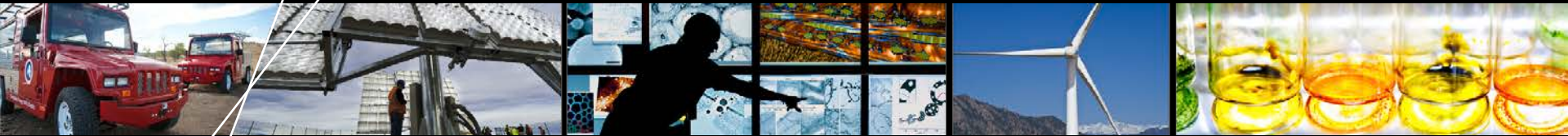


# Preliminary Assessment of Spatial Competition in the Market for E85



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# Overview

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- **Motivation**

- Assess retail pricing of E85
- Inform policy for future E85 expansion
- Provide benchmark prior to U.S. Department of Agriculture's Biofuel Infrastructure Partnership

- **Question**

- Does spatial competition in the market for E85 influence retail pricing behavior?

- **Methods**

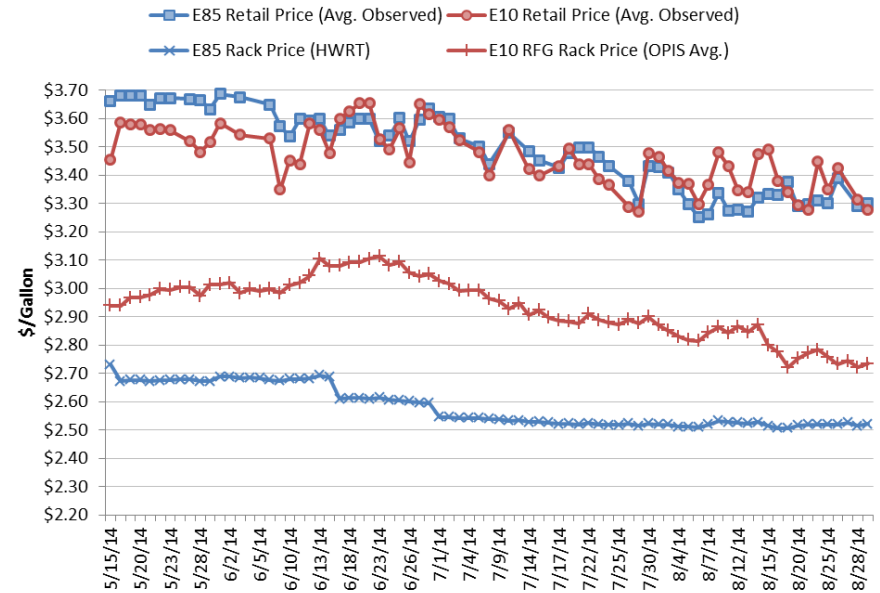
- Econometric analysis using panel data set of station-level wholesale and retail fuel prices

- **Conclusion**

- Evidence of correlation between station density and E85 prices from publicly available data (e85prices.com) and purchased Minnesota data set (Oil Price Information Service)
- More station-level data may produce better-identified and more precise causal results

# Background and Motivation

- **What are recent findings regarding E85 pricing?**
  - Retail E85 prices follow retail prices of regular gasoline.
  - Margins for retail E85 are larger than margins for retail gasoline (Fuels Institute 2014).
- **Why is this important?**
  - Higher E85 prices limit adoption for price-sensitive consumers.
  - Adopters in some areas pay prices that are higher than they would be under cost-based pricing (RFA 2014).
- **Where can we provide insight?**
  - Investigate one potential cause of deviation from cost-based pricing (local market power)
  - No existing national studies of E85 competition



**Figure 1. E85 and E10 pricing in St. Louis, 2014.** Source: “Evidence of E85 Price Gouging?” Source: Renewable Fuels Association (2014); rack price data from OPIS, retail prices from study observations.



**Figure 2. Retail margins for E85 and regular gasoline.** Source: “E85: A Market Performance Analysis and Forecast,” Fuels Institute (2014, November); data from NACS-CSX.00

# Methodology

- **Data**

- Publicly available data set for United States, 2007–2015
  - Price observations reported by individual users based on retail price signage and fuel purchases
  - Sources: Renewable Fuels Association (RFA), e85prices.com
- Proprietary data set for Minnesota, 2014
  - Fuel prices recorded from credit card transactions and direct feeds from retailers
  - Source: Oil Price Information Service (OPIS)
- Both data sets report concurrent retail prices for regular gasoline and E85 at individual stations

- **Competition metrics**

1. Number of competing E85 stations within a given radius
  - Existing studies of this metric for retail gasoline: Lee (2007), Barron et al. (2004), Hastings et al. (2004)
  - Evidence that lost retail gasoline sales are distributed to competing stations within a one-mile radius (Lee 2007)
2. Distance to nearest station that offers E85

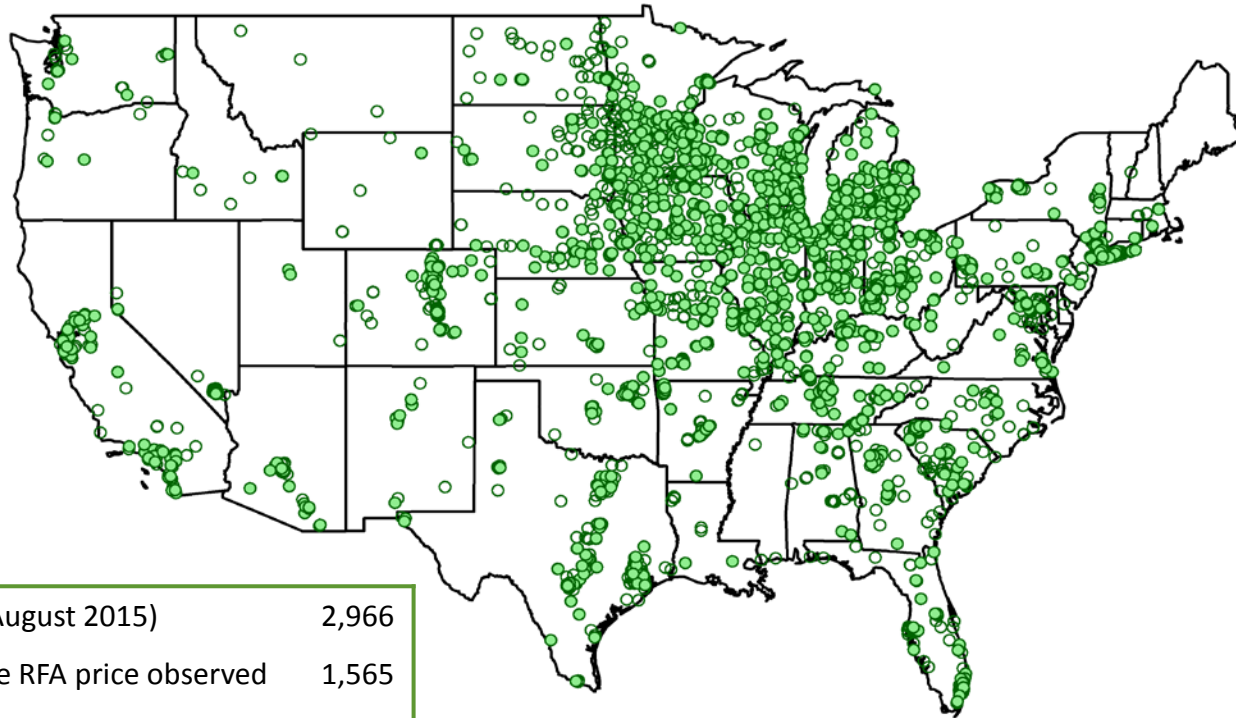
# Methodology

- **Empirical strategy**
  - Across-station variation (cross-sectional analysis)
    - Compare pricing among stations given variation in spatial competition faced by each station
    - Control for time-invariant, spatial variation (e.g., density of flexible-fuel vehicles, access to highway infrastructure, and local regulation) through spatial fixed effects
    - Address national, time-varying effects (e.g., changes in E85 infrastructure costs, national trends in wholesale fuel cost, and E85 familiarity and adoption) with temporal fixed effects
  - Within-station variation
    - Track price variation for a single station when number of nearby E85 competitors changes
    - Replace spatial fixed effects with station-level fixed effects to control for station-level, time-invariant effects (e.g., brand, location, and amenities)
  - All models control for same-day, same-station retail gasoline price.
  - Estimates of local market power effects are computed in terms of change in price (\$/gal) and percent change in price.

