2016 TN Statewide Litter Study

Results Web-Exchange

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Power Industry Planners • Analysts • Advisors

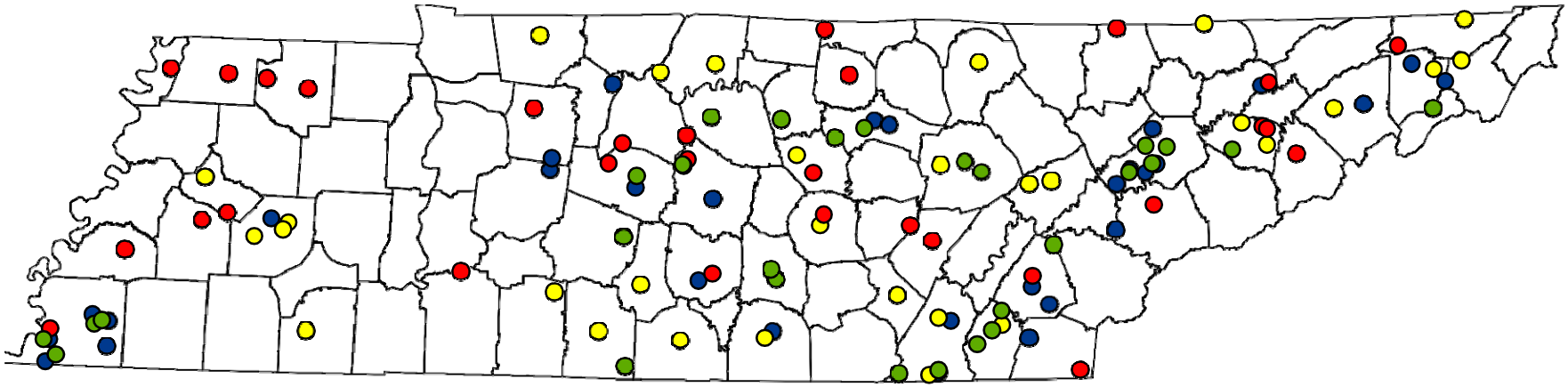
Presentation Overview

- Purpose of Study
- Study Design and Logistics Planning
- Basic Study Results
  - Litter per Mile Estimates by Roadway Classification
  - Composition Breakdown (Negligent vs. Deliberate)
  - Cigarette Counts
  - 2006 Comparative Results
  - Brand Name Analysis & Metrics
- Econometric Analysis
- Policy Implications and Q&A
  - Cross-Walk Findings to Attitudinal Survey

Purpose of Study

- Characterize the state of litter on TN Roadways
- Compare the state of litter relative to 2006 litter study database
- Leverage customized econometric modeling to determine which factors result in statistically significant differences in litter per mile across all roadways and isolated to one of 4 Roadway Classifications
  - *Theory confronts data – develop theories → gather data → → test hypotheses/quantify impacts/explain variation → derive objective conclusions*
- Utilize range of analytical results to drive actionable abatement policies/strategies/messaging

Study Design and Logistics Planning



120 Samples (30 Per Roadway Classification)
GIS Segment Data Provided by TDOT
Random Sample Ensures Representativeness
Daily Log for Field Team with GPS Coordinates
Replicable Study Design

Roadway Classifications

- Interstates
- State Highways
- US Highways
- Local Roads

Basic Study Results – Key Metrics

Litter Counts

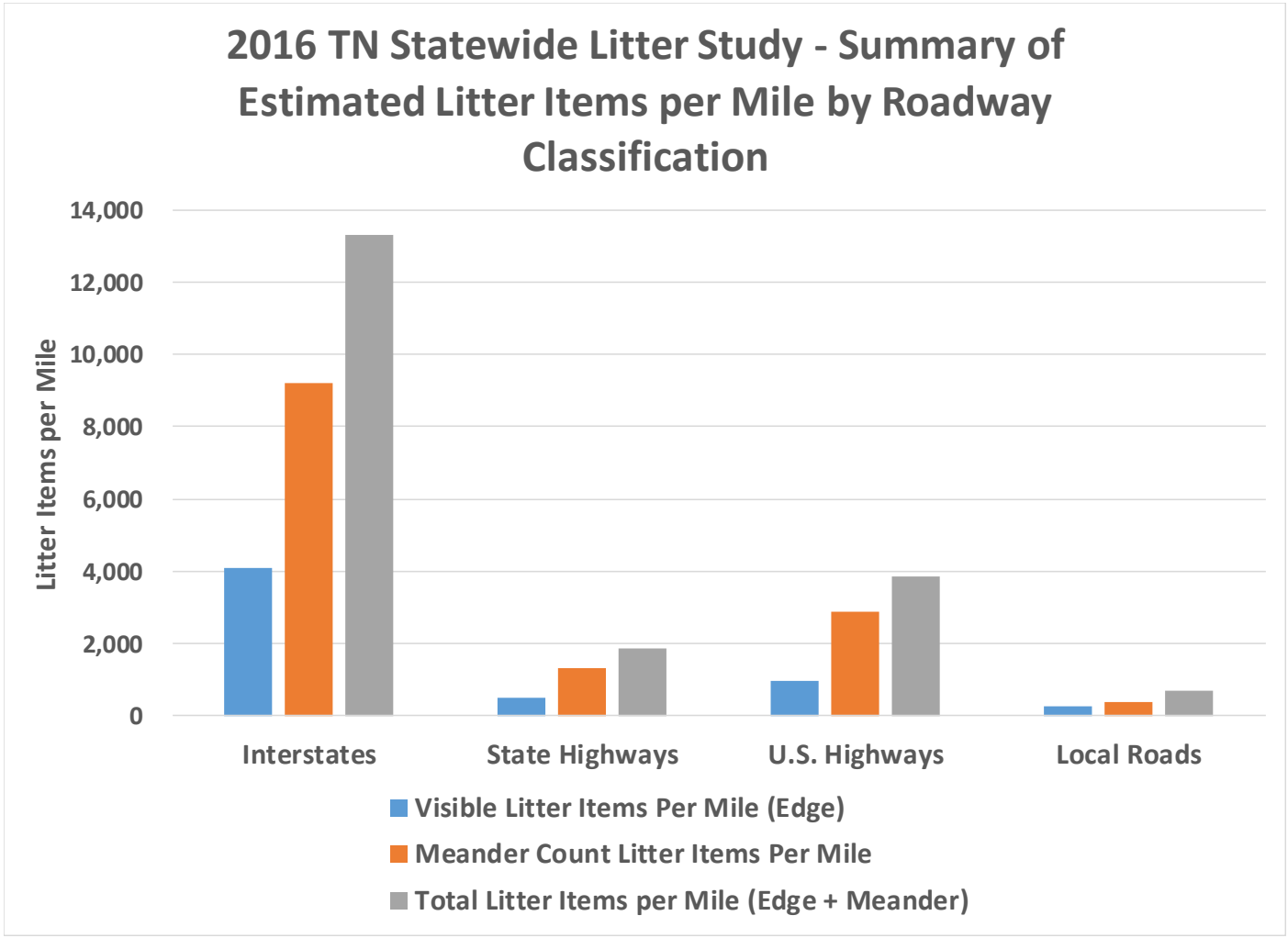
- Visible Litter – based on sample edge count
- Total Litter – based on edge + meander count
- Both metrics extrapolated to per mile rate based on edge distance and the presence/width of a median
- Supplemental cigarette and brand name audits
  - Side analysis on both cigs & brands

Litter Characterization

- Assign Each item of litter to one of 30 predefined categories
- Split between negligent (accidental) and deliberate litter (on purpose) groupings, subject to flex/situation
- Results are weighted based on total litter per mile to provide realistic composition results that take quantity of litter by sample into account

