these methods to impact Pavement Competition

Life-Cycle Cost Analysis (LCCA)	• An economic analysis tool that quantifies the differential costs of alternative investment options for a given project • LCCA determines which pavement design is most cost effective over the analysis period

Alternate Pavement Bidding (APB)	• Alternate Pavement Bidding is a Procurement process to in which both concrete and asphalt pavements are options
	  • Alternate pavement designs (asphalt and concrete) are developed for a project
	  • The contractor then chooses which material to submit for his bid
	  • Low bid – after life cycle adjustment – wins the project

LCCA and APB by Themselves Do Not Create a Competitive Environment

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TRANSPORTATION AGENCIES CAN CREATE OPPORTUNITIES FOR INDUSTRIES TO COMPETE

Transportation agencies often try these methods to impact Pavement Competition

Issues

1. **There is no bidding with LCCA**
   - **Agencies don't know what are realistic costs for concrete pavement**
2. **Non Dominant (Concrete) industry does not invest in equipment, training, etc. because uncertainty of future jobs**
   - **Dominant (Asphalt) industry is not threatened & no "culture" is developed**

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EXAMPLE: NOT KNOWING BID PRICES

Kentucky Concrete Overlay Bid Results for Pennyrile Parkway: A 13.3 mile project using a 9-inch concrete overlay of an existing 4-lane concrete pavement

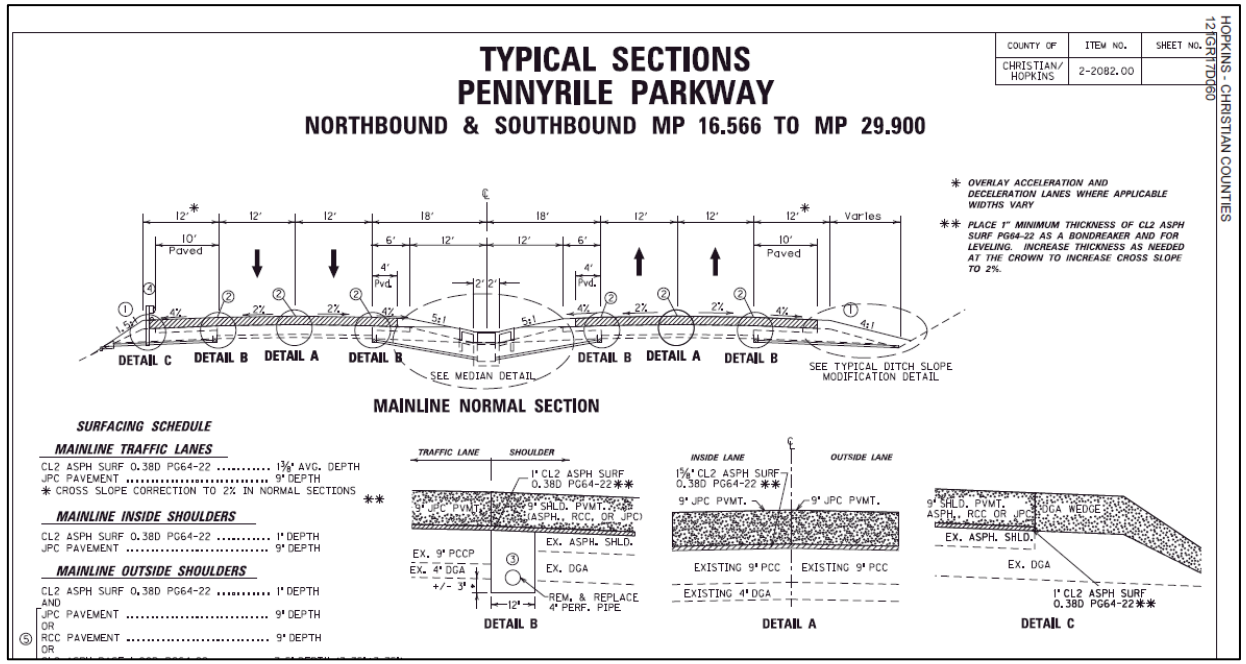
Bid in December (December 8, 2017)

KY Engineer's estimate = $52 M

Winning bid = $43.2M (16.9% below estimate)

- **Unit bid price = $34/SY.**
- **Bid price range = $34.00 - $38.10/SY. (4 contractors)**

If KY had used the $52M estimate in the LCCA to determine pavement type, they would not have bid concrete or created "competition."



Agencies need to bid concrete on a consistent basis in order to know what true costs are

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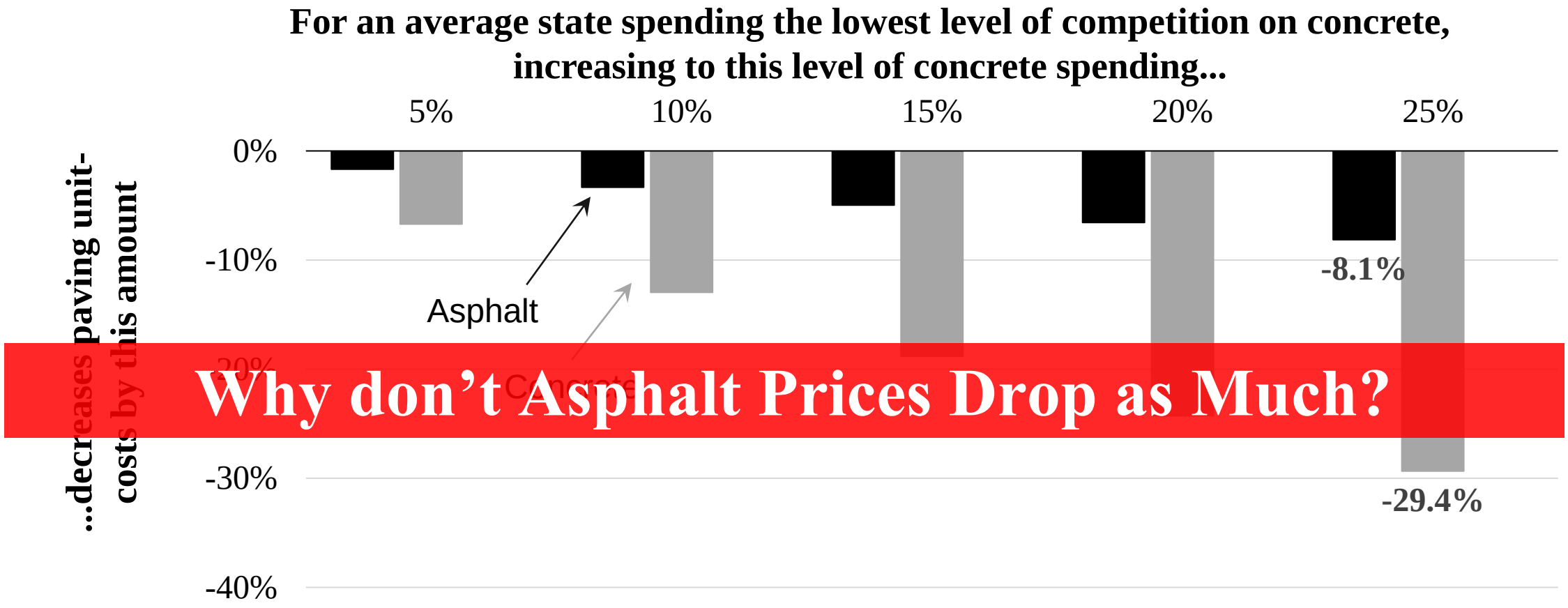
INTER-INDUSTRY COMPETITION LOWERS UNIT COSTS

Allows Highway Agencies to do More with their Budgets



Why don't Asphalt Prices Drop as Much?

States with high industry competition pay ~ 8% and 29% less for asphalt and concrete pavements respectively vs. states with the low competition (increasing competition between contractors only lowers cost ~ 5%)

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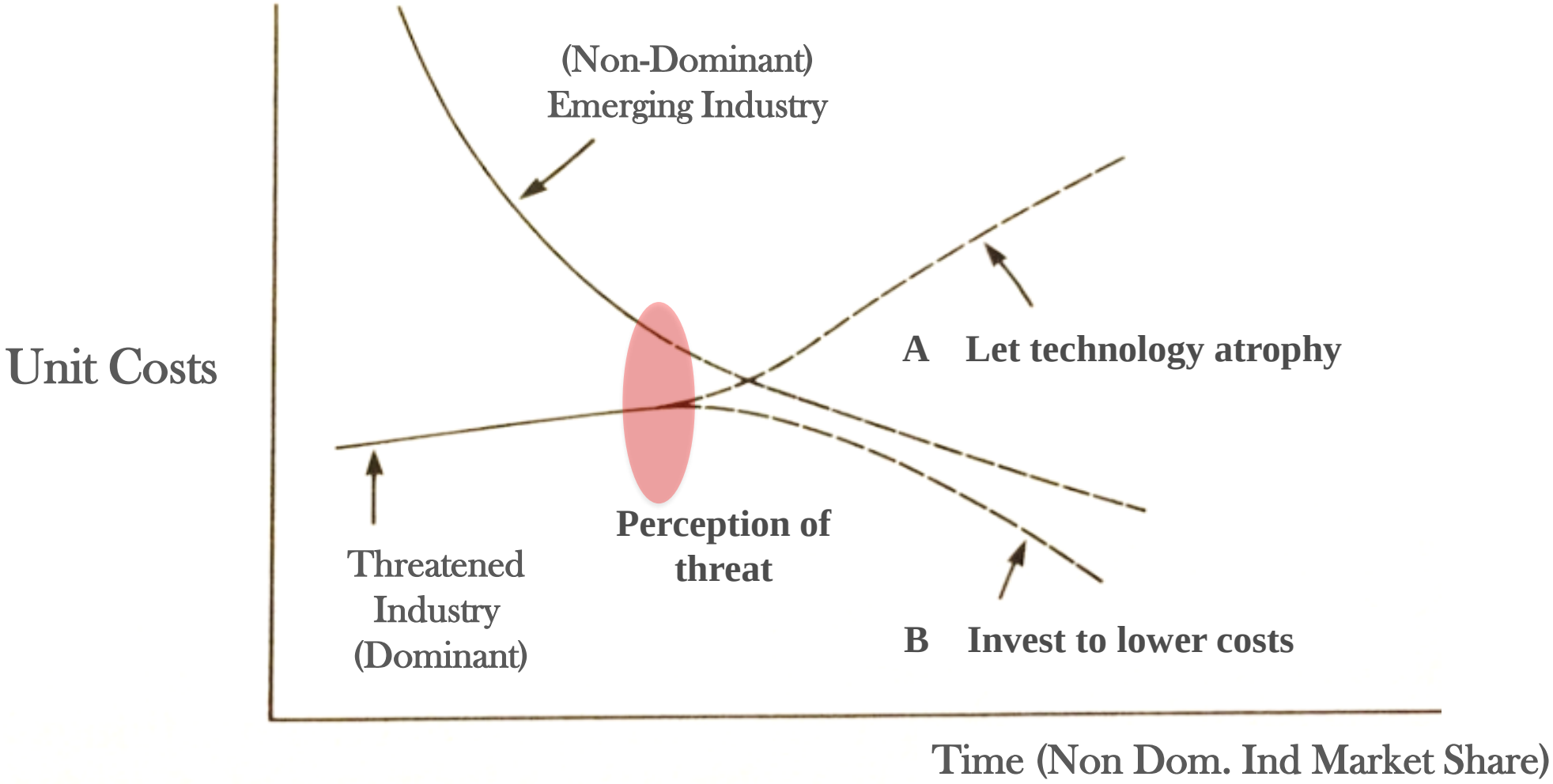
WHY THREAT IS NEEDED