# National Analysis: Data—Price Series

- **Compiled national price series**
  - Publicly available, user-reported pricing data from e85prices.com
  - Prices reported between January 2007 and August 2015

**Figure 3. Map of E85 Stations in National Data Set**



|   |       |
|---|-------|
| E85 stations per AFDC (August 2015)           | 2,966 |
| Stations with at least one RFA price observed | 1,565 |
| Mean number of price observed per station     | 25    |
| Median number of price observed per station   | 7     |

Notes: Circles represent E85 stations. Circles with light green fill represent stations with at least one price observation. Sources: AFDC, E85Prices.com, Clean Cities.

# National Analysis: Data—Price Spreads

Figure 4. Price Spread in \$/gallon

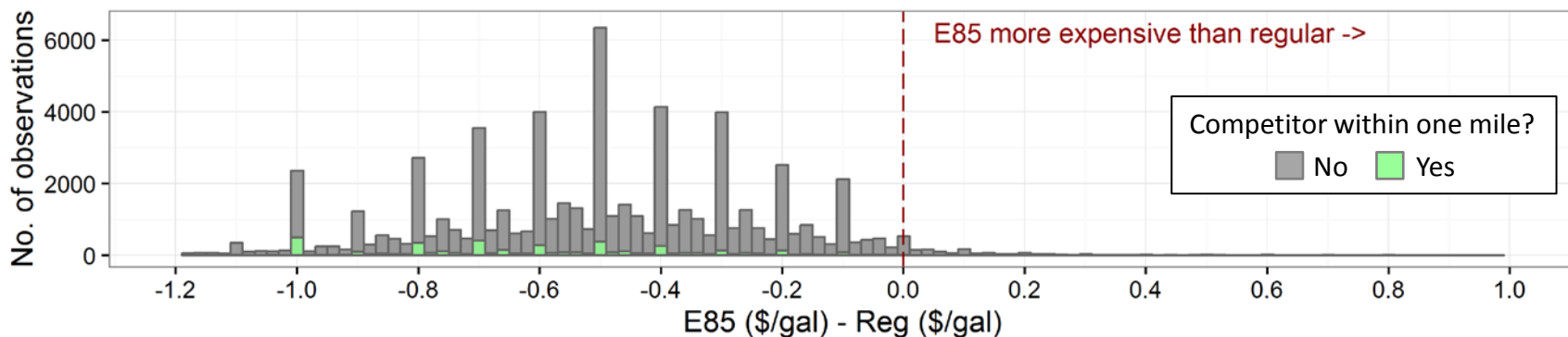
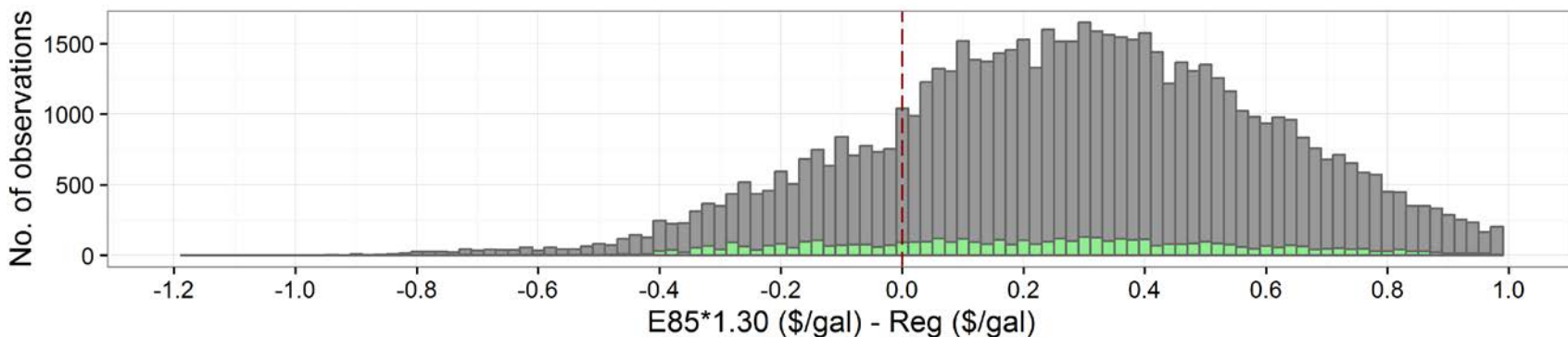


Figure 5. Price Spread in \$/GGE



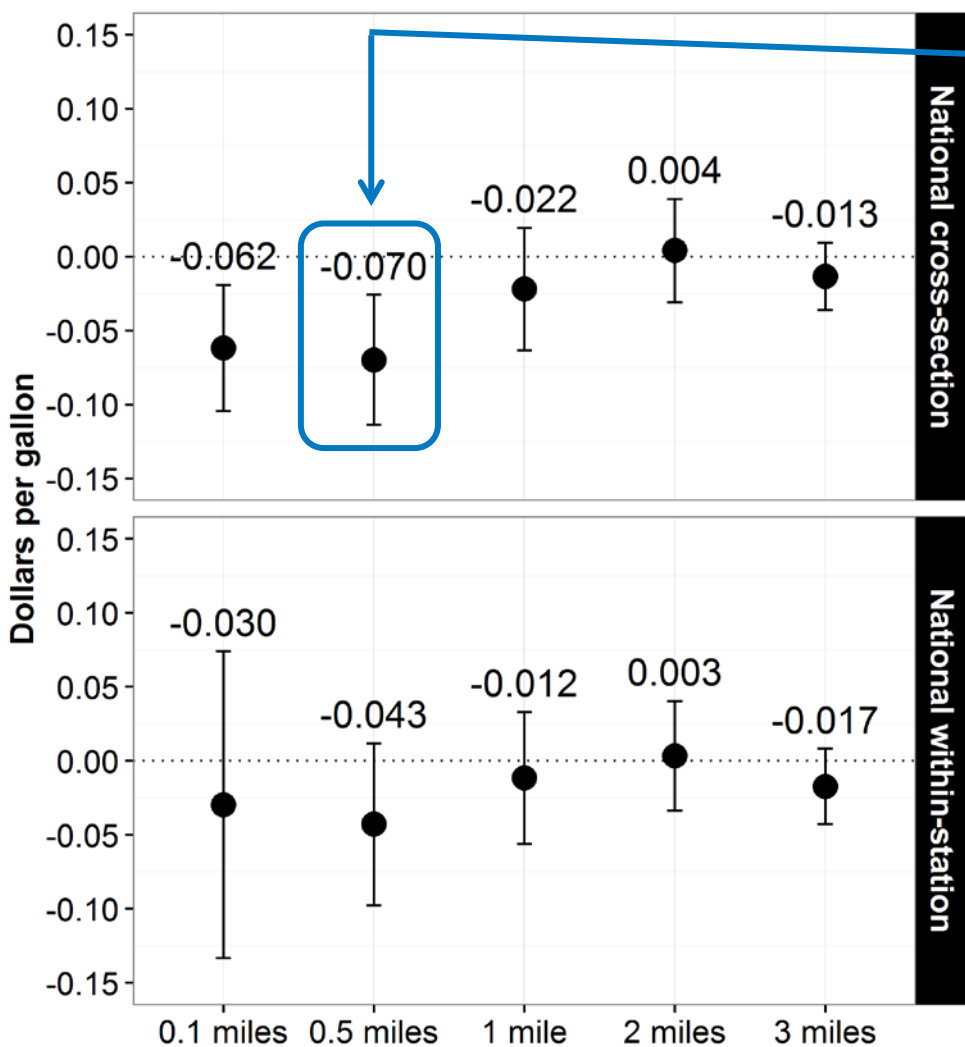
| Spread Units | Competitor within One Mile? | Number of Price Observations | Percent of Price Observations   |                                 |
|--------------|-----------------------------|------------------------------|---------------------------------|---------------------------------|
|              |                             |                              | E85 Less Expensive than Regular | E85 More Expensive than Regular |
| \$/gal       | No                          | 33,253                       | 97.8                            | 2.2                             |
|              | Yes                         | 5,116                        | 98.1                            | 1.9                             |
| \$/GGE       | No                          | 33,253                       | 22.4                            | 77.6                            |
|              | Yes                         | 5,116                        | 28.2                            | 71.8                            |

Note: Gasoline gallon equivalent (GGE) assumes 70 percent ethanol blend. [E85 \$/GGE]=[E85 \$/gal]\*1.30. Source: Clean Cities 2015.