Cross-Walk & Compare to 2006 Database As Applicable

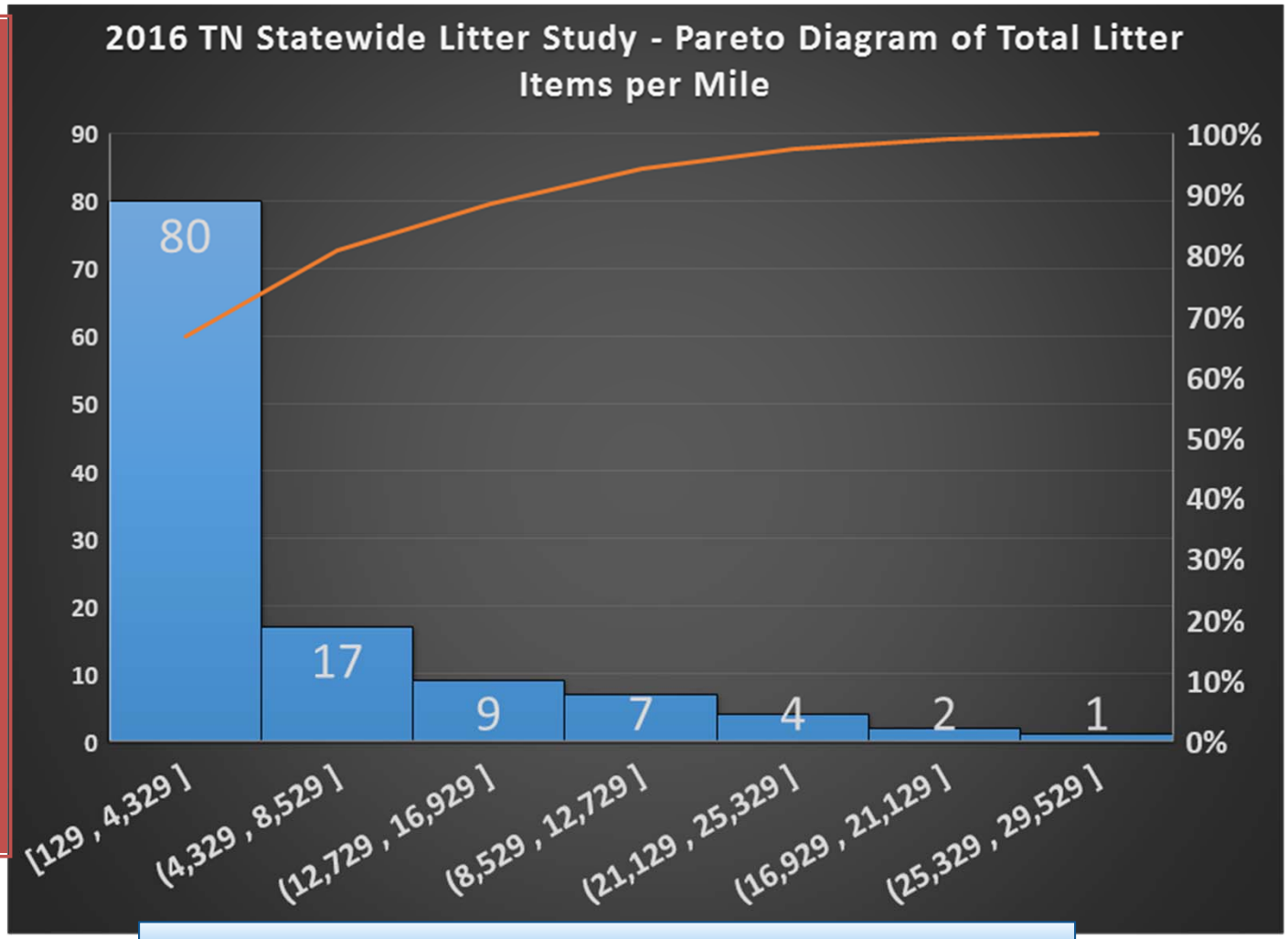
Basic Results – Estimated Litter Counts



Basic Results – Estimated Litter Counts

Line Reflects Cumulative Probability Distribution of estimated total litter per mile

Bars reflect counts of samples that fall into "bins" of total litter per mile as bracketed on the horizontal axis



Bins (Estimated Total Litter per Mile)

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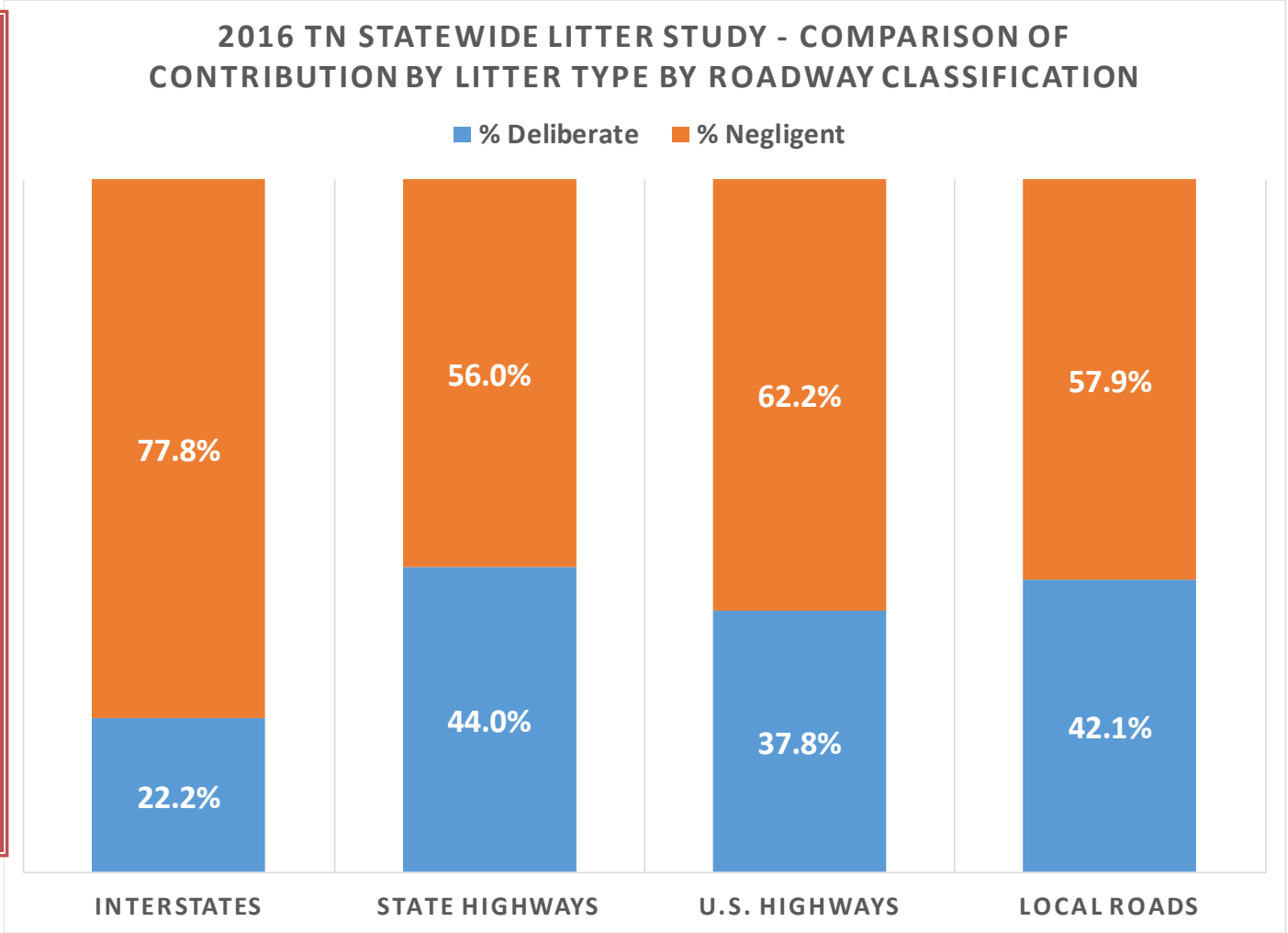
Basic Results – Estimated Litter Characterization