Competition Theory Threshold & Price Impact

Competitive Strategy in Emerging Industries



Source: Porter, M. E. (1980). Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free Press.

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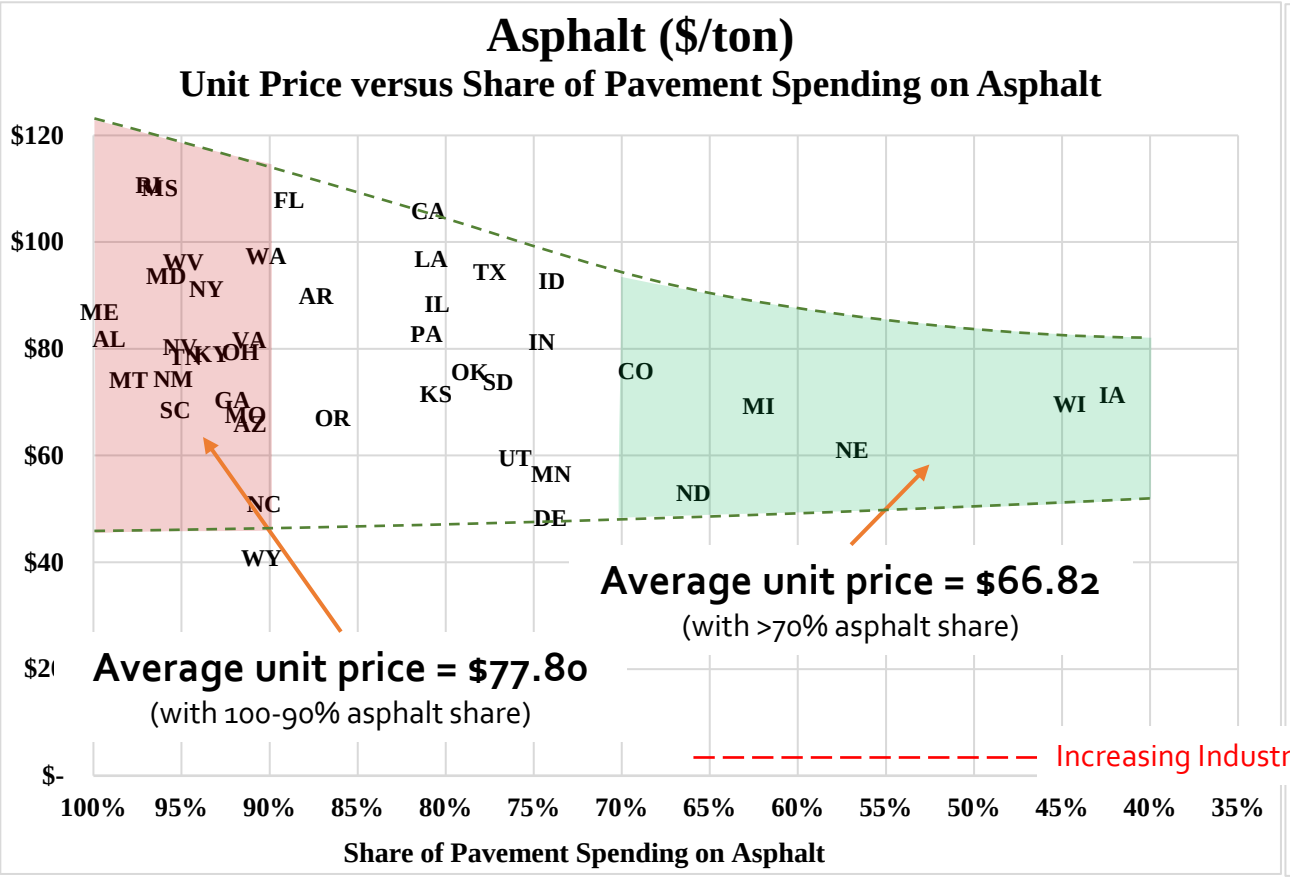

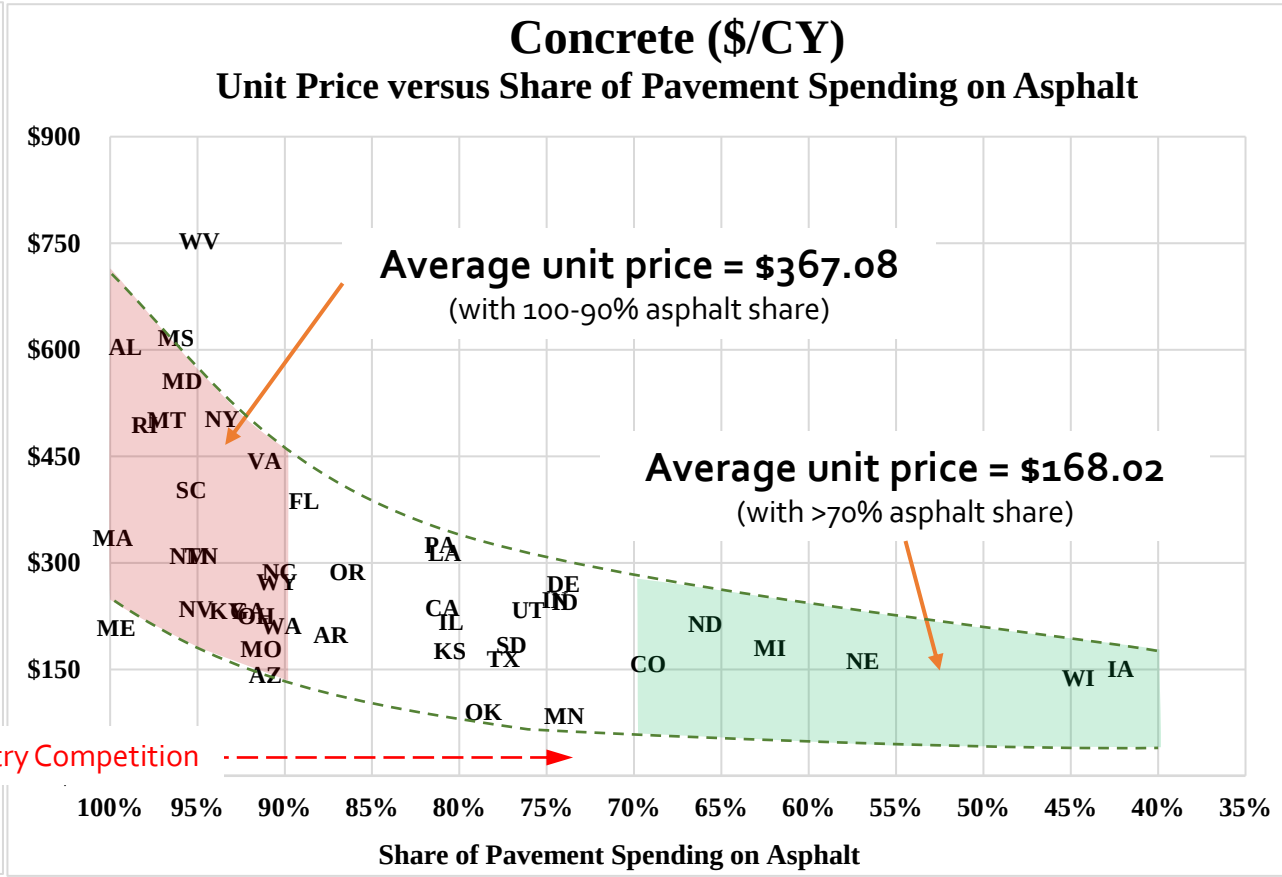

Increasing Industry Competition

The "Perception of Threat" occurs somewhere between 10 and 30% Concrete Pavement Market Share