# National Analysis: Results—Station Density

**Figure 6. Station Density Pricing Impacts**

Number of stations within ...



**Interpretation:** One more station offering E85 within 0.5 miles is associated with a \$0.07 lower E85 price per gallon, all else being equal. Confidence intervals indicate estimates range from approximately -\$0.11 to -\$0.03.

- **Cross-section results**

- Spatial competition associated with lower E85 pricing within 0.5 miles

- **Within-station results**

- Point estimates suggest possible inverse relationship between E85 prices and spatial density
- Coefficient estimates for variables of interest lack statistical significance
- Imprecise estimates likely result from limited number of observable price and station density changes (e.g., five identifying stations at 0.1 miles for within-station analysis)

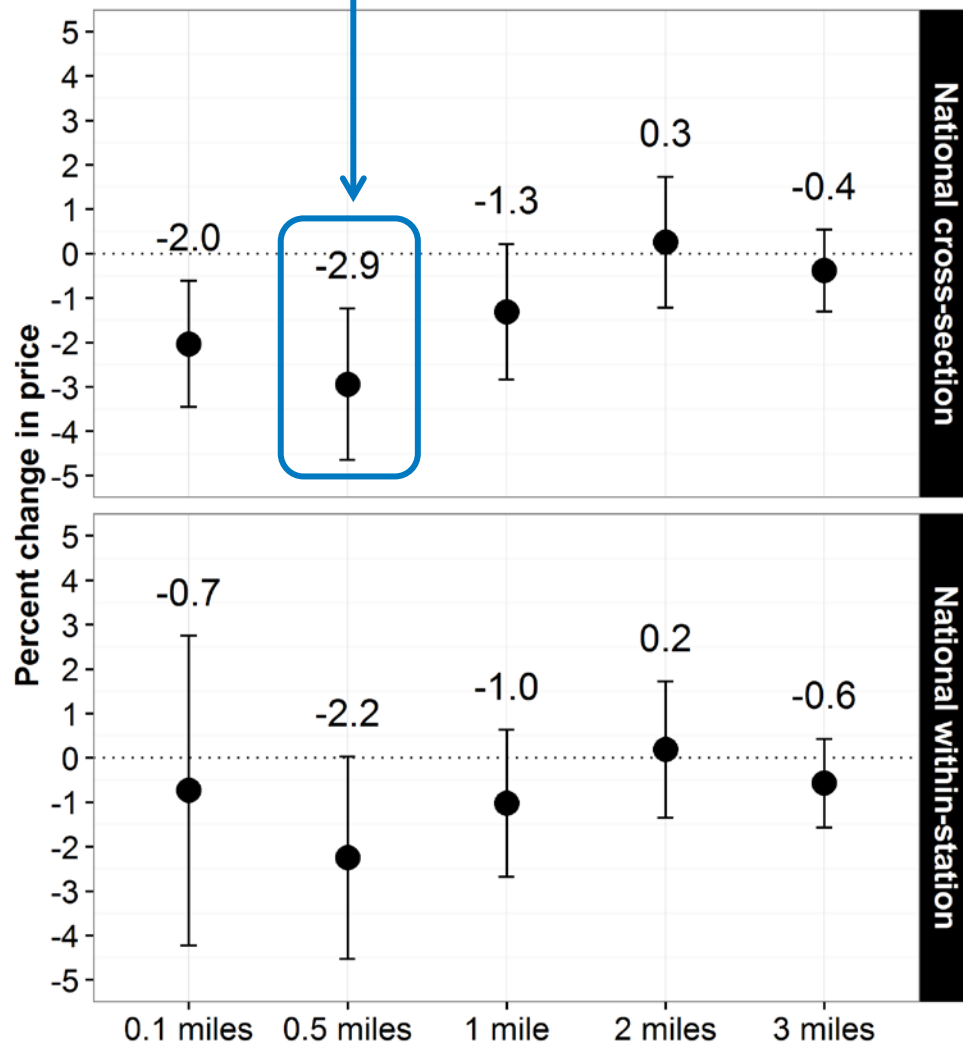
Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals.



# National Analysis: Results—Station Density

**Figure 7. Station Density Pricing Impacts**

Number of stations within ...



**Interpretation:** One more station offering E85 within 0.5 miles is associated with a 2.9 percent lower E85 price per gallon, all else being equal. Confidence intervals indicate estimates range from approximately -1.2 to -4.6 percent.

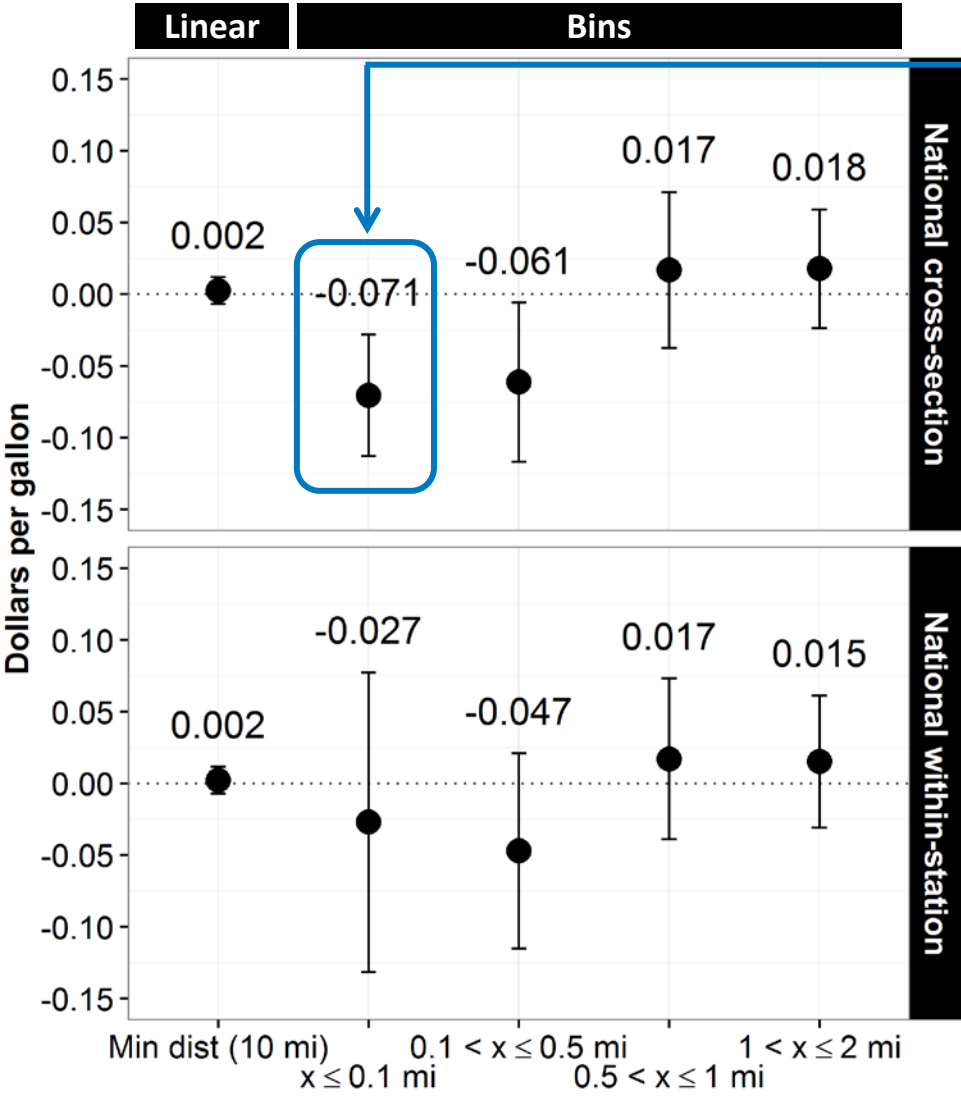
- **Impacts in percent price change**
  - Point estimates of competition effect are qualitatively similar to price changes
  - Cross-sectional analysis of competitive effects within 0.5 miles maintains significance at the 95 percent level

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals.