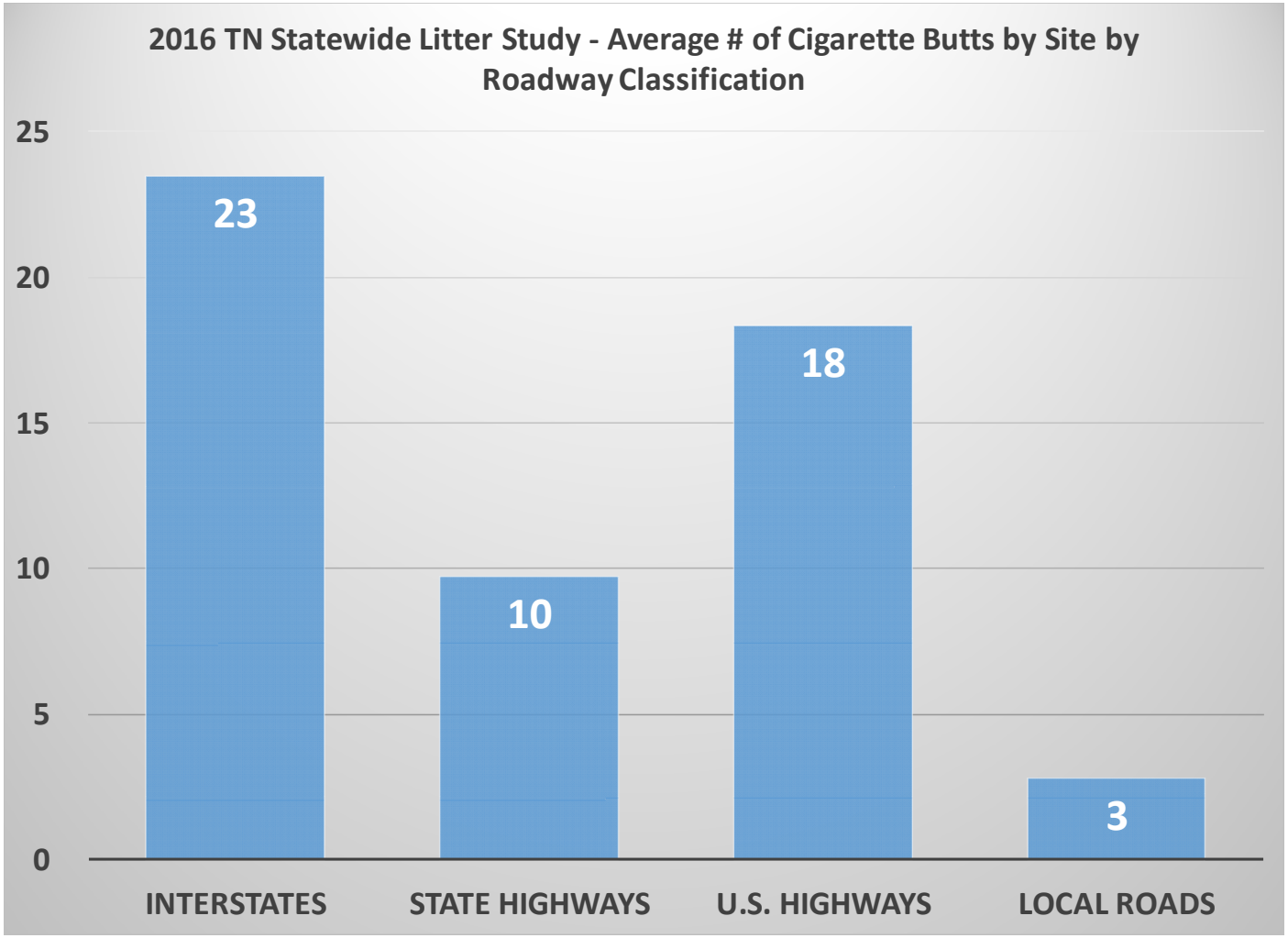
Top 2 Categories

Deliberate: Snack Food Packaging (5.93%), Cups, Lids, Straws (5.03%)

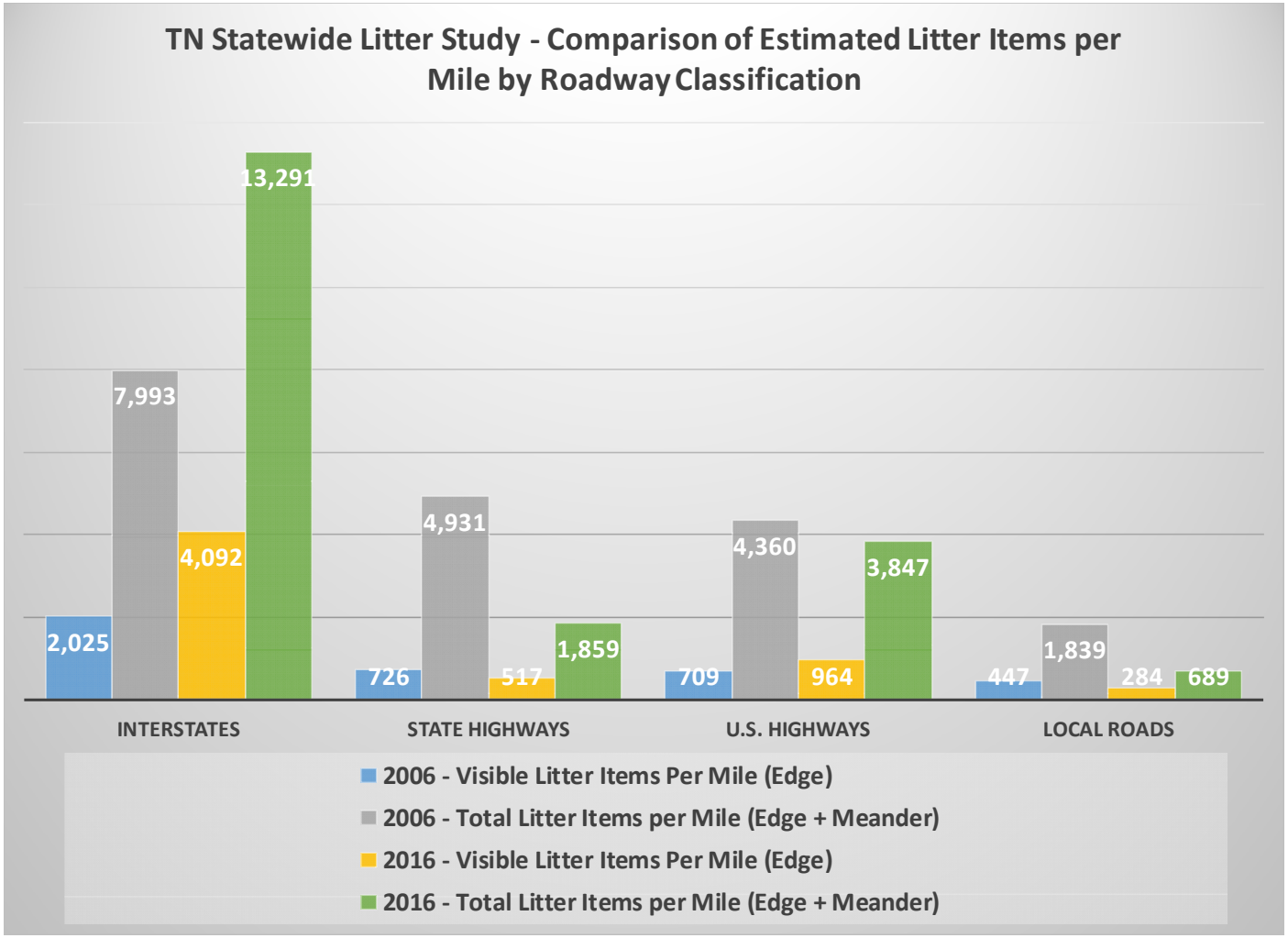
Negligent: Vehicle Debris & Packaging (41.76%), Miscellaneous Paper (11.68%)