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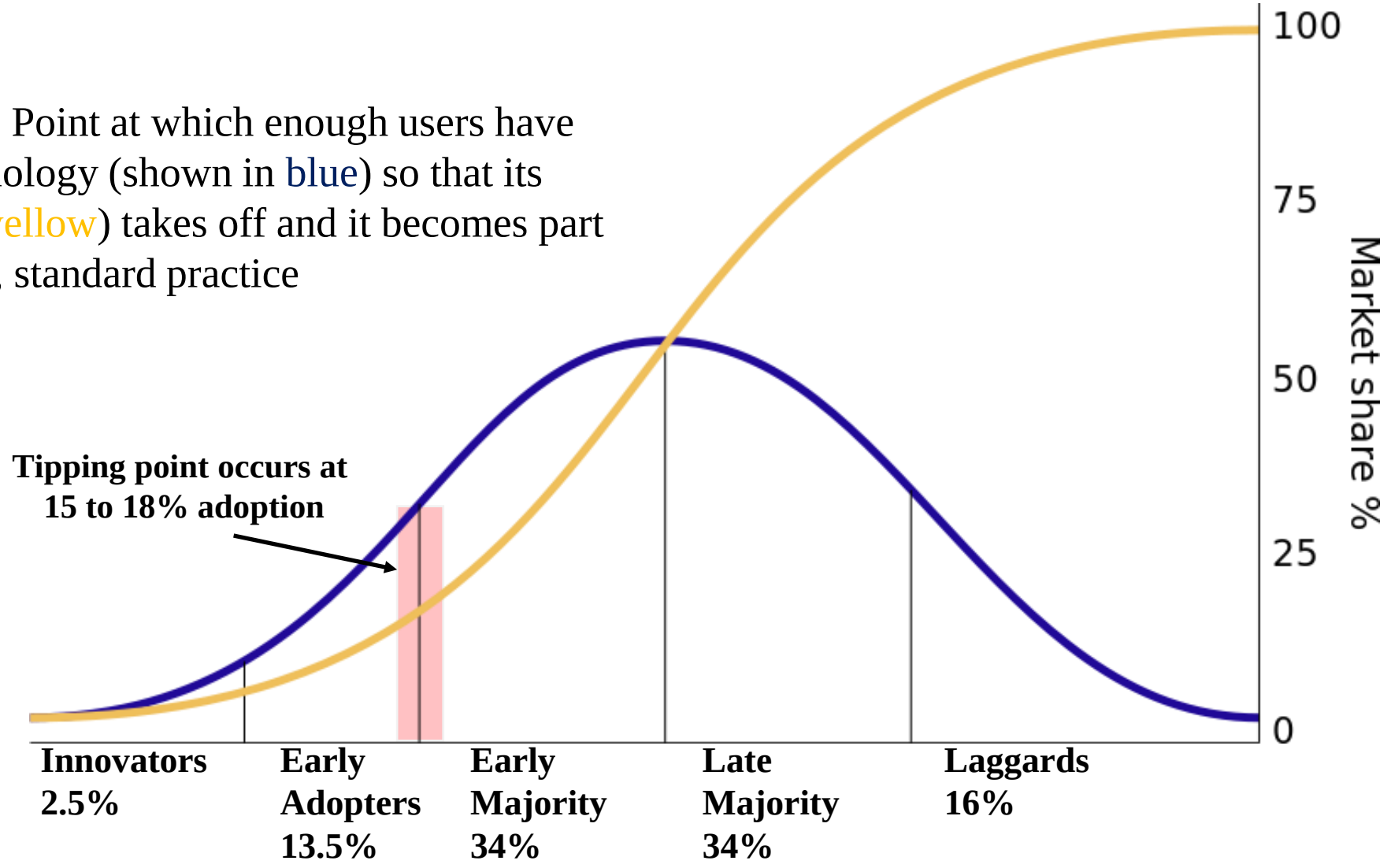
ADOPTION CURVE FOR INNOVATIONS.

When the number of adopters reach the tipping point, the innovation is self-sustaining

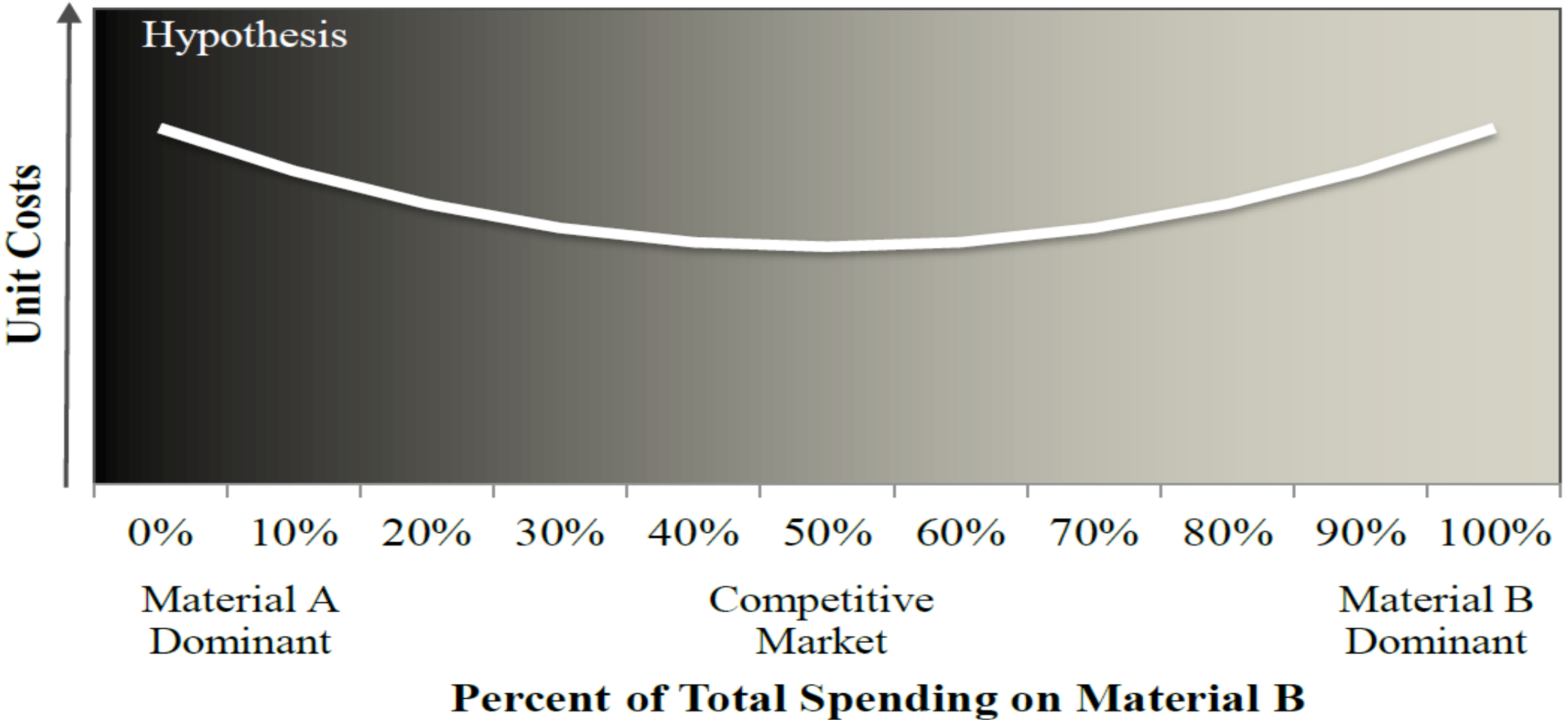
Tipping point = Point at which enough users have adopted a technology (shown in blue) so that its use (shown in yellow) takes off and it becomes part of the accepted, standard practice



Source: Everett Rogers' *Diffusion of Innovations* (Rogers, 2003)
https://en.wikipedia.org/wiki/Diffusion_of_innovations

HYPOTHESIS: UNIT COSTS OF BOTH PAVING MATERIALS ARE HIGHEST AT THE EXTREMES

Unit Costs will be at Minimum when both Industries are Equally Present



Source:
Presence of Competition between Paving Material Substitutes and Impact on Material Costs, T. R. Miller, R. Kirchain, J. Gregory, 11th International Conference on Concrete Pavements August 28-31, 2016

STEPS TO CREATE A PAVING PROGRAM WITH OPPORTUNITIES FOR INDUSTRIES TO COMPETE

Signals that the agency is serious about creating competition between industries

1. Transportation Agency announces their intention to have a 2 Pavement System (e.g. a concrete paving program)

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1. Transportation Agency announces their intention to have a 2 Pavement System (e.g. a concrete paving program)
2. Agency adopts and uses all cement based / concrete solutions in multiple market applications
   - New Concrete Pavement, Concrete overlays, etc
   - Interstates, State Highways, Rural roads, Intersections and Ramps
     - Creates multiple opportunities for potential concrete projects

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3. Agency purposely lets a concrete projects each year and develops a Project Pipeline that covers several years

METHODS FOR DEVELOPING A PROJECT PIPELINE

Examples of how US States have Ensured both the Concrete & Asphalt Industry Participate

I. Programmatically balances the market based on some metric such as volumes.
- Wisconsin & Michigan DOT – Balances their program to the same volume each year
  - Tons of asphalt ≈ square yards of concrete pavement
- Iowa DOT targets a 50/50 balance with a commitment to stay within a 40-60 market share range

II. Designate a certain number of projects will be Concrete.
- Florida DOT – ~40 miles of new roads are concrete pavement / year.
- TxDOT – Consistently bids ~ 5M sy^2 (~26%) of concrete pavement every year

III. Use Traffic or road classifications to designate specific markets for each product.
- Minnesota DOT – based on Equivalent Single Axle Load (ESAL))
  - ESAL < 1 Million = Asphalt
  - ESAL > 7 Million = Concrete
  - Between 1 and 7 Million – go thru LCCA process

Goals is to develop a "Program of Projects" vs a series of "Individual Projects"

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4. Agency develops Technical Task Forces to address issues with specifications, design procedures, and other policy / design / construction issues
   - There will be issues with design, construction, specifications, etc.
   - Task forces give the opportunity for industry and DOT come to a mutually agreeable solution that meets both groups needs
     - Lowers costs for future projects

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5. Use Life Cycle Cost Analysis and Alternate Pavement Bidding on Specific Pavement Projects

Only after agencies set the groundwork for an Inter-Industry Competitive Pavement Environment can LCCA and APB be used to lower costs even further on specific projects

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TO GET CREDIBLE AND RELIABLE LCCA RESULTS

The Process, Engineering and Economics need to be correct

1. **Process** needs to well-structured and follows best practices
2. **Engineering** must be fundamentally sound and pertain to <u>that specific</u> design for a particular project
   - Equivalent designs with similar performance
   - Realistic rehabilitation strategies for each particular design based on anticipated performance
3. **Economics** needs to accurately represent – as best as possible – the current economic conditions
   - **Cost** need to accurately represent the Agency's <u>probable expenditures</u> for the expected rehabilitation strategy for <u>that specific</u> design