# National Analysis: Results—Competitor Proximity

Figure 8. Competitor Proximity Pricing Impacts

**Interpretation:** A station whose nearest competitor is within 0.1 miles will price E85 approximately \$0.07 per gallon lower than an otherwise identical station whose nearest competitor is more than two miles away.

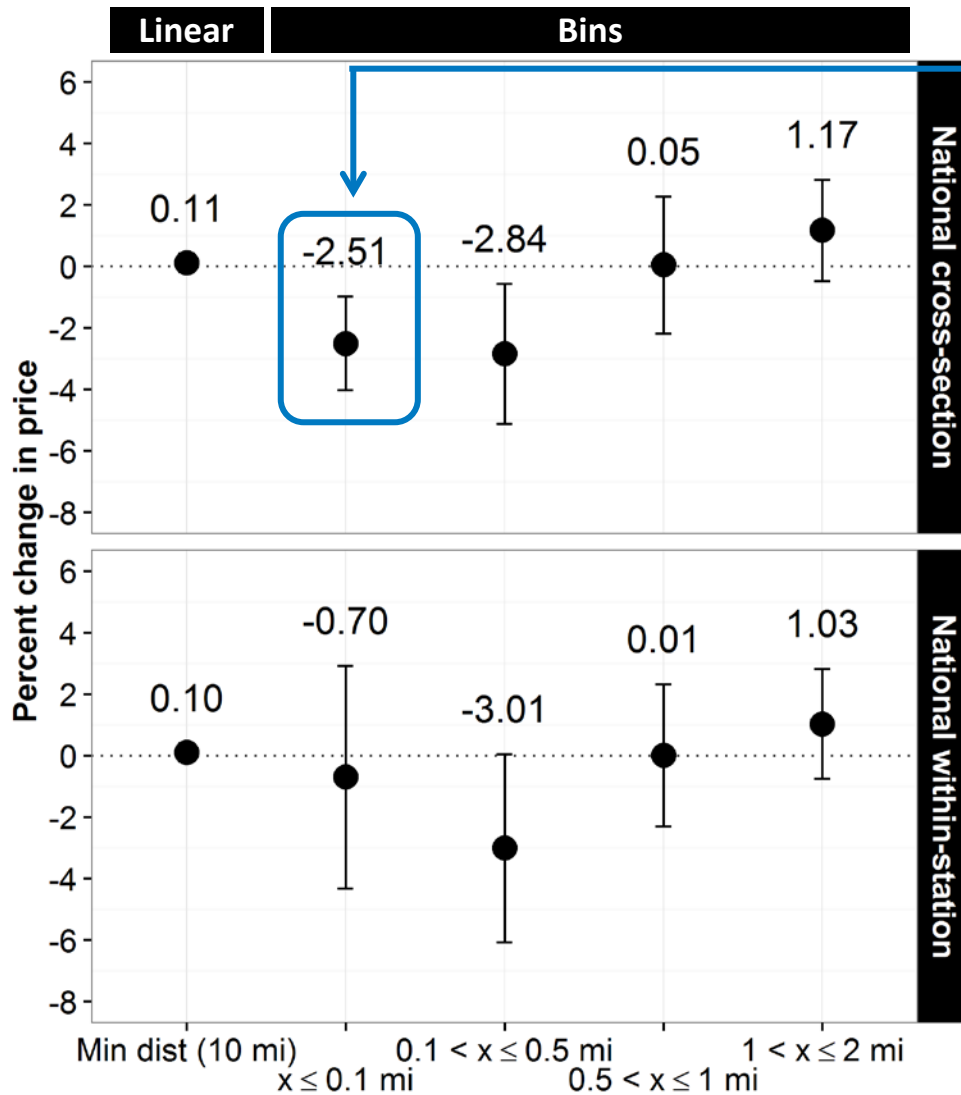


- **Linear minimum distance metric**
  - Neither cross-section nor within-station specification indicates a statistically significant relationship between nearest competitor distance and E85 pricing
  - Result possibly due to non-linear relationship between competitor proximity and E85 price
- **Binned minimum distance metric**
  - Cross-sectional analysis reveals a statistically significant relationship within 0.5 miles
  - Within-station results lack precision, but point estimates display a pattern similar to the cross-sectional result

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals. The omitted bin is nearest competitor more than two miles away.

# National Analysis: Results—Competitor Proximity

Figure 9. Competitor Proximity Pricing Impacts



**Interpretation:** A station whose nearest competitor is within 0.1 miles is associated with a 2.9 percent lower E85 price per gallon than an otherwise identical station whose nearest competitor is more than two miles away.

- **Impacts in percent price change**
  - Point estimates of competition effect are qualitatively similar to price changes
  - Cross-sectional analysis of competitive effects within 0.5 miles maintains significance at the 95 percent level

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals. The omitted bin is nearest competitor more than two miles away.

# Alternative Data Set: Minnesota

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- **Oil Price Information Service (OPIS) proprietary retail price data**
  - Station-level prices and station attributes for all Minnesota stations in 2014
  - Daily prices for regular gasoline and E85 purchases included in data set
  - Minnesota identified as best candidate for data purchase based on conversations with OPIS personnel and analysis of E85 station entry from AFDC data
  - Cross-referenced OPIS price reports with AFDC station identification data and RFA user-reported prices from e85prices.com
  - Where possible, supplemented data with RFA observations

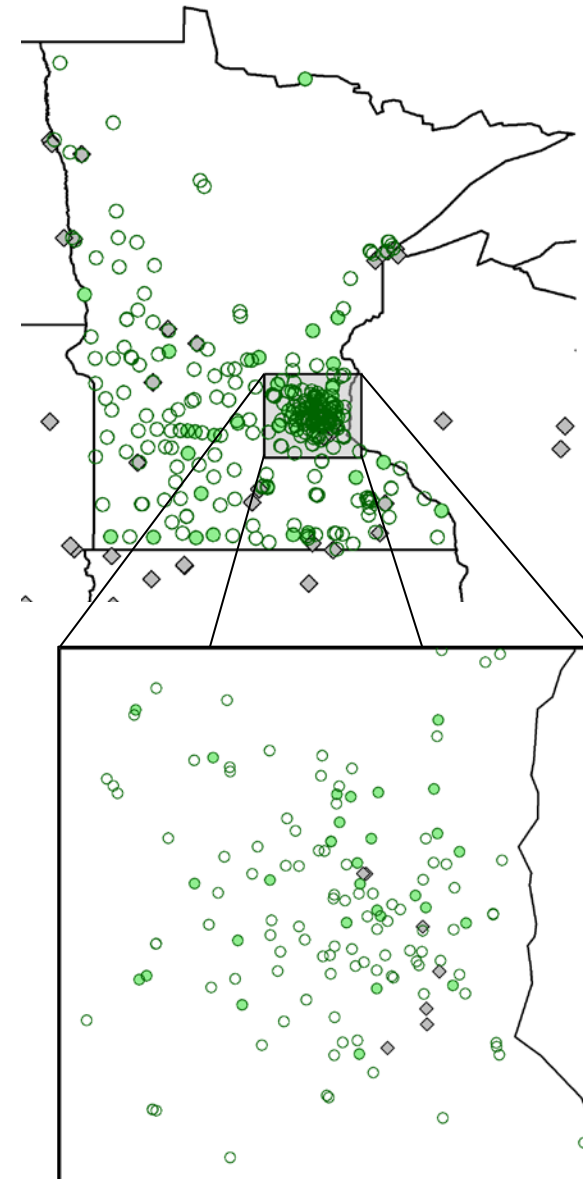
# Minnesota Analysis: Data—E85 Stations

**Table 1. Counts and Average Prices for Minnesota E85 Stations, 2014**

|    |  | Retail Fuel Stations | E85 Stations | Stations with E85 Data | Average E10 Price | Average E85 Price |
|----|--|----------------------|--------------|------------------------|-------------------|-------------------|
| 1  | Minnesota stations                                 | 2,660                | 288          | 109                    | 3.24              | 2.59              |
| 2  | Isolated stations <sup>a</sup>                     | 2,074                | 237          | 93                     | 3.23              | 2.63              |
| 3  | With an E85 station within ...                     |                      |              |                        |                   |                   |
| 4  | ... 1 mile   | 586                  | 51           | 16                     | 3.21              | 2.40              |
| 5  | ... 0.5 miles                                      | 295                  | 23           | 7                      | 3.19              | 2.35              |
| 6  | ... 0.1 miles                                      | 69                   | 7            | 2                      | 3.28              | 2.49              |
| 7  | With E85 station density change in 2014 within ... |                      |              |                        |                   |                   |
| 8  | ... 1 mile   | 55                   | 6            | 2                      | 3.23              | 2.24              |
| 9  | ... 0.5 miles                                      | 28                   | 2            | 1                      | 3.22              | 2.30              |
| 10 | ... 0.1 miles                                      | 12                   | 1            | 1                      | 3.22              | 2.30              |

Retail fuel prices in dollars per gallon. Price data are from OPIS and in the absence of OPIS price observations are supplemented with RFA user-reported data. Minnesota stations exclude unidentifiable stations and 12 restricted access stations. AFDC data identify 18 stations that enter the E85 market in Minnesota in 2014.