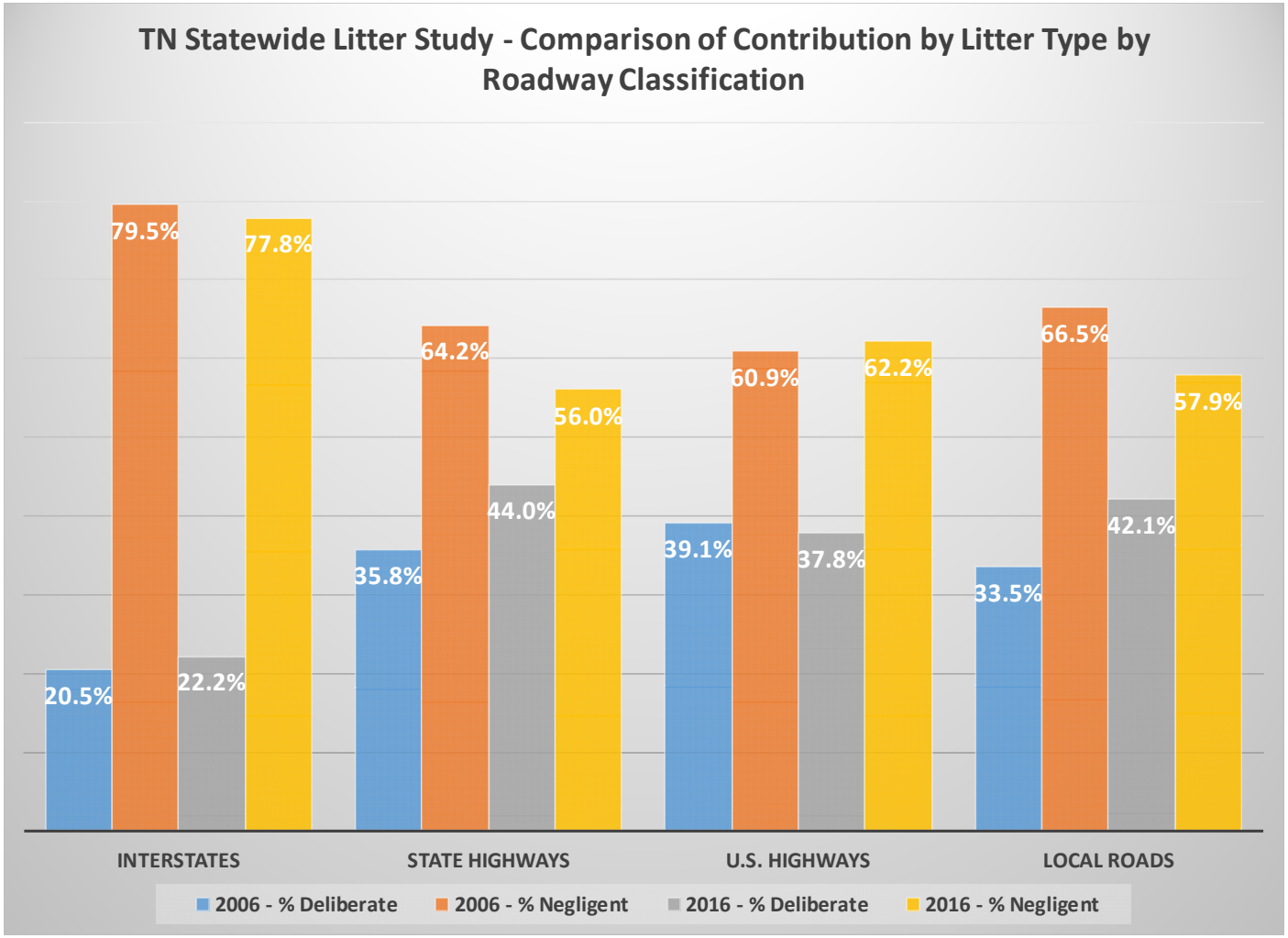
Basic Results – Cigarettes



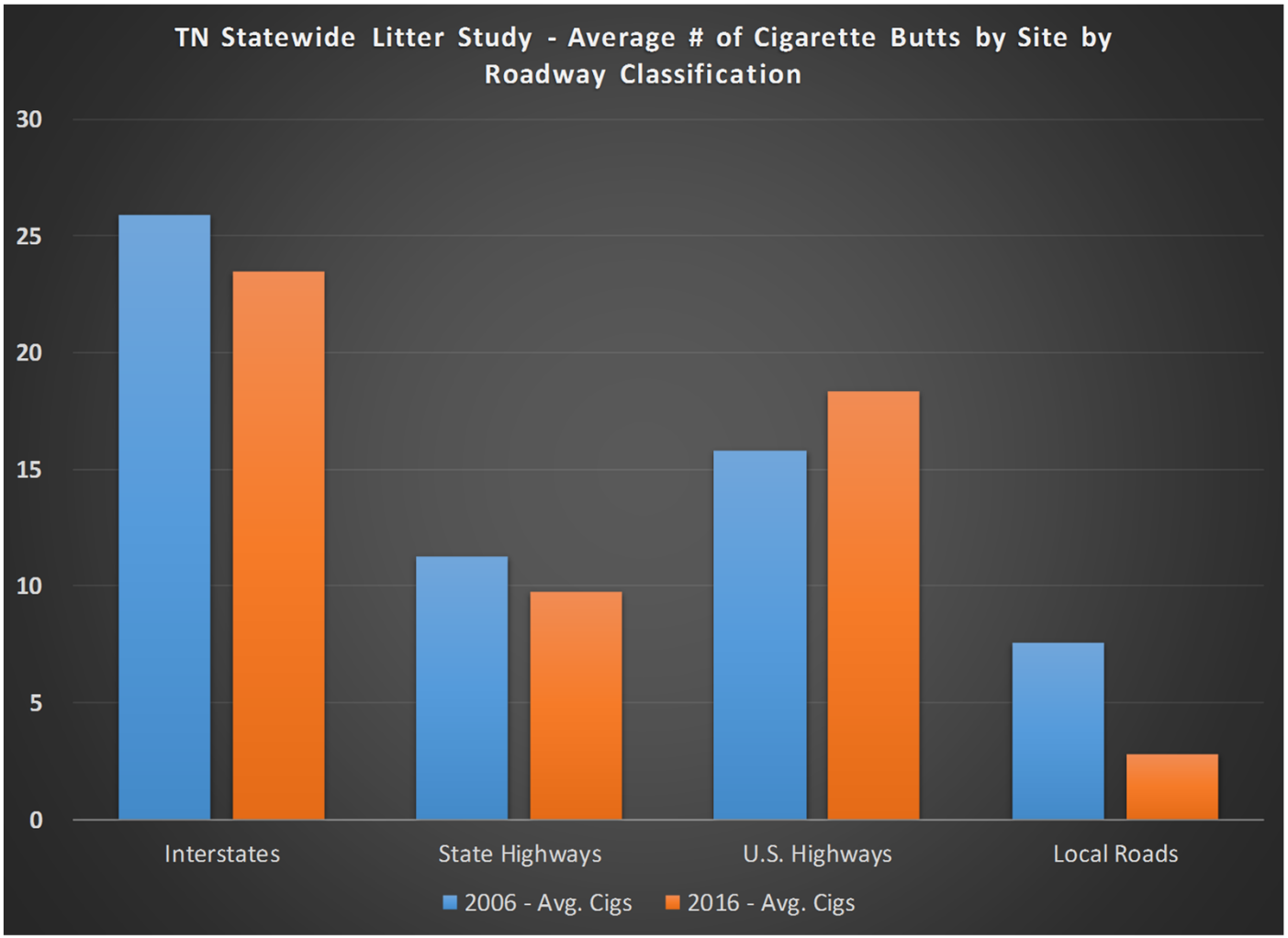
Comparison to 2006 – Estimated Litter Counts