The LCCA must be based on the designs "Being Proposed" & not on a "Average or Standard Pavement"
(Most LCCAs do not accurately represent future pavement expenditures b/c of inflation & poor cost estimates)

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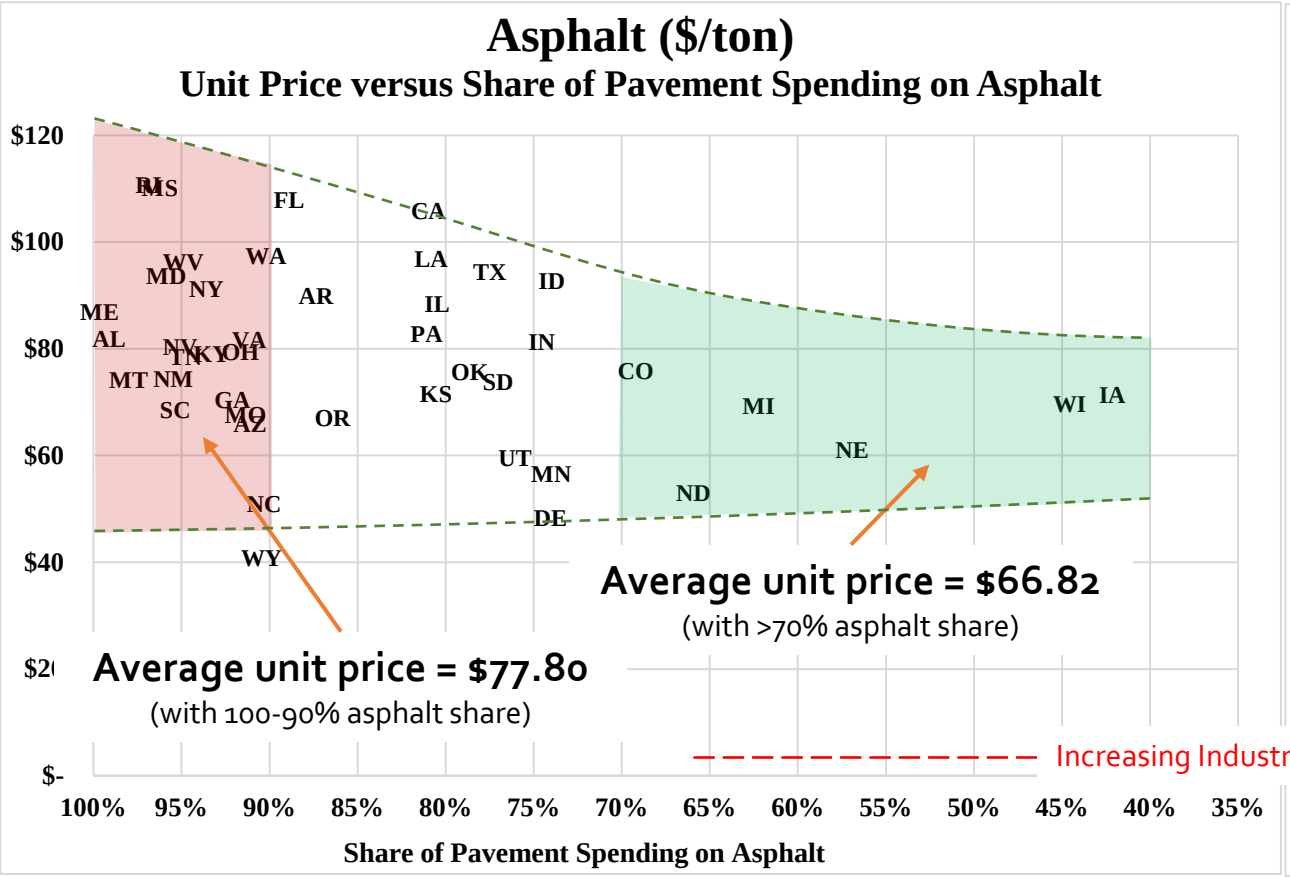