<sup>a</sup> Row 2 (“isolated stations”) reports data for E85 stations without another E85 station within one mile.



# Minnesota Analysis: Data—Price Spreads

Figure 10. Price Spread in \$/gallon

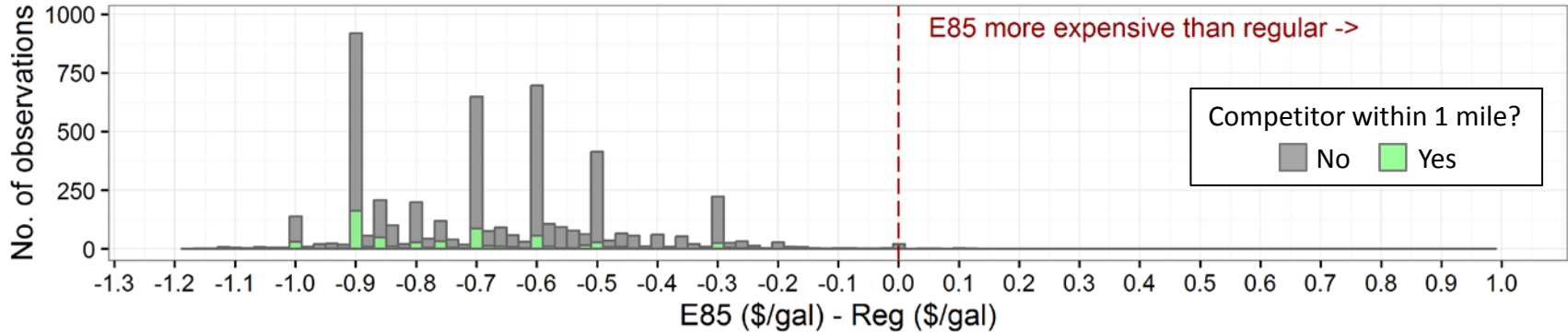
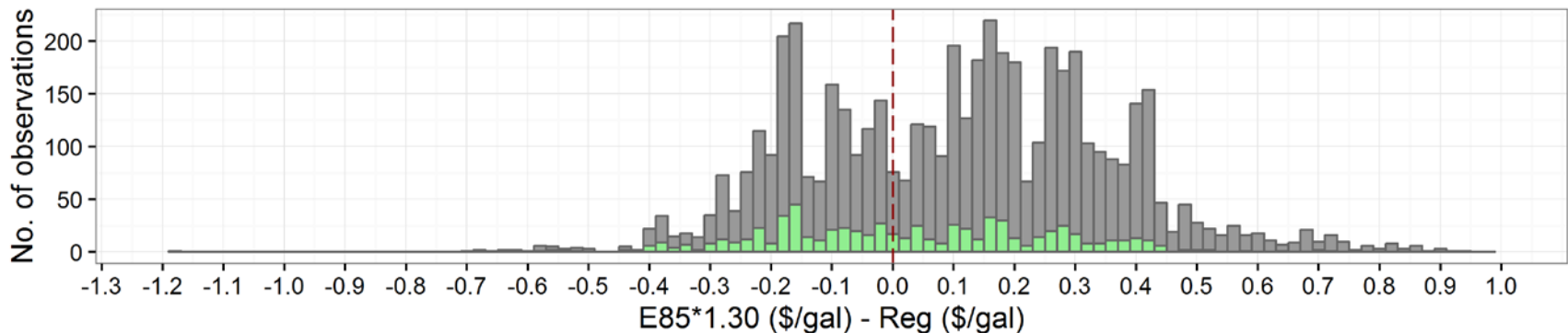


Figure 11. Price Spread in \$/GGE



| Spread Units | Competitor within One Mile? | Number of Price Observations | Percent of Price Observations   |                                 |
|--------------|-----------------------------|------------------------------|---------------------------------|---------------------------------|
|              |                             |                              | E85 Less Expensive than Regular | E85 More Expensive than Regular |
| \$/gal       | No                          | 4,354                        | 99.7                            | 0.3                             |
|              | Yes                         | 708                          | 99.8                            | 0.2                             |
| \$/GGE       | No                          | 4,354                        | 33.7                            | 66.3                            |
|              | Yes                         | 708                          | 48.4                            | 51.6                            |