Comparison to 2006 – Litter Characterization

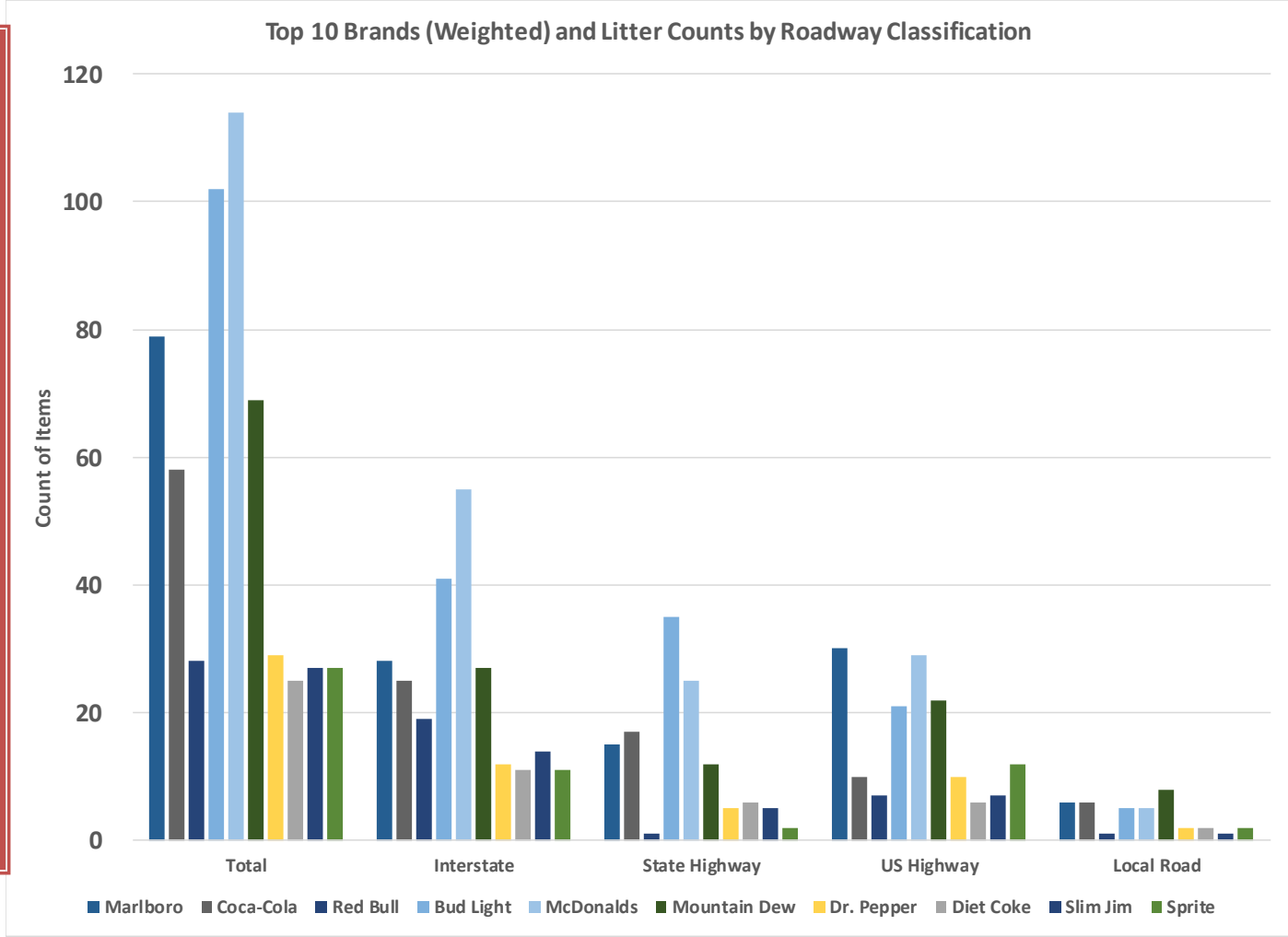


Comparison to 2006 – Cigarettes



Brand Name Results – Top Level

Brand "Universes" Dominate Discernable Items – Fast Food, Alcohol, Cigarettes, Soda and Snacks



Brand Name Cross-Walk Analysis

Limitations:

- Indicative market research only
- Some chronology diversity of revenue estimates
- Estimates of market are in total, but assumed to align with TN

- Reviewed the most prevailing brand names in each "universe" to group and tally by universe