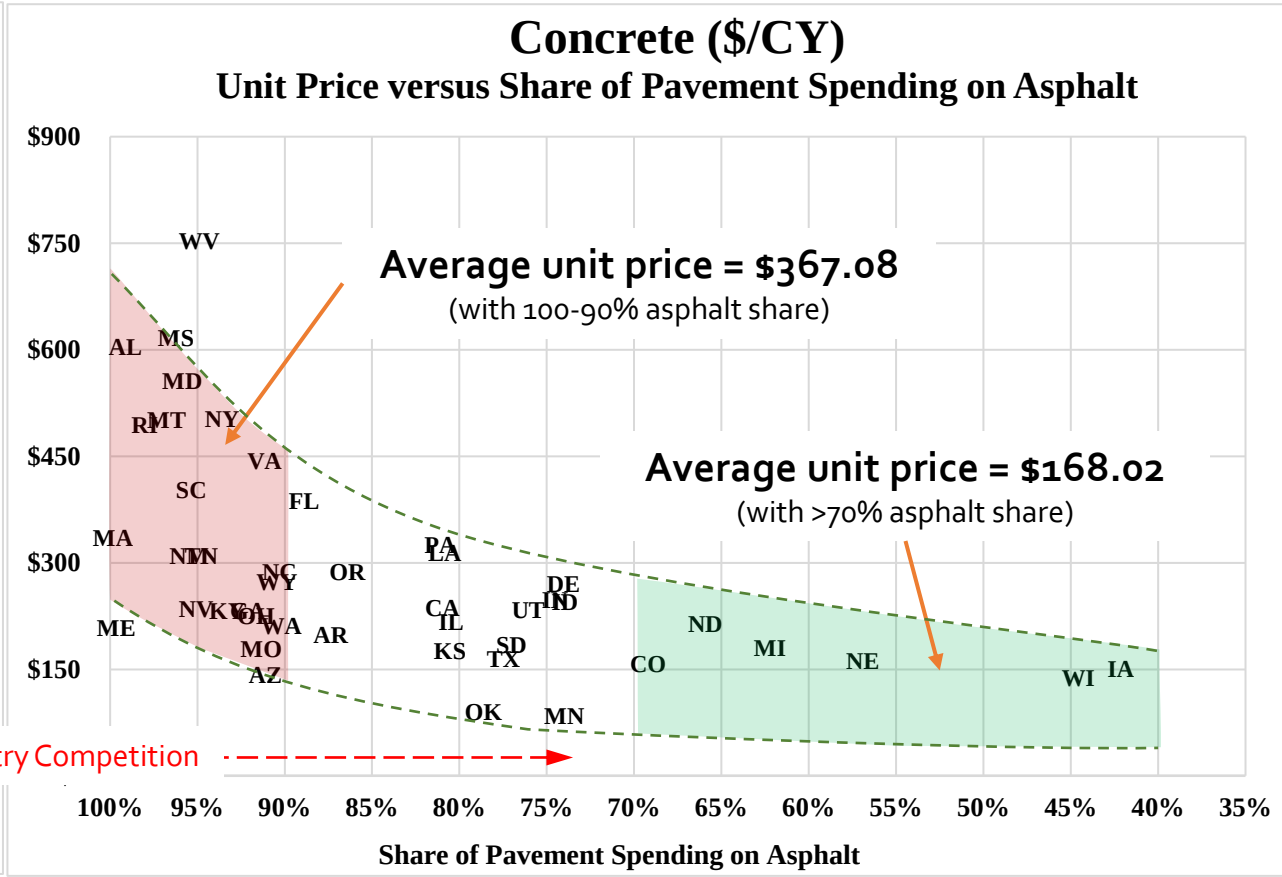

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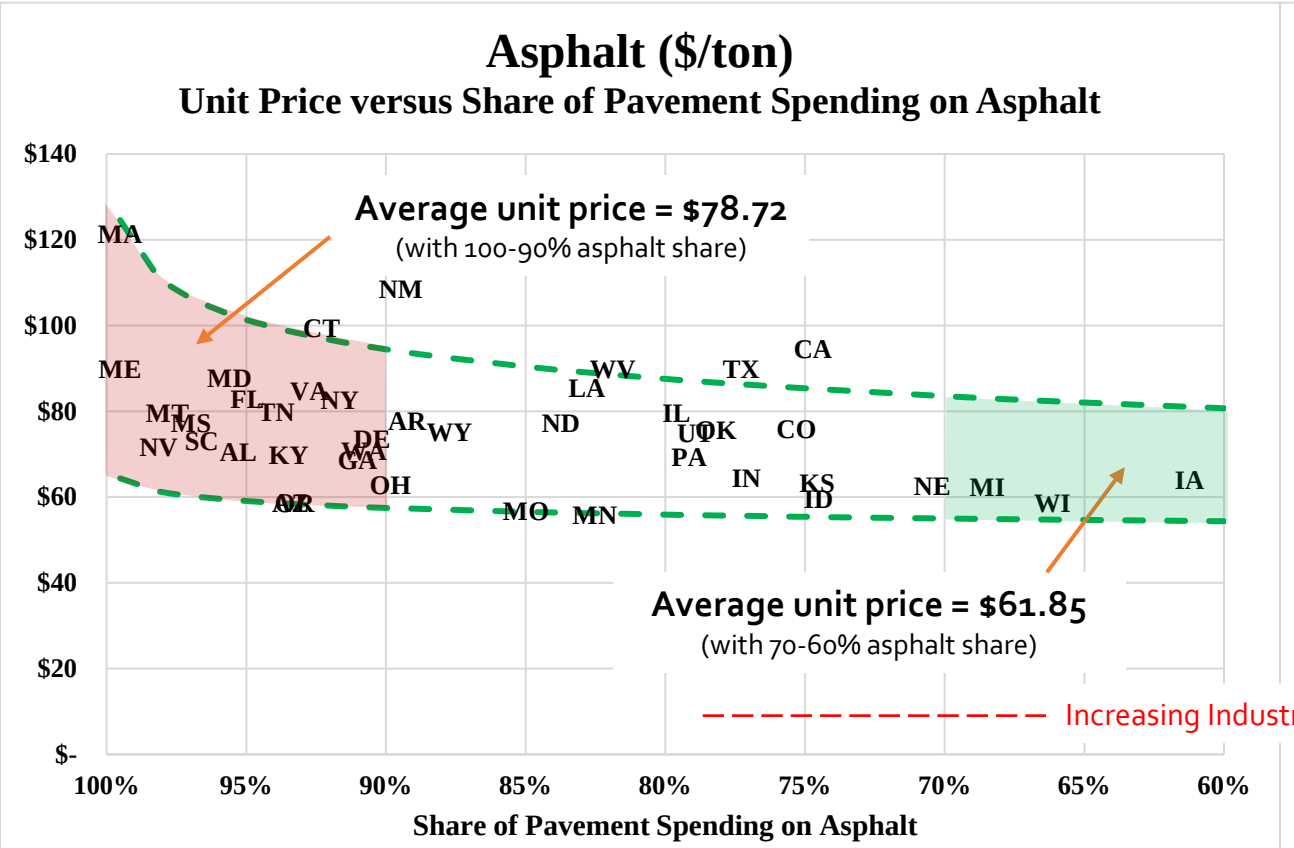
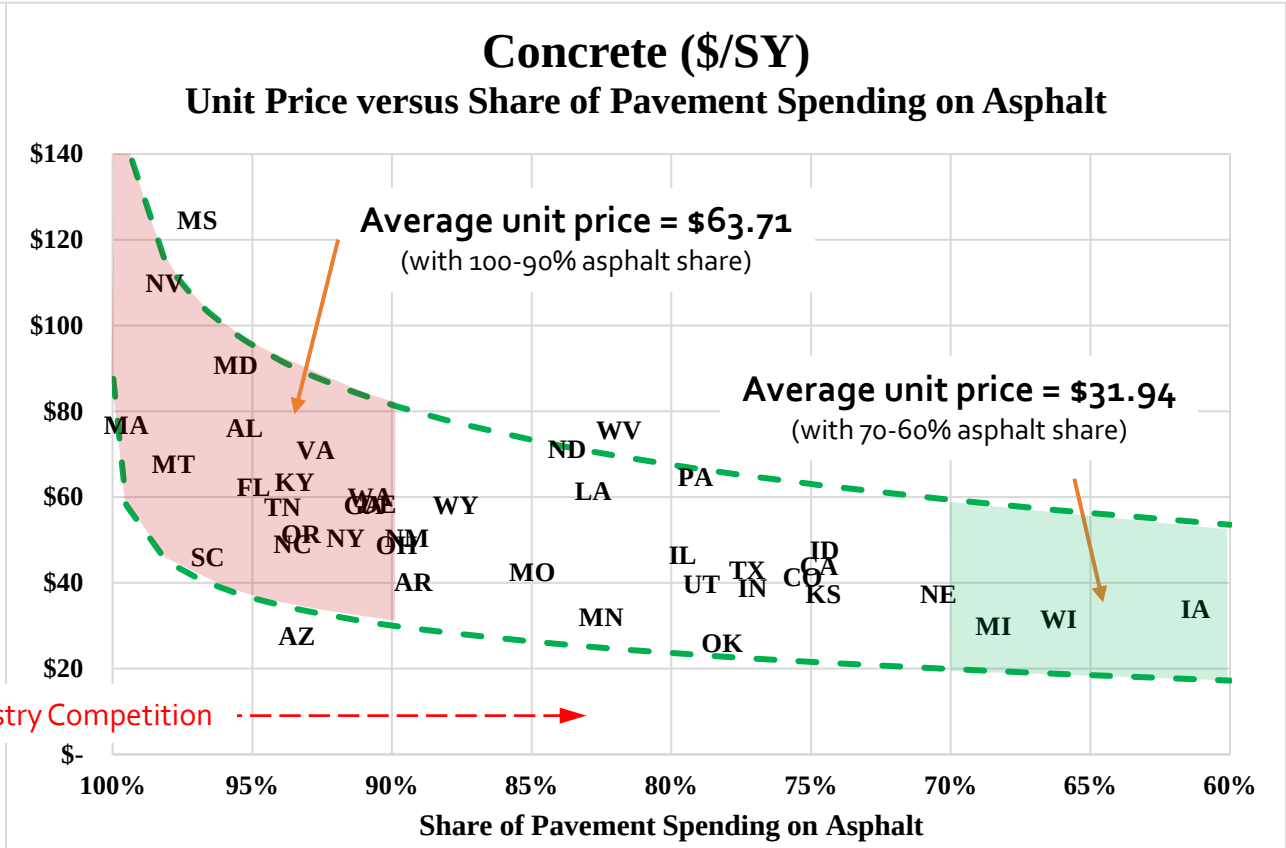
SUSTAINED OPPORTUNITIES TO COMPETE BETWEEN PAVING INDUSTRIES BRINGS VALUE

2009-2013





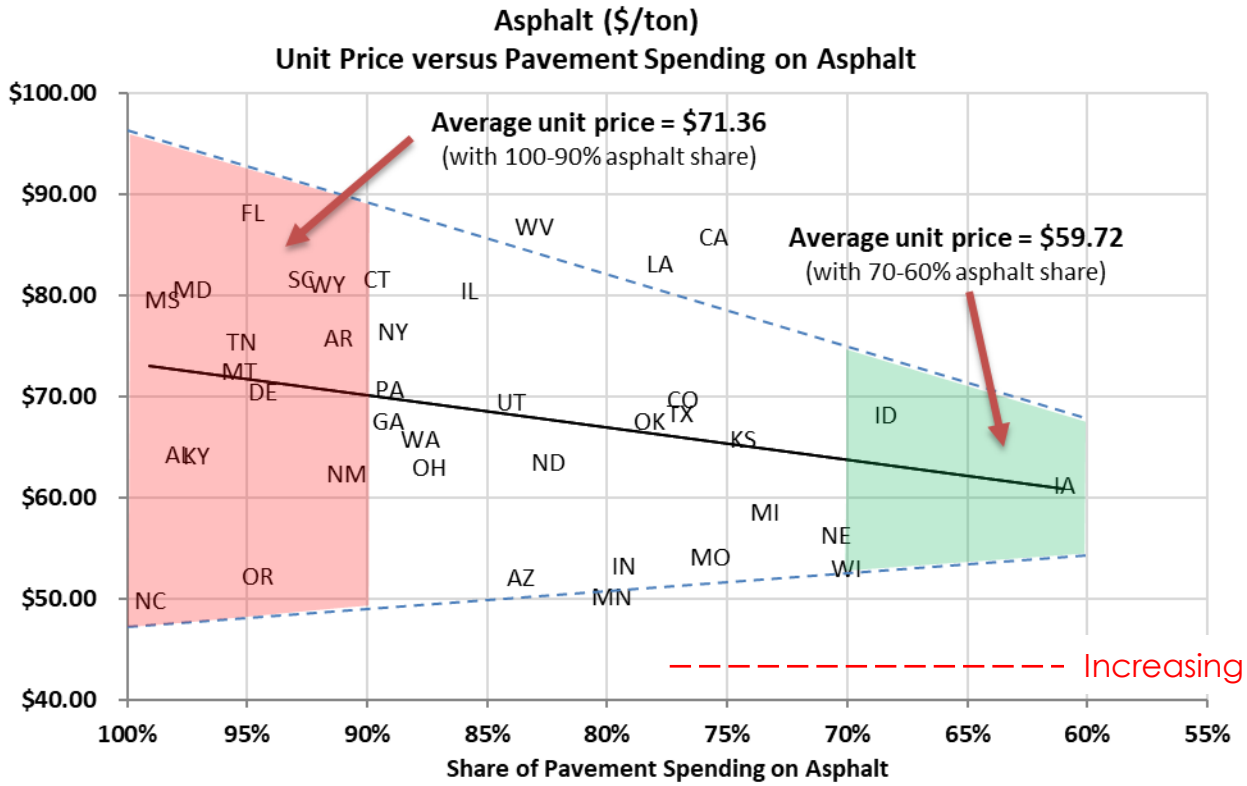
Sources:

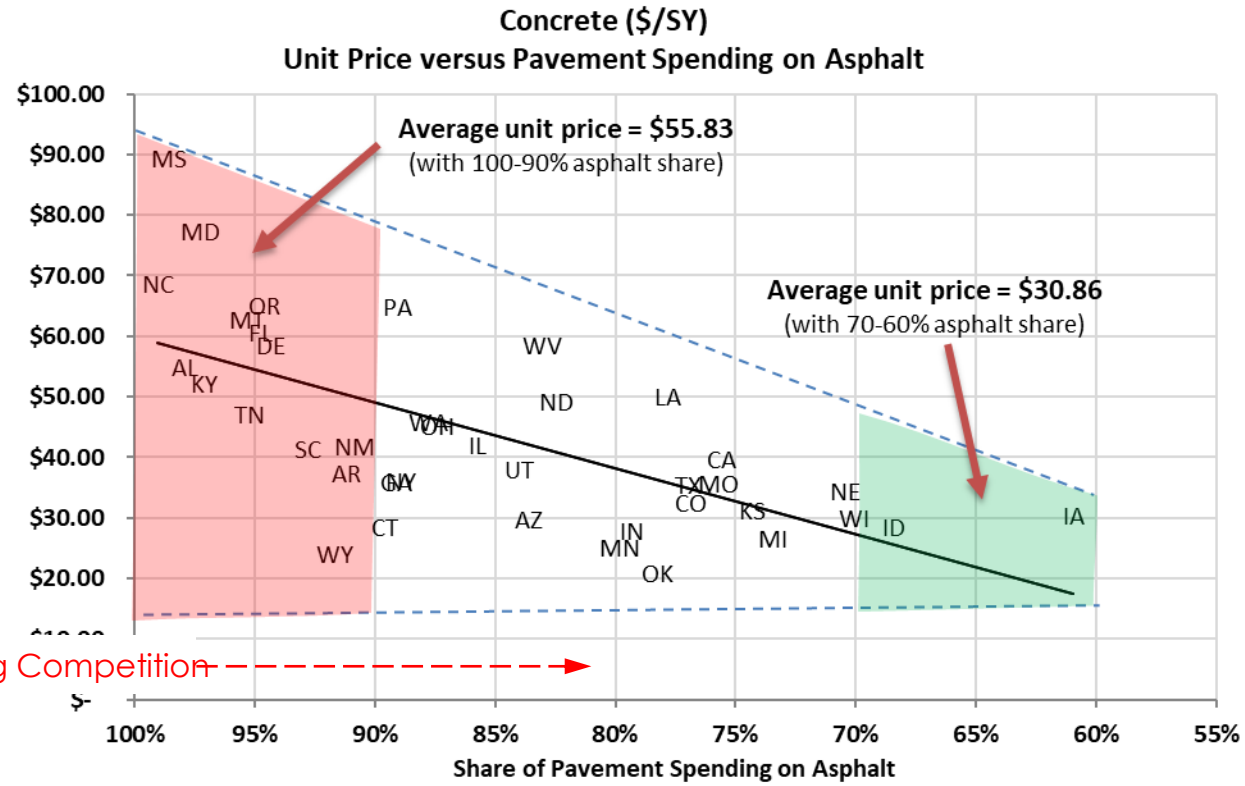
1. Mack, J., Wathne, L., & Mu, F. (2016). Improving Network Investment Results by Implementing Competition and Asset Management in the Pavement Type Selection Process. *Proceedings of the 11th International Conference on Concrete Pavements, Aug 28-Sept 1, 2016.* San Antonio, TX.
2. Oman Systems, Inc Bid Tabulation Data. Retrieved from http://www.omansystems.com