# Minnesota Analysis: Price Correlations

Figure 12. Retail E85 vs. Retail E10

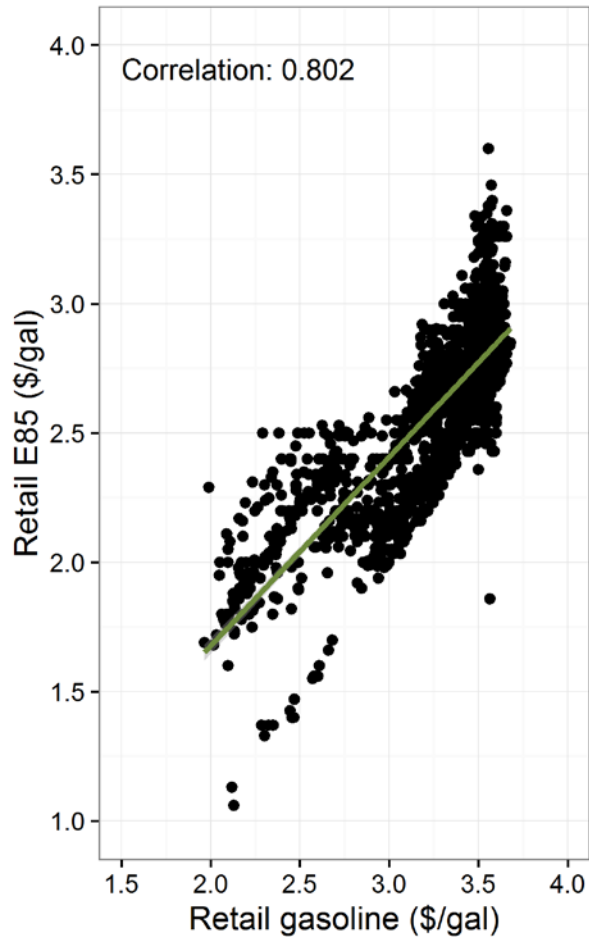


Figure 13. Retail E85 vs. Ethanol

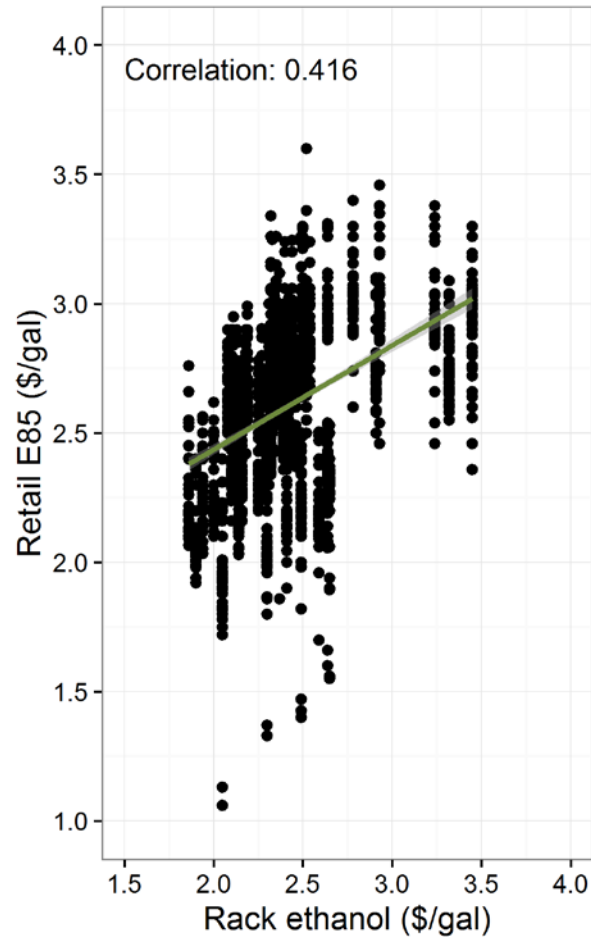
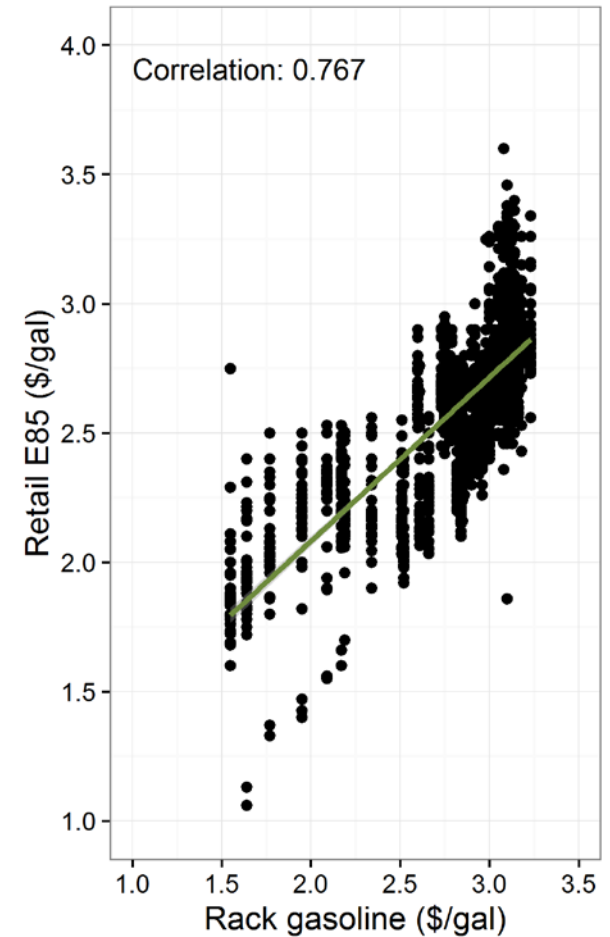


Figure 14. Retail E85 vs. Gasoline

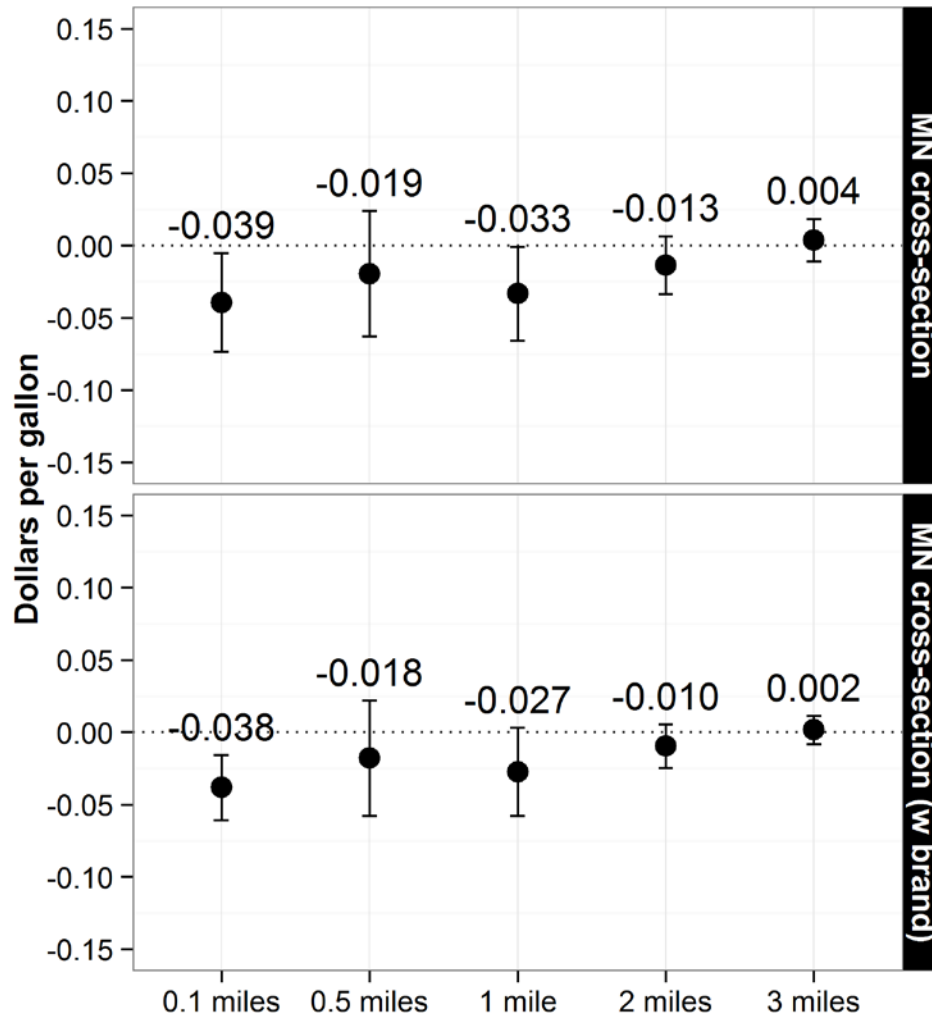


Sources: OPIS retail pricing data, Minnesota 2014; RFA user-reported data, e85prices.com; Minnesota Dept. of Agriculture, "Ethanol Market News," August 2015; EIA, "Minnesota Regular Gasoline Wholesale/Resale Price by Refiners."

# Minnesota Analysis: Results—Station Density

**Figure 15. Station Density Pricing Impacts**

Number of stations within ...



- **Cross-section results**

- Spatial competition associated with lower E85 pricing within one mile
- Insufficient identifying variation in data set for within-station analysis
  - Two stations with variation within one mile, one station with variation within 0.1 miles.
- Refinement with station brand controls produces similar point estimates and decreases variance

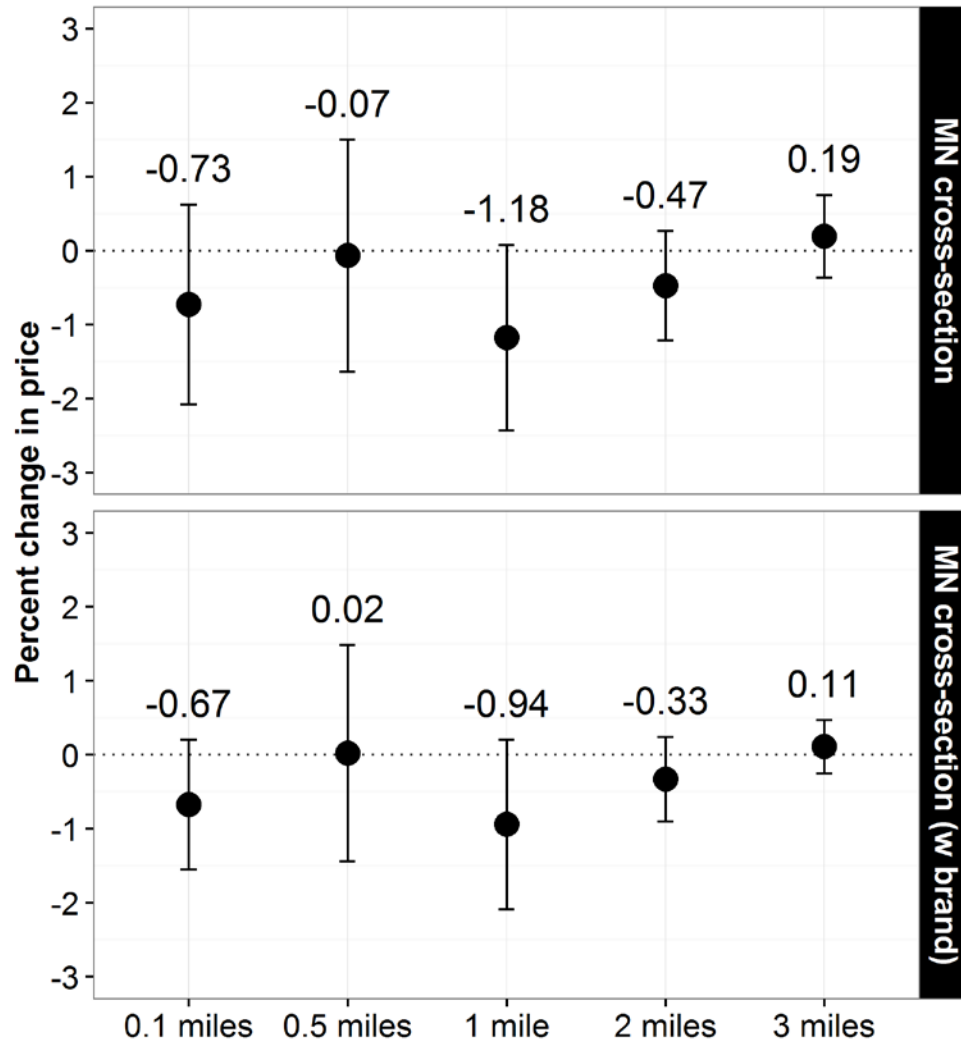
Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals.