- Researched recent revenue levels for universe members to derive "revenue adjusted" counts to capture relationship between revenue and counts encountered
- Adjusted metric accounts for brand size/scope to determine under/over on expected frequency of encounters

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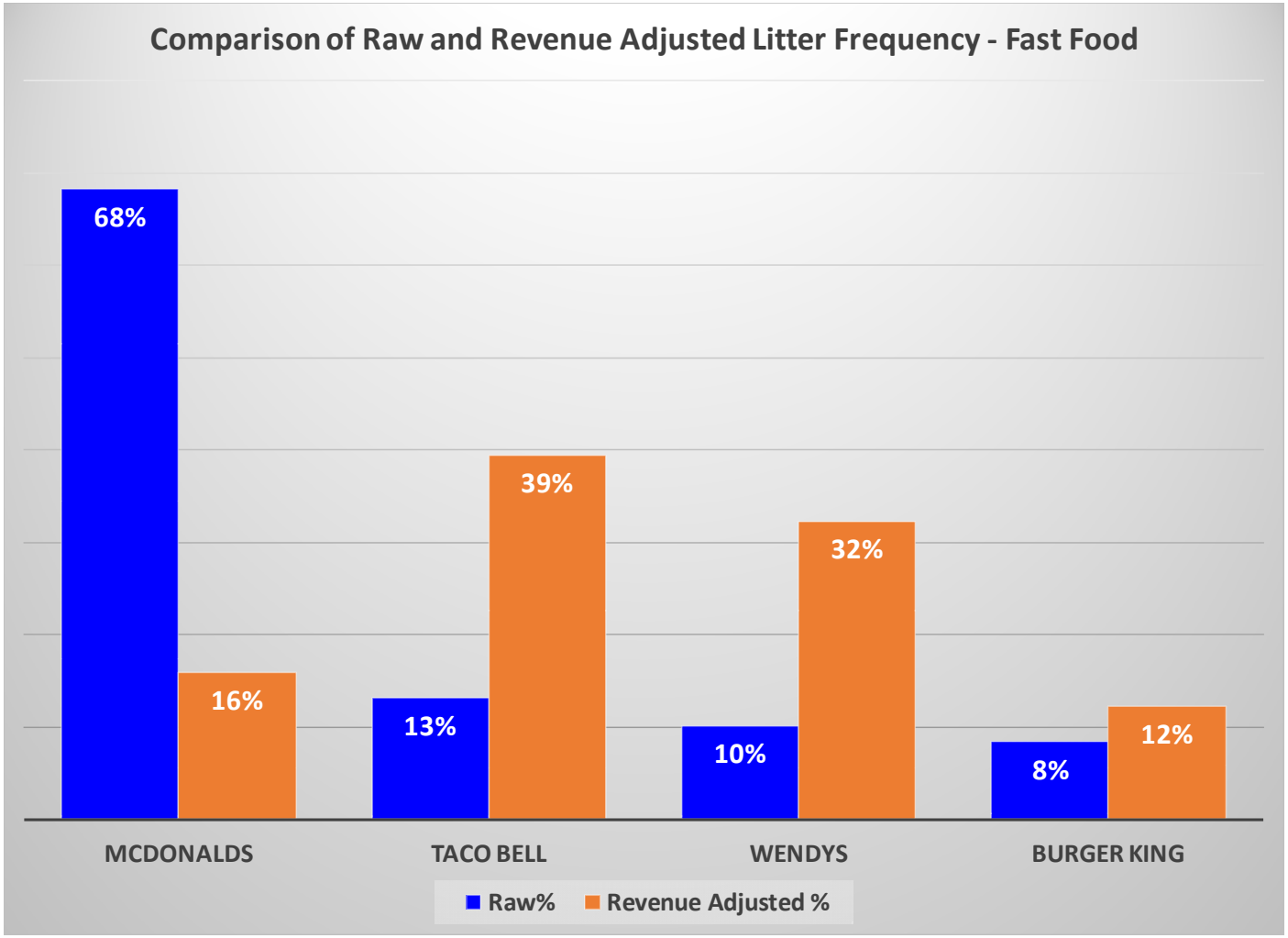
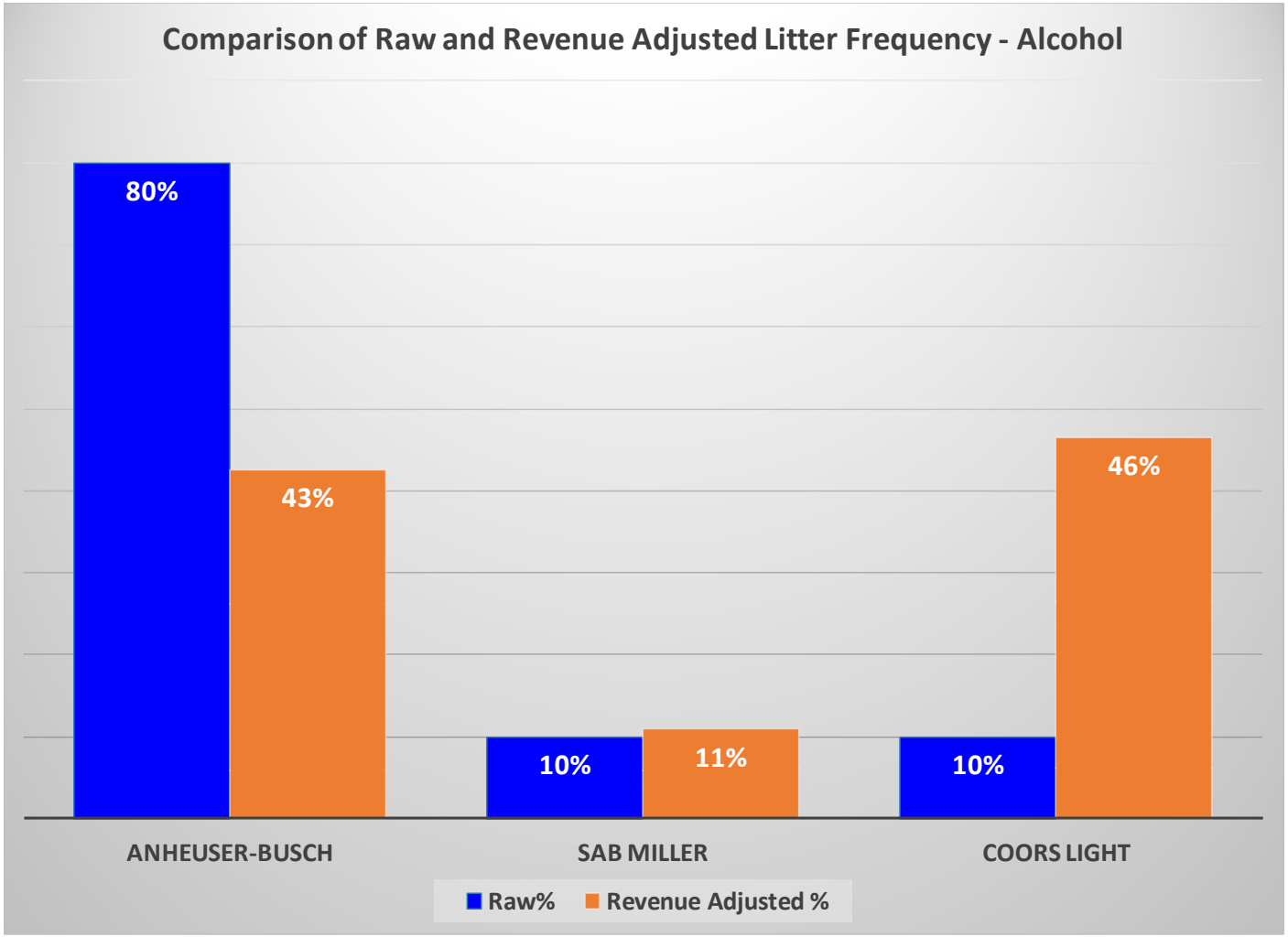
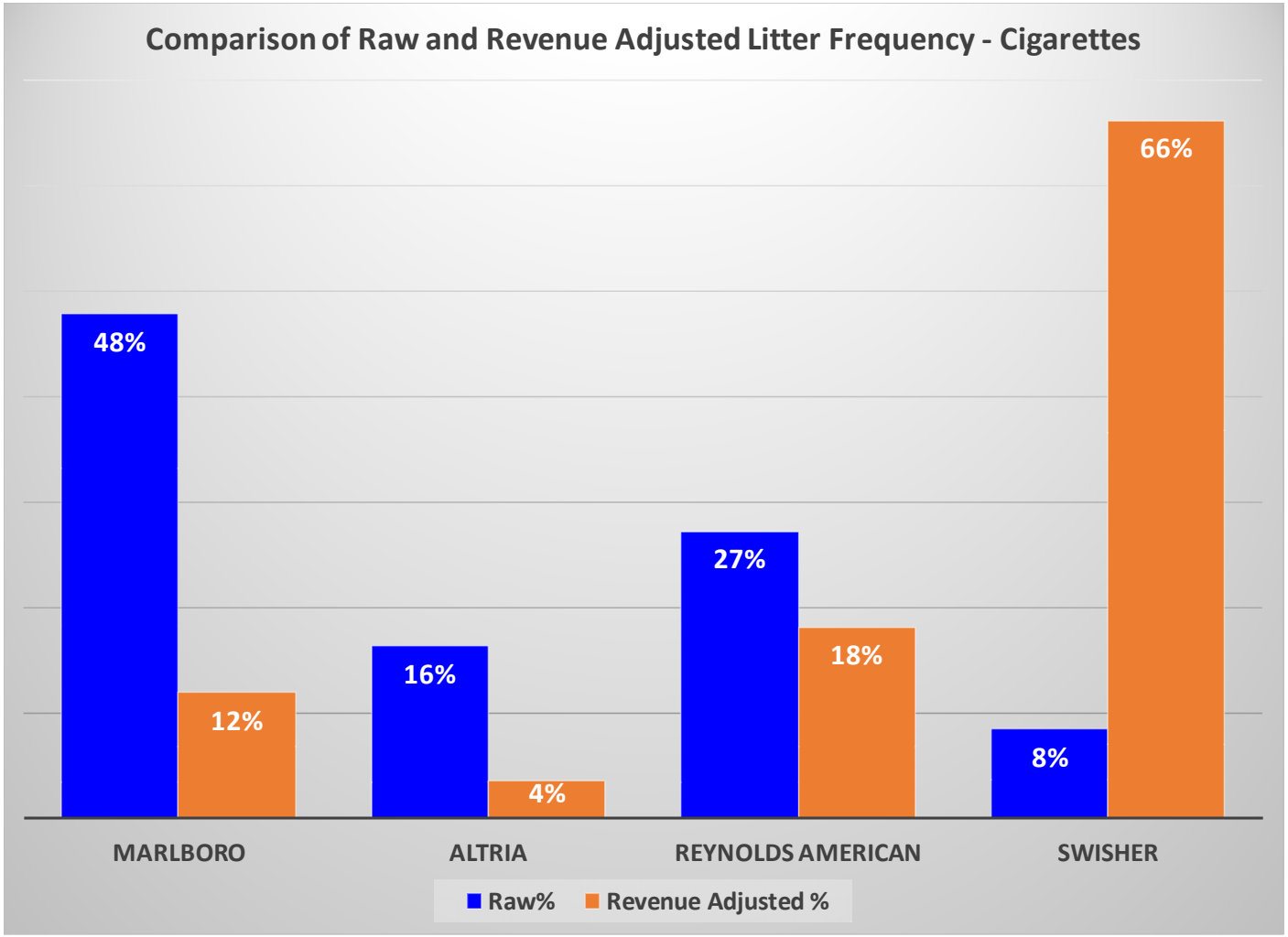
Brand Name Analysis – Fast Food