SUSTAINED OPPORTUNITIES TO COMPETE BETWEEN PAVING INDUSTRIES BRINGS VALUE

2007-2011

2007-2011 weighted unit costs vs. five-year average balance of DOT pavement type usage for asphalt and concrete pavements





Increasing Competition

Source Oman Systems, Inc Bid Tabulation Data. Retrieved from http://www.omansystems.com

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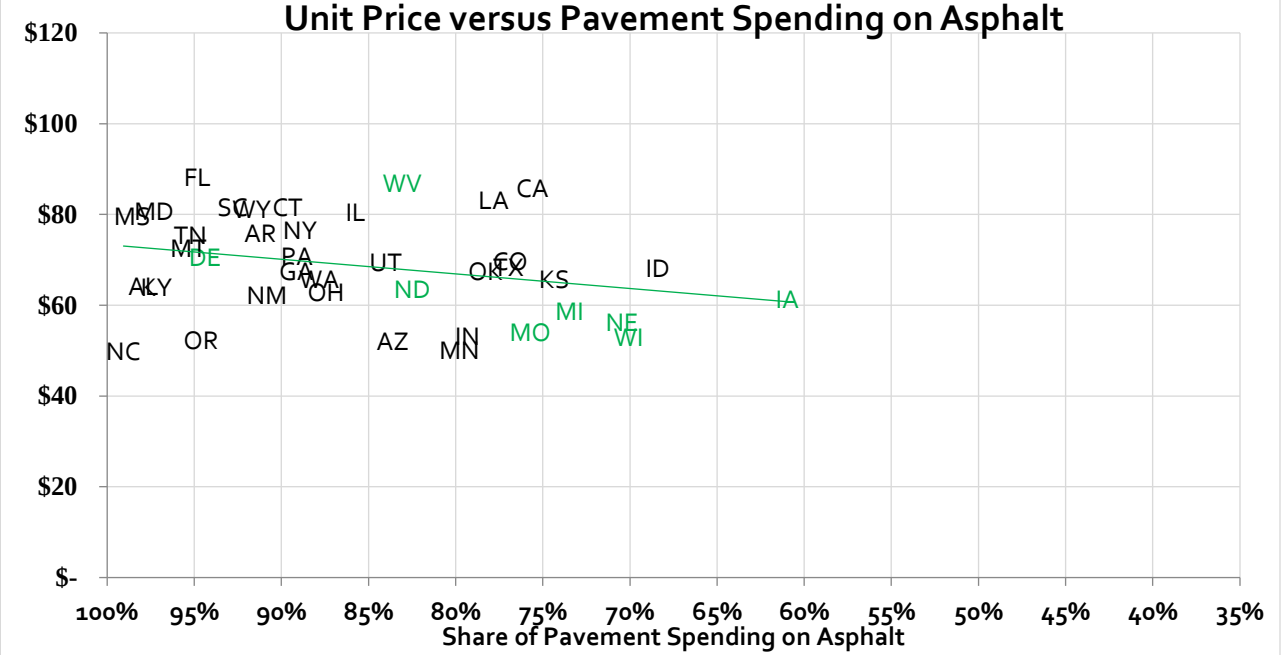
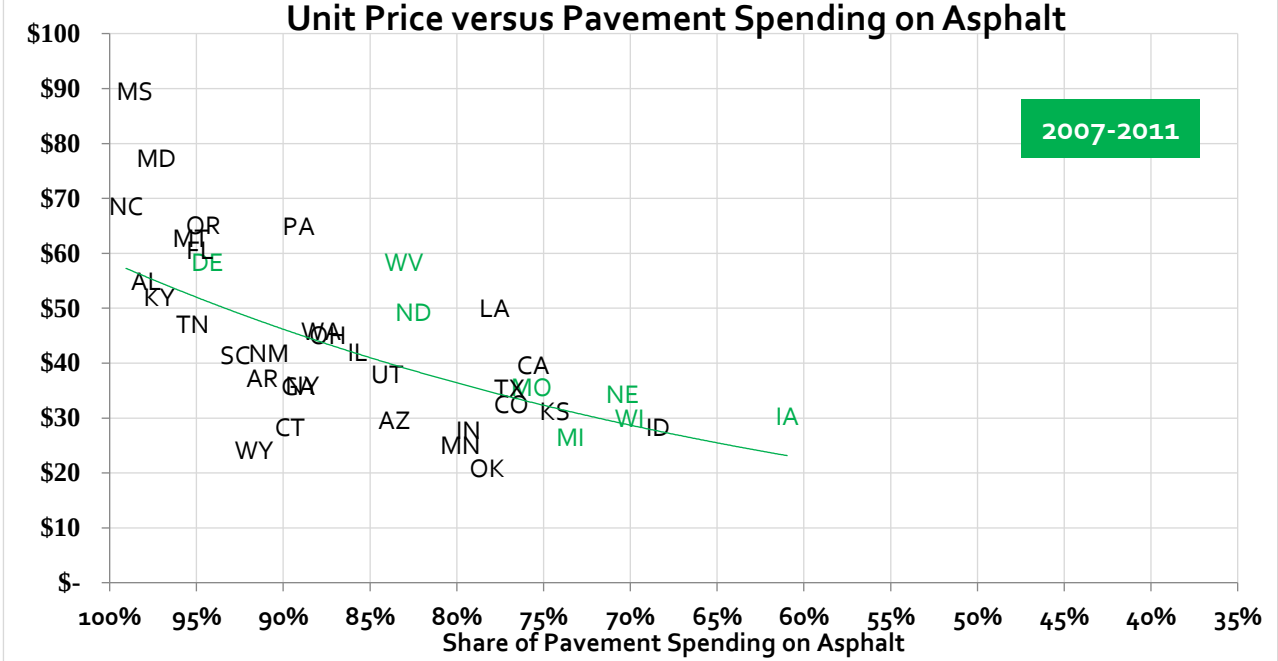
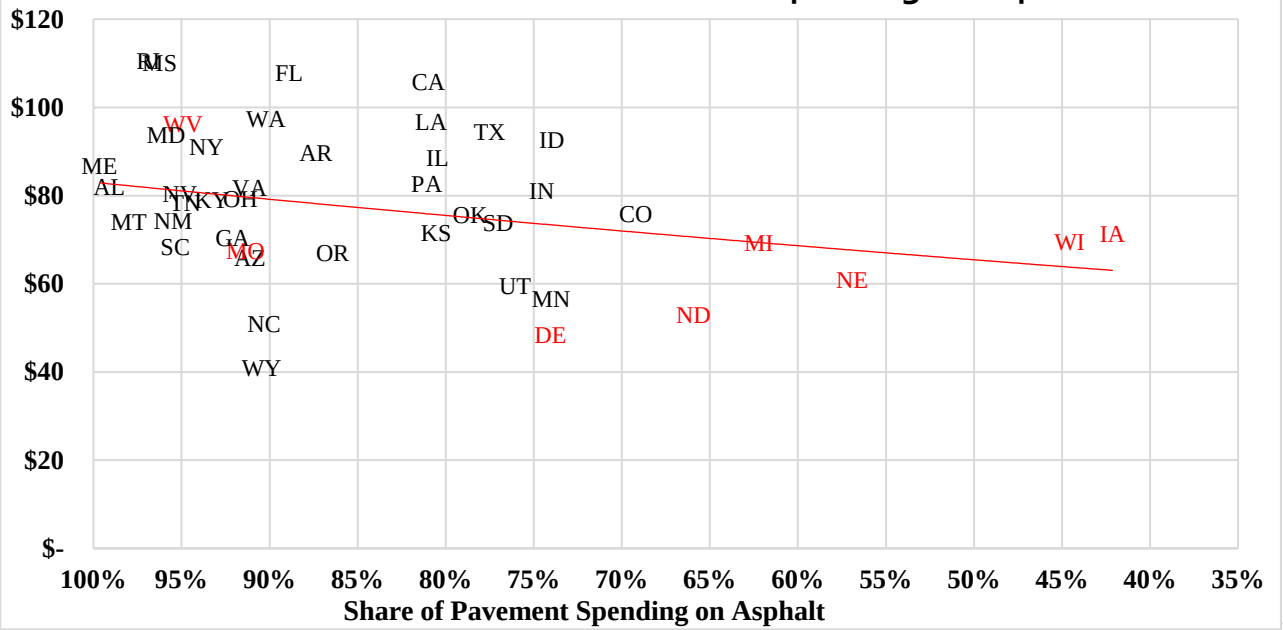
Asphalt ($/ton)
Unit Price versus Pavement Spending on Asphalt