# Minnesota Analysis: Results—Station Density

Figure 16. Station Density Pricing Impacts

Number of stations within ...

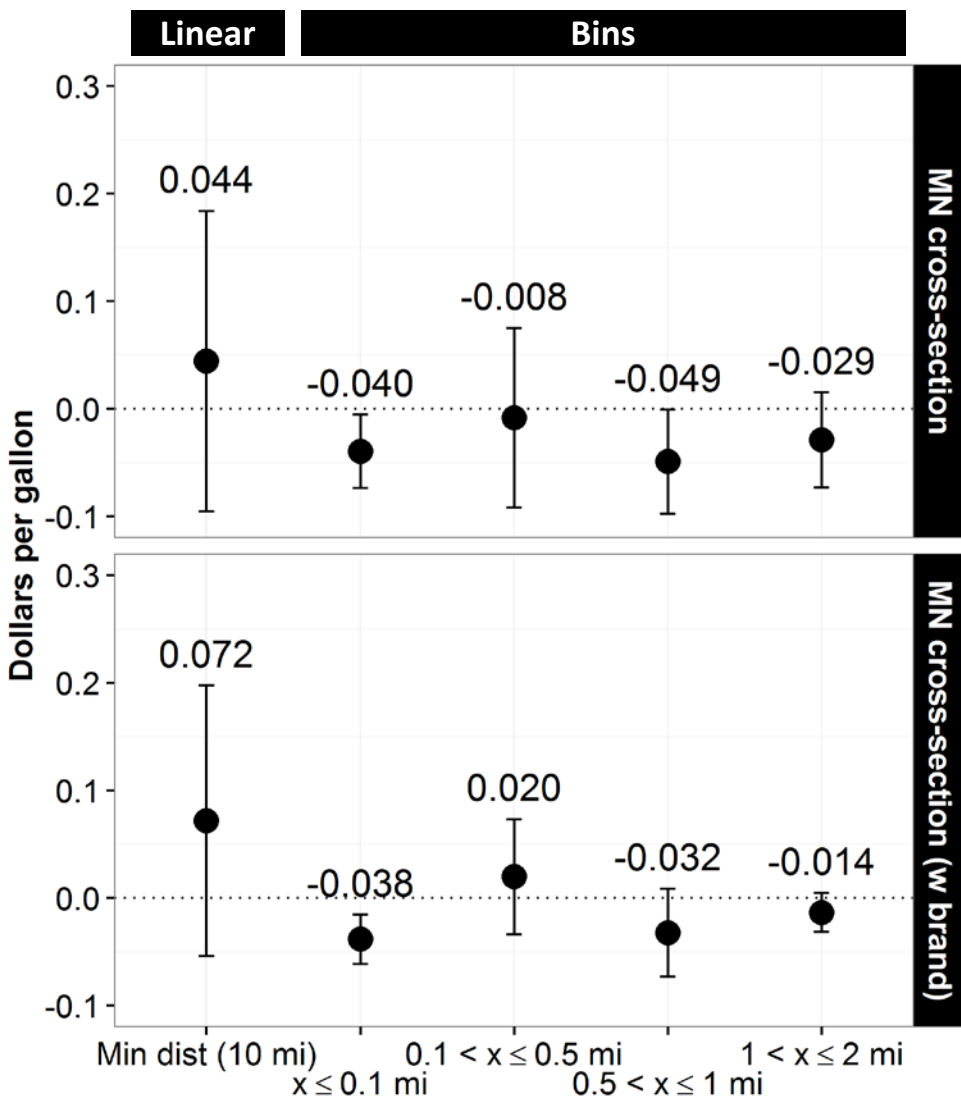


- Impacts in percent price change
  - Point estimates of competition effect are qualitatively similar to price changes
  - No estimates demonstrate statistical significance at the 95 percent level

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals.

# Minnesota Analysis: Results—Competitor Proximity

Figure 17. Competitor Proximity Pricing Impacts

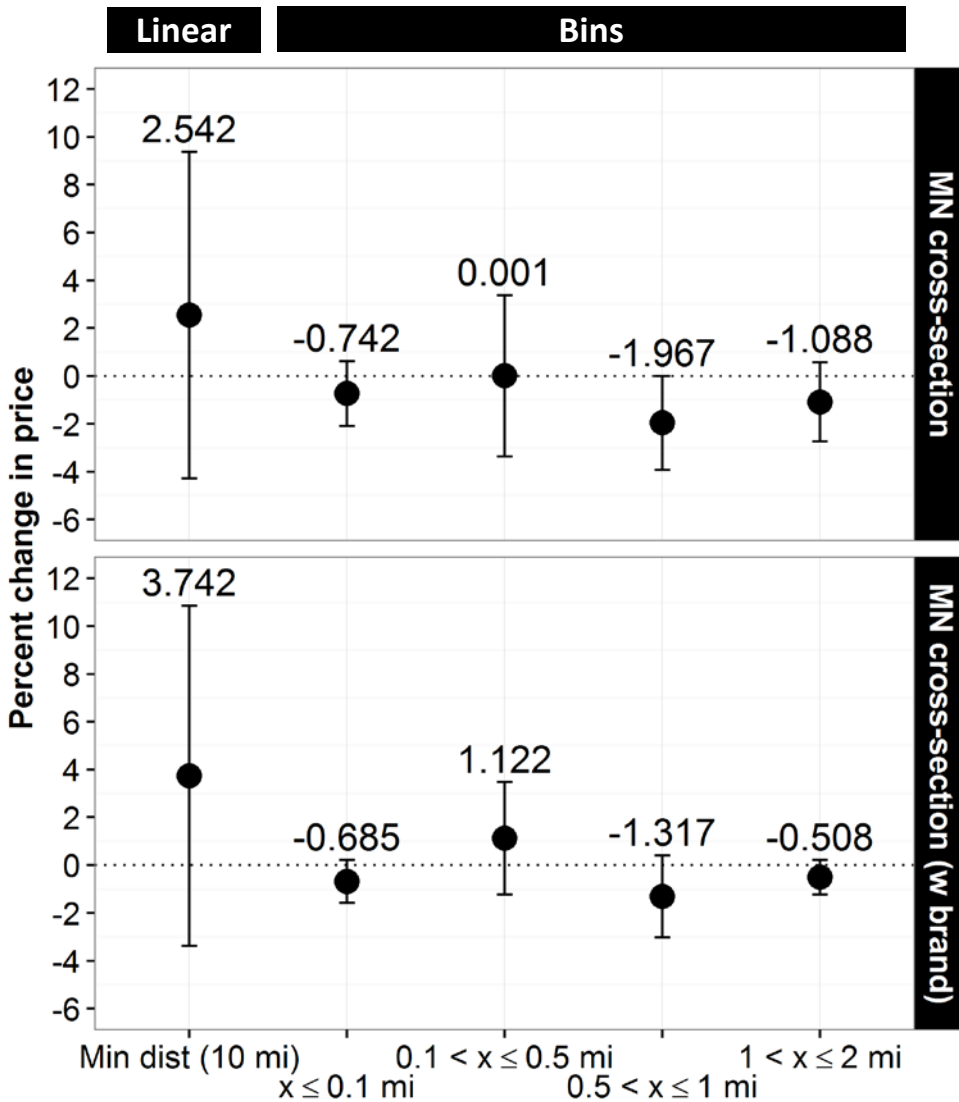


- **Linear minimum distance metric**
  - Point estimates are of larger magnitude than in national analysis
  - Specifications do not suggest a statistically significant, linear relationship between E85 retailer proximity and E85 price
- **Binned minimum distance metric**
  - Both specifications indicate a statistically significant effect for station competition within one tenth of a mile
  - Effects for bins beyond 0.1 miles lack necessary precision to indicate a nonzero effect

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals. The omitted bin is nearest competitor more than two miles away.