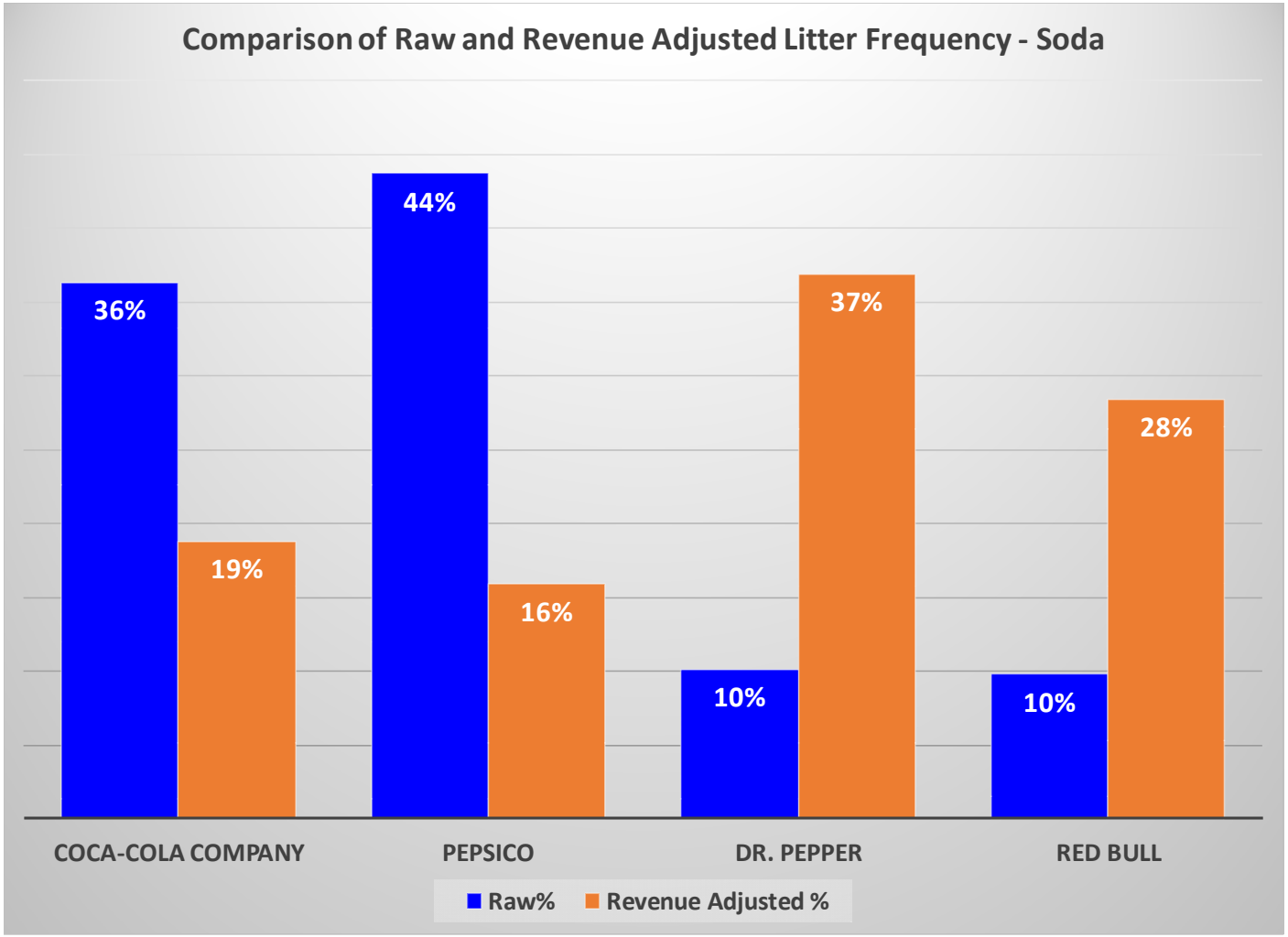
Brand Name Analysis – Alcohol



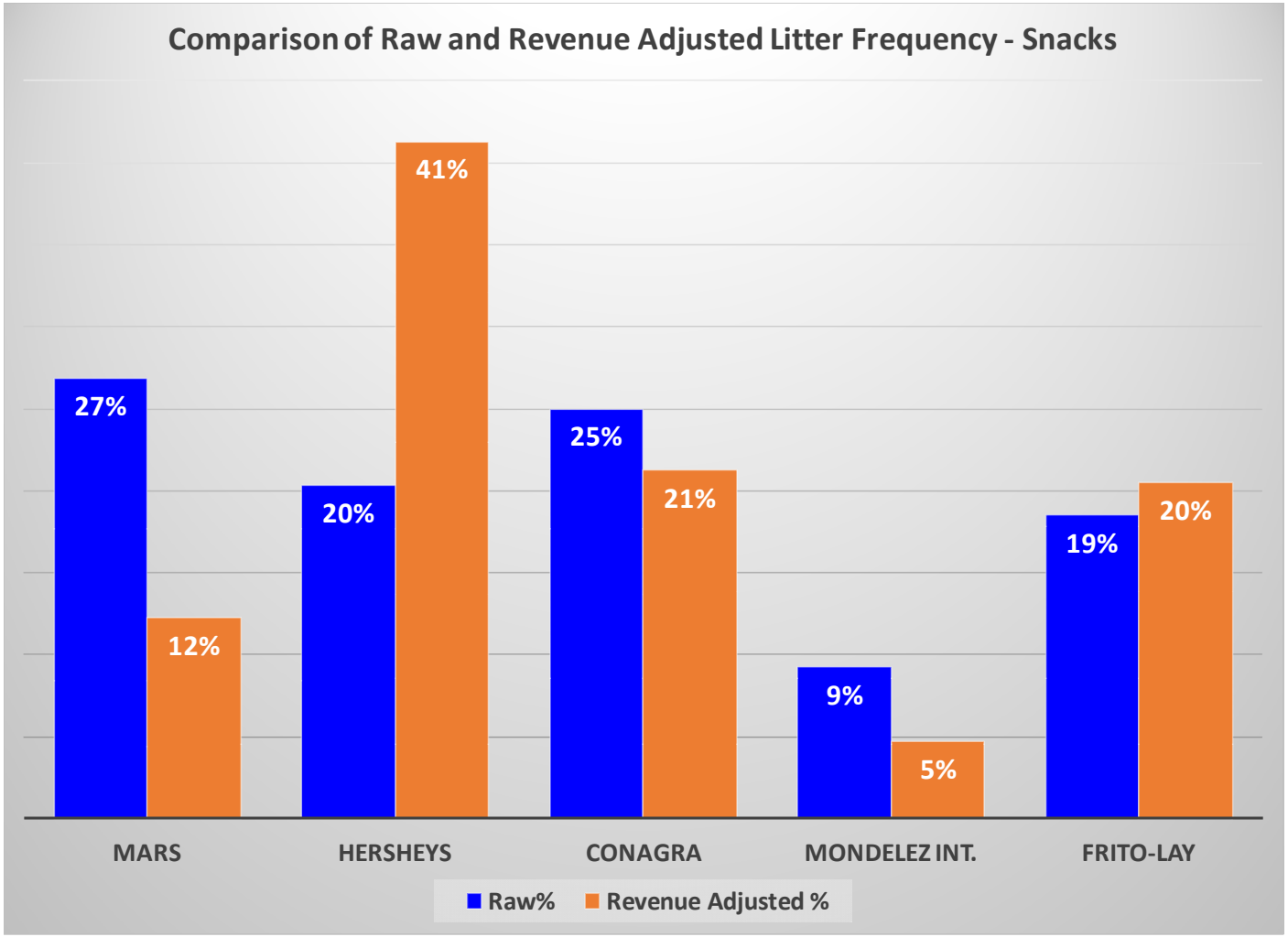
Brand Name Analysis – Cigarettes



Brand Name Analysis – Soda



Brand Name Analysis – Snacks



Econometric Analysis Overview

- Historical studies of litter have focused on “basic” results and limited binary comparisons (e.g. Interstates have more litter than local roads)
- Econometric analysis leverages primary (on site) and secondary (nearby conditions) data to attempt to determine which factors result in significantly more or less litter, all else equal
- Reduces guesswork and intuition by allowing theories to “confront” the available data
- Quantification of impacts fosters thoughtful messaging/policy and application of resources
- Analysis procedure for 2016 study reflects custom approach designed by nFront

Econometrics – Data Sources

- Primary Data - collected via field team while onsite through field log
- Secondary Data - collected via a wide-ranging secondary data effort – backed by Premise Document previously shared with TDOT that identified theories/premises regarding relationship of tract, site-specific and county level variables with litter prevalence

Econometrics – Key Primary Data Categories

Stoppage Opportunities	• Stop signs/traffic lights
Traffic Metrics/Counts	• Cars/trucks, speed limit, etc.
Construction/Lane Closures	• Expansion, New Buildings, etc.
Roadway Paving	• Dirt. Vs. concrete. Vs. Stone
Proximity to Litter Generating Sources	• Fast food, rest stop, hardware
Grass Height	• None up to > 6 inches
Building Distance from Road	• < 50 ft. up to > 100 ft.
General/Specific Aesthetic Factors	• Damage, graffiti, trees, etc.

Econometrics – Key Secondary Data Sources

- AAH Segments – TDOT and County Interfacing
- Accidents – TN Traffic Crash Data – TN Department of Safety & Homeland Security (March 2016)
  - County rankings and statistics in key accident types and causes; each county in TN ranked over 2011-2015
- Census Tract Data – American Community Survey – tract-level match-up of demographic, housing, educational attainment, population/density, and selected social characteristics

Econometrics – Key Secondary Data Sources

- County Business Patterns (April 2016 Census Bureau Release) – number of types of business via North American Industry Classification System (NAICS) codes by county
- Average Listing Price of Homes by County – Trulia (June 2016)
- 2016 TN County Health Rankings – University of Wisconsin Population Health Institute and Robert Wood Johnson Foundation – health ranks by county across numerous outcome/lifestyle factors