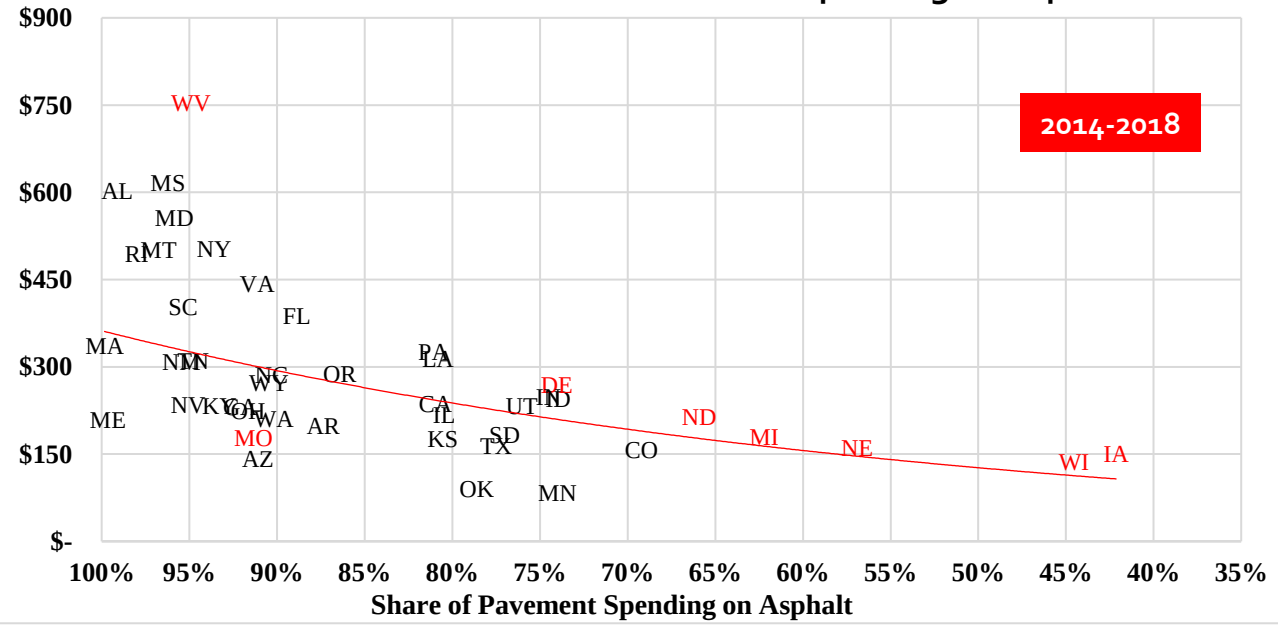
Concrete ($/SY)
Unit Price versus Pavement Spending on Asphalt



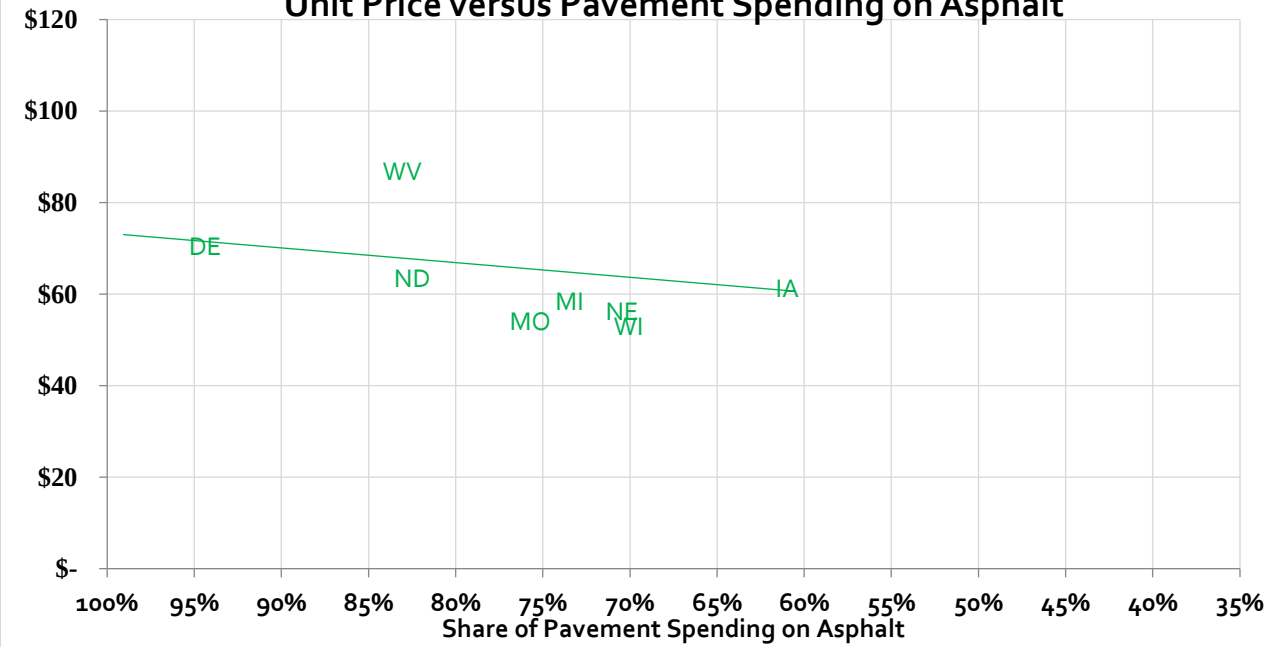
Asphalt ($/ton)
Unit Price versus Share of Pavement Spending on Asphalt



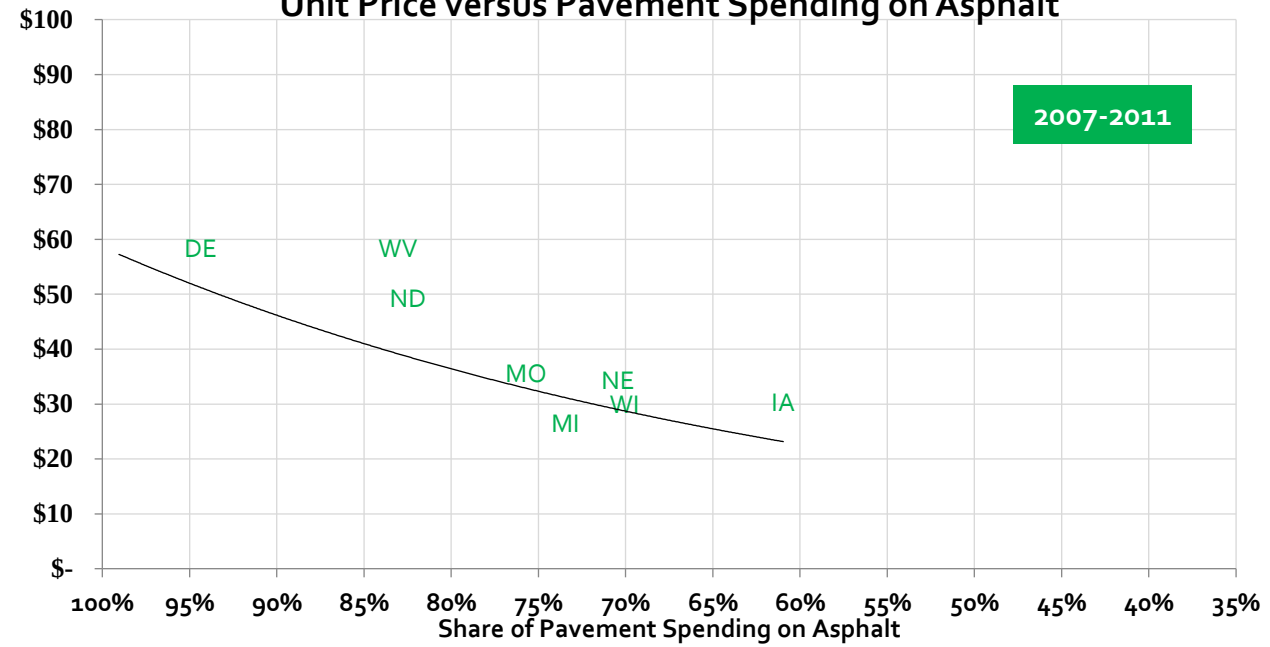
Concrete ($/CY)
Unit Price versus Share of Pavement Spending on Asphalt