# Minnesota Analysis: Results—Competitor Proximity

Figure 18. Competitor Proximity Pricing Impacts



- **Impacts in percent price change**
  - Point estimates of competition effect are again qualitatively similar to price changes
  - No estimates demonstrate statistical significance at the 95 percent level

Notes: Dots and labels indicate point estimate values. Error bars represent 95% confidence intervals. The omitted bin is nearest competitor more than two miles away.

# Summary, Discussion, and Conclusions

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- **Conclusions**

- Descriptive analysis

- Correlation between E10 and E85 retail pricing
- Evidence that E85 price differences are possibly due to local market power

- Econometric analysis

- Inverse relationship between retail E85 prices and station density
- Indications of nonlinear effect of competitor proximity on E85 prices

- Data availability—a primary concern for future analysis of E85 pricing behavior

- Current sources (RFA, OPIS) lack comprehensive retail price coverage for E85
- Improved data may produce more precise and better-identified results

- **Questions or comments**

# About the Project

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This analysis was conducted by **Bentley Clinton** as part of the Research Participant Program at the **National Renewable Energy Laboratory** while pursuing a Ph.D. degree in the **Department of Economics, University of Colorado Boulder**.

Contact: [bentley.clinton@colorado.edu](mailto:bentley.clinton@colorado.edu)

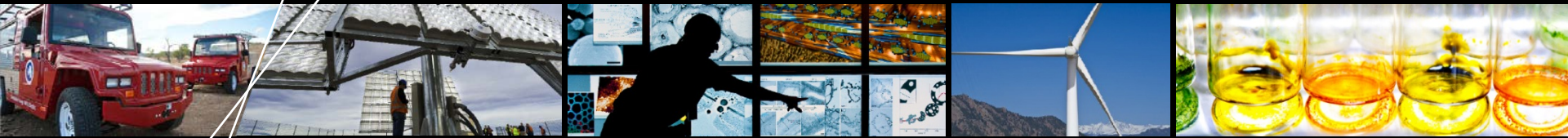
The following colleagues and reviewers are acknowledged for their helpful comments:

- U.S. Department of Energy
- NREL colleagues Michael Elchinger, Caley Johnson, Kristi Moriarty, Emily Newes, Daniel Steinberg, and Laura Vimmerstedt

NREL contacts: [laura.vimmerstedt@nrel.gov](mailto:laura.vimmerstedt@nrel.gov) or [emily.newes@nrel.gov](mailto:emily.newes@nrel.gov)

- Daniel Kaffine, Associate Professor, University of Colorado-Boulder
- Participants in related presentations at the University of Colorado-Boulder
- Participants at the 2016 annual meeting of the Northeast Agricultural and Resource Economics Association

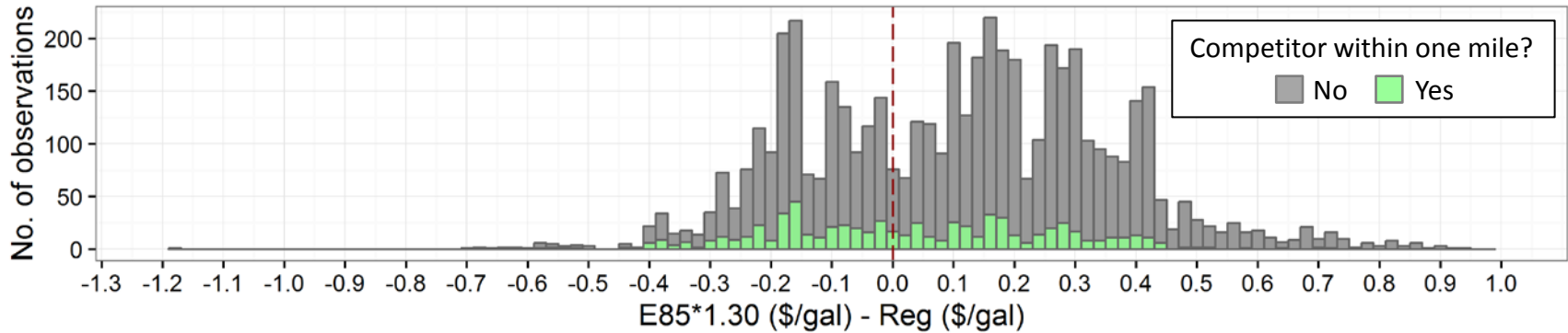
For additional detail, please see the related technical report ([Clinton 2017](#)).



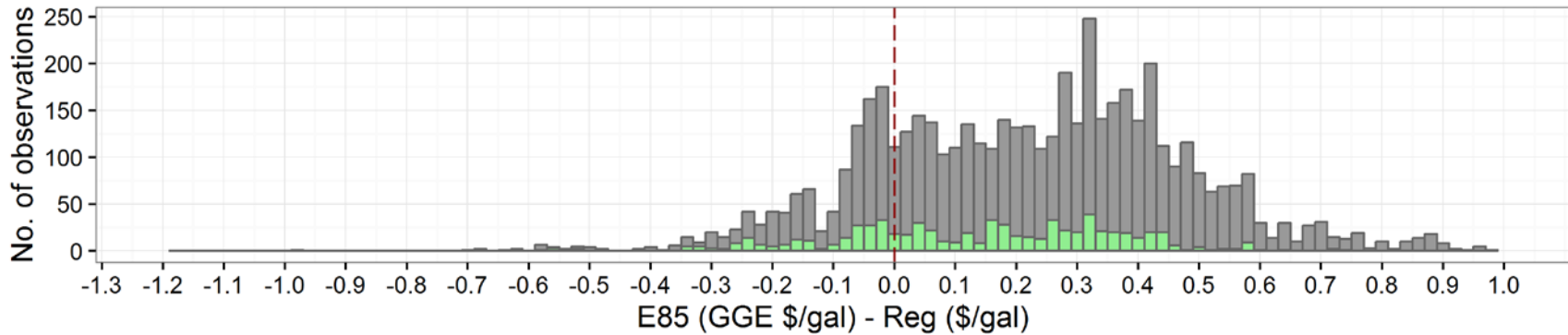
# Appendix

**Figure 11. Price Spread in \$/GGE**

[Repeated from Slide 14]



**Figure 19. Price Spread in \$/GGE with Seasonal Adjustment**



| Spread Units                                | Competitor within One Mile? | Percent of Price Observations   |                                 |
|---|-----------------------------|---------------------------------|---------------------------------|
|   |                             | E85 Less Expensive than Regular | E85 More Expensive than Regular |
| \$/gal (Figure 10)                          | No                          | 99.7                            | 0.3                             |
|   | Yes                         | 99.8                            | 0.2                             |
| \$/GGE (Figure 11)                          | No                          | 33.7                            | 66.3                            |
|   | Yes                         | 48.4                            | 51.6                            |
| \$/GGE with seasonal adjustment (Figure 19) | No                          | 22.0                            | 78.0                            |
|   | Yes                         | 33.1                            | 66.9                            |

Note: Seasonal adjustment assumes retail fuel contains minimum amount of ethanol based on volatility classes for E85. "Handbook for Handling, Storing, and Dispensing E85 and Other Ethanol-Gasoline Blends," U.S. Department of Energy, February 2016.

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*Additional references and a detailed literature review are included in the forthcoming technical report (Clinton 2017)*