Asphalt ($/ton)
Unit Price versus Pavement Spending on Asphalt



Concrete ($/SY)
Unit Price versus Pavement Spending on Asphalt



Asphalt ($/ton)
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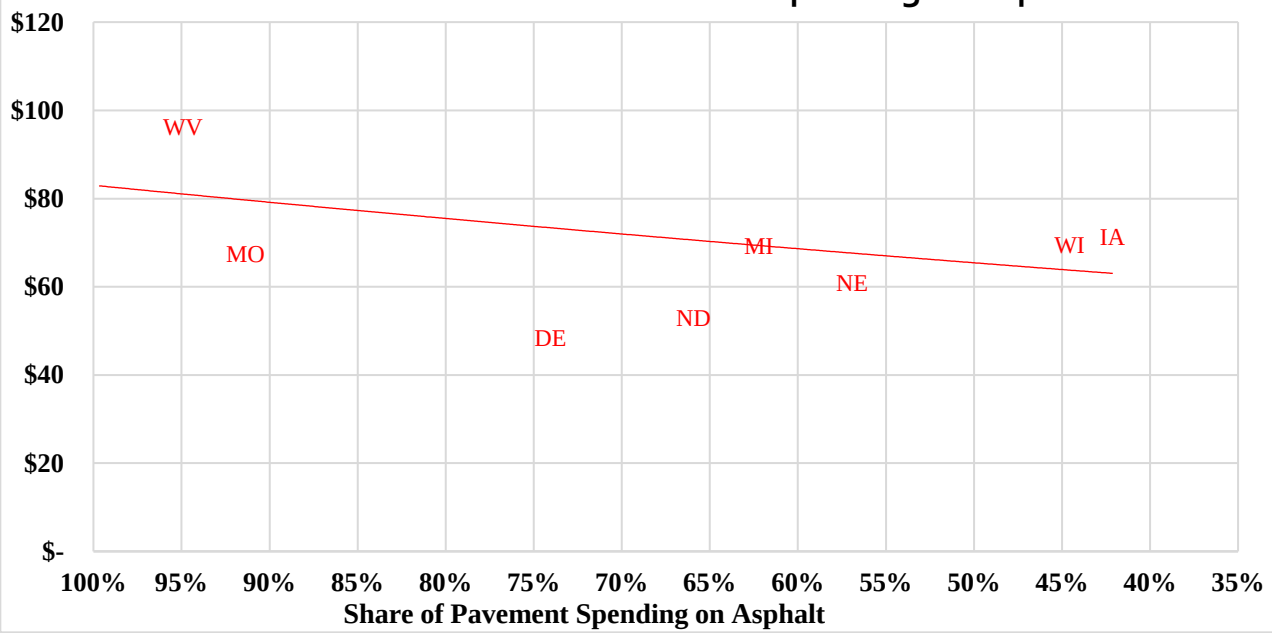
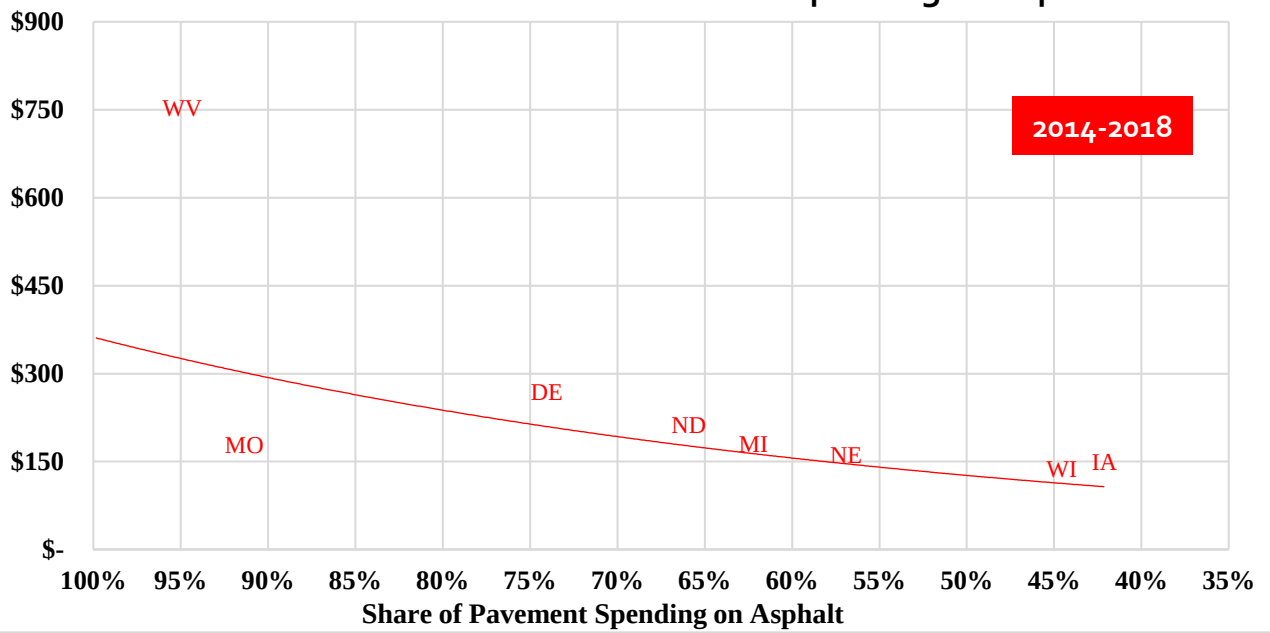
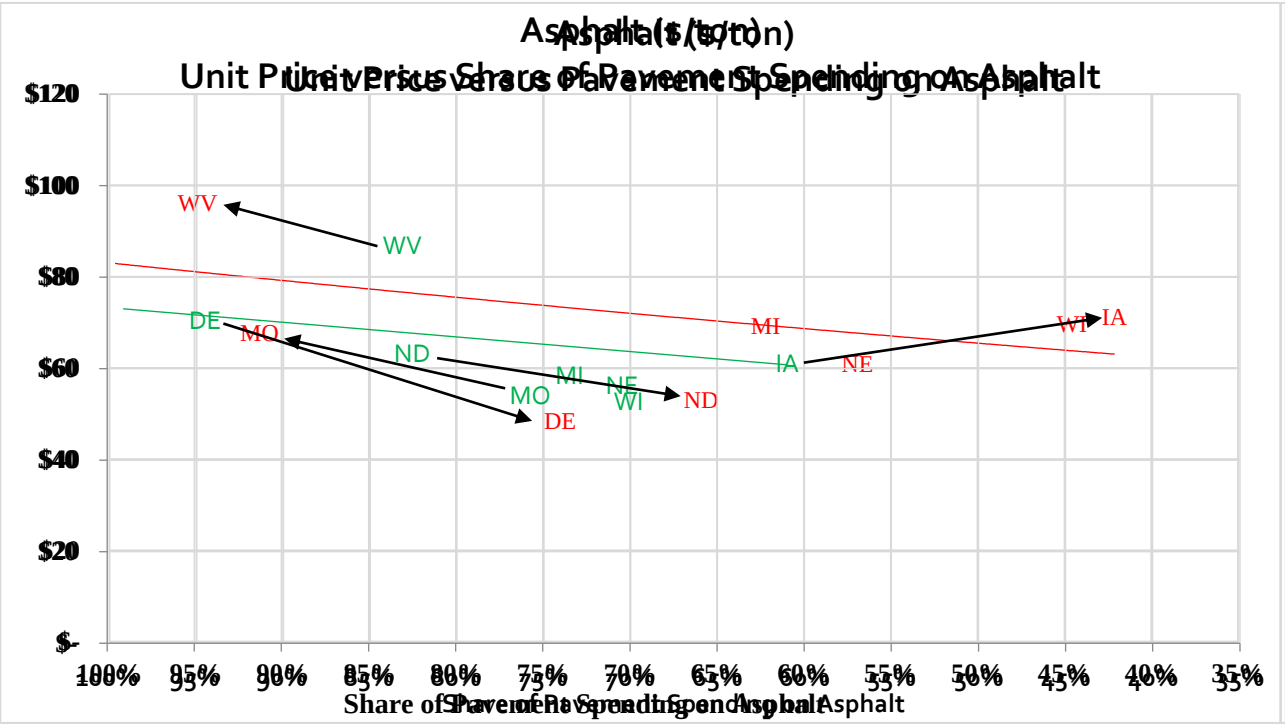


Concrete ($/CY)
Unit Price versus Share of Pavement Spending on Asphalt

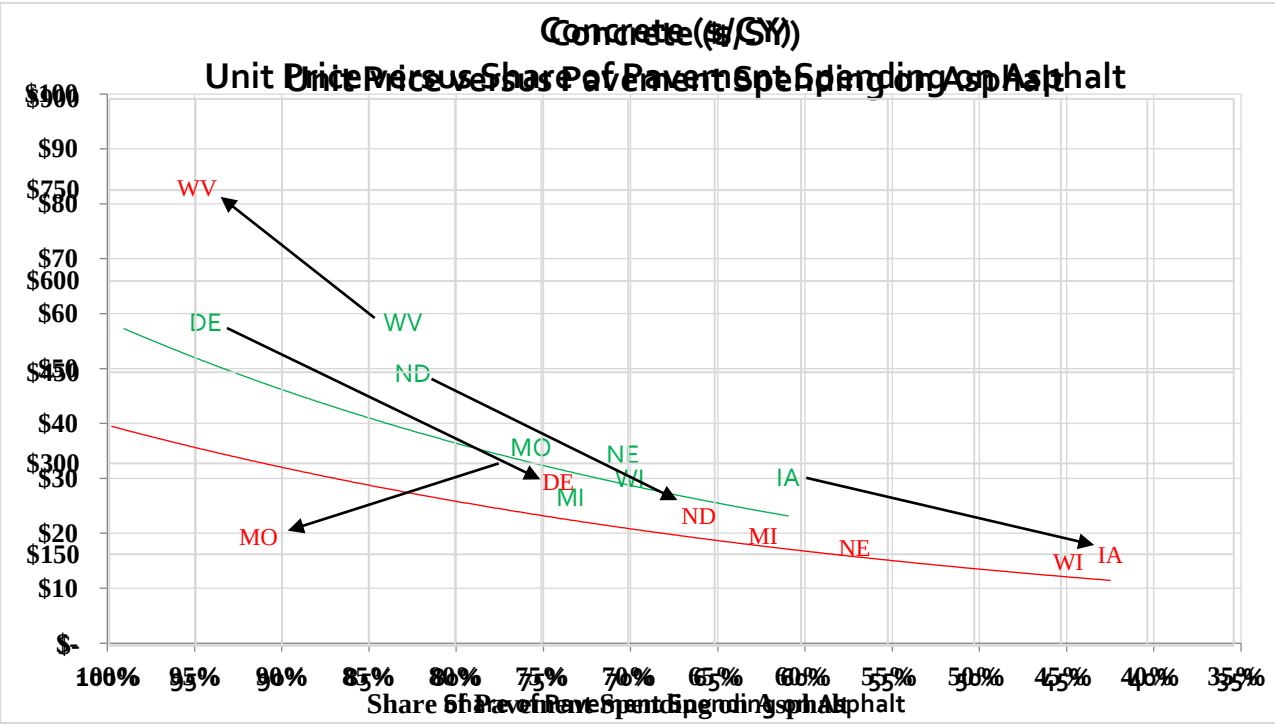


Beginning 2007-2011

Asphalt Prices



Concrete Prices



End 2014-2018

IA, WI, NE and MI all increased their Market share in Concrete Paving

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SUMMARY

Transportation agencies need to find effective methods to maximize performance of pavement segments and make their limited infrastructure dollars go farther

Increasing inter-industry competition (firms that pave with different materials):

- Brings additional contractors and another level of competition to the supply chain
  - Lowers asphalt & concrete pavement costs by 8% and 29%, respectively (highest level of competition vs the lowest level)
    - Intra-industry (same material) competition only reduces costs ~ 3%.

- Agencies should proactively pursue policies that increase inter-industry competition
  - Agencies with a two-pavement system can get more materials at lower costs than agencies that pave with only one material

Iowa DOTs current program is leader as to what competetion can do and IDOT should continue to follow its current practices

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THANK YOU

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