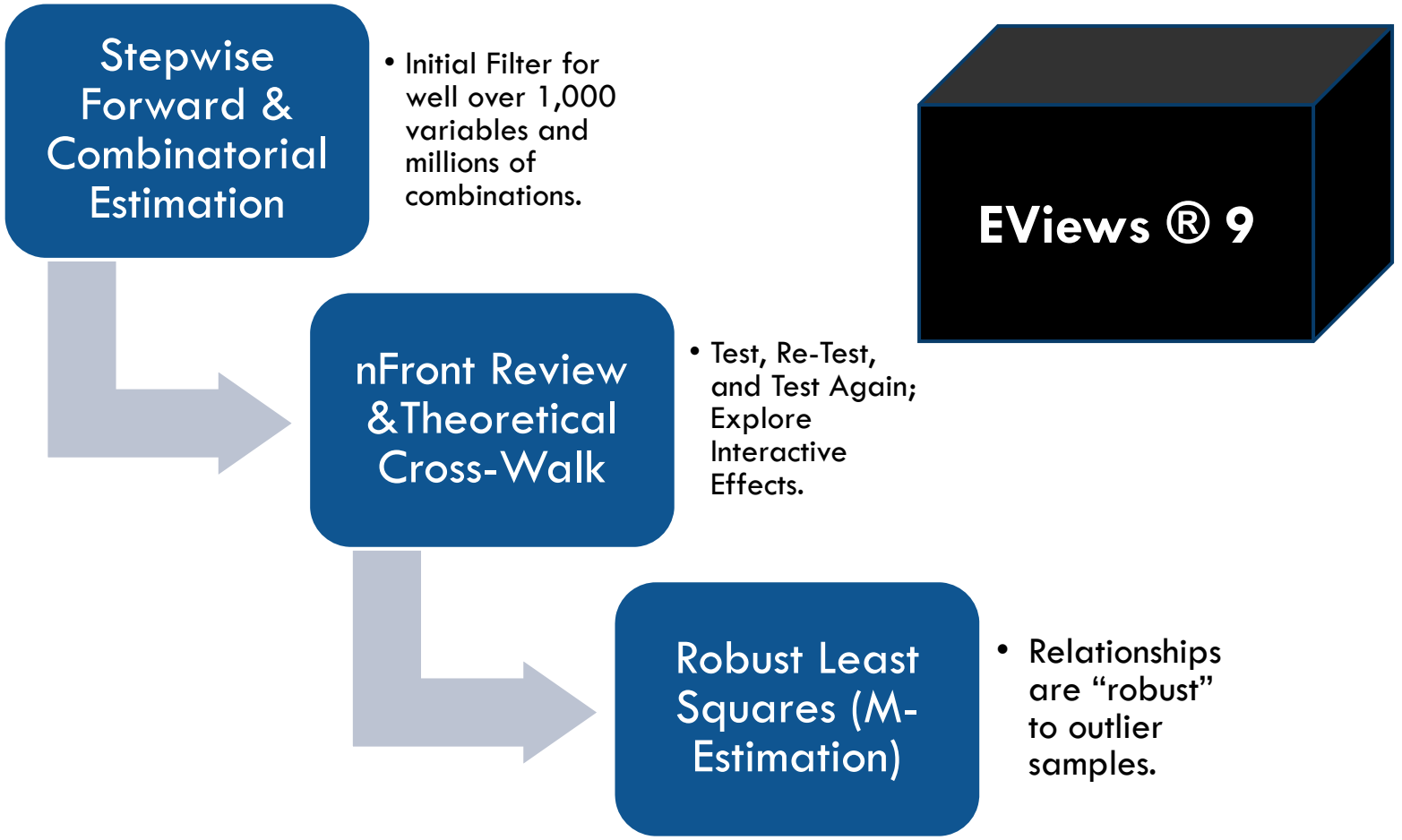
Econometrics – Key Secondary Data Sources

- Low-Income Housing Tax Credit Qualified Census Tracts – HUD (July 1, 2016 effective date)
- Metadata Fields – derived by segment from TDOT GIS master database – includes special segment codes (e.g. scenic highway)
- Vehicle Registration data by type by county – provided by TDOT/state of TN interfacing
- SWMF Proximity/Counts – based on county maps and Google Earth © verification process

Econometrics – Key Secondary Data Sources

- Tourism Stats – 2014 TN Economic Impact Report – statistics on tourism employment and economic metrics
- Proximity to tourism/schools/parks – Google Earth © and research process
- County Level Economic/Demographic Data – Woods and Poole Economics, Inc.
- Waste Collection Services – existing databases + TDOT interfacing by county

Econometric Analysis - Process



Econometric Analysis - Models

- Visible Litter per mile
  - All Samples and 4 Roadway Classifications
- Total Litter per mile
  - All Samples and 4 Roadway Classifications
- Percent Negligent Litter (Supplemental Model)
  - All Samples only – due to subjective nature of litter category assignations
- Cigarette Counts (Supplemental Model)
  - All Samples only – due to limited counts/zero counts for some samples

Model Interpretation

- % Impact of 1-Unit Change in Variable – all else equal, a change of one unit (or for binary variables, the existence of a given condition) was found to reflect X% higher/lower [insert litter metric]
- Statistical Significance Level (%) – how confident are we that the variable in question has a significant impact on litter – typically 90% or higher, but there is nothing magical about 90% - data sets measuring human behavior call for loosened standards, within reason
- Focus on teasing out policy variables – not all factors are within TDOT control

Results – Visible Litter (All Samples)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Proximity to Rest Stop (Binary,3 miles, Sample)	187%	90%
Professional, Scientific, & Technical services Est. per 1,000 ppl. (County)	93%	95%
Federally Designated Truck Route (Binary, Sample)	81%	95%
Distance of Buildings/Structures from Road (<50 ft. to >100 ft., Sample)	12%	71%
# of Convenience Stores Nearby (GPS, 1 mile, Sample)	7%	95%
Selected Monthly Owner Costs - No Mortgage - <$100 (Tract)	6%	90%
% Transportation, Warehousing & Utilities Employment (Tract)	5%	95%
Roadway Speed Limit (MPH, Sample)	2%	95%
Teen births / Females Ages 15-19 * 1,000 (County)	2%	95%
# of Registered Refuse Trucks (County)	1%	90%
# of Open Bed Vehicles (Count, Sample)	0%	95%
Male Population Ages 25 - 34 (Tract)	0%	90%
% Government Employees (Tract)	-3%	95%
# of Convenience/Drop-Off Centers (County)	-3%	90%
% of Householders who Moved in during 1990s (Tract)	-5%	95%
Finance and Insurance Employment (Thousands, County)	-9%	95%
Local Road AND Residential Area (Sample)	-22%	70%
Agriculture, Forestry & Fishing Est. per 1,000 ppl. (County)	-100%	95%

Results – Total Litter (All Samples)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Graffiti (Binary, Sample)	279%	95%
Damaged Buildings (Binary, Sample)	68%	95%
Professional, Scientific, & Technical services Est. per 1,000 ppl. (County)	55%	95%
Transportation & Warehousing Est. per 1,000 ppl. (County)	50%	84%
Proximity to an On-Ramp/Exit-Ramp (Binary, Sample)	46%	95%
Federally Designated Truck Route (Binary, Sample)	43%	90%
Paved Road (Binary, Sample)	37%	95%
# of Lanes (Sample)	12%	95%
# of Utilities Est. (County)	5%	89%
% Adults Obese (County)	4%	95%
Roadway Speed Limit (MPH, Sample)	3%	95%
# of Manufacturing Est. (County)	0%	89%
# of Registered Motor Homes (County)	0%	83%
State Tax Receipts per Capita ($M, County)	0%	95%
% Government Employees (Tract)	-1%	80%
# of Agriculture, Forestry & Fishing Est. (County)	-11%	95%
Local Road AND Residential Area (Binary, Sample)	-32%	90%
Welcome Sign (Binary, Sample)	-42%	90%
# of Public Transportation Hubs Nearby (1,000 ft., Sample)	-45%	95%

Results – Visible Litter (Interstates)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Finance and Insurance Est. per 1,000 ppl. (County)	287%	95%
Road Expansion (Binary, Sample)	185%	95%
Proximity to Rest Stop (3 miles, Sample)	183%	95%
Traffic Backup (Binary, Sample)	91%	95%
Proximity to an On-Ramp/Exit-Ramp (Binary, Sample)	32%	95%
Health Care and Social Assistance Est. per 1,000 ppl. (County)	22%	95%
# of Hardware Stores Nearby (GPS, 1 mile, Sample)	4%	95%
# of Fast Food Est. Nearby (GPS, 1 mile, Sample)	2%	95%
AADT (Sample)	0%	95%
AAH Program (Binary, County)	-20%	95%
Curbside MSW Collection (Binary, County)	-20%	95%
Overpass Intersecting Site (Binary, Sample)	-37%	95%
Admin/Support/Waste Management/Remediation Est. per 1,000 ppl. (County)	-78%	95%

Results – Total Litter (Interstates)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
AAH Program (Binary, County)	67%	95%
Road Expansion (Binary, Sample)	61%	90%
Traffic Backup (Binary, Sample)	52%	89%
Distance of Buildings/Structures from Road (<50 ft. to >100 ft., Sample)	46%	95%
Roadway Speed Limit (MPH, Sample)	8%	95%
# of Open Bed Vehicles (Count, Sample)	0%	95%
Older Concrete (Binary, Sample)	-36%	95%
Near Major Construction Zone (Binary,3 miles, Sample)	-38%	95%

Results – Visible Litter (State Highways)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Grass Height > 6 Inches (Binary, Sample)	321%	95%
# of Visible Convenience Stores (1 mile, Sample)	128%	95%
# of Convenience/Drop-Off Centers (County)	8%	95%
# of HHs with PY $20K - $29K (Thousands, County)	8%	95%
AADT (Sample)	0%	89%
Manufacturing Employment (Thousands, County)	-6%	95%
AAH Program (Binary, County)	-19%	86%
# of Stop Signs (1,000 ft., Sample)	-31%	95%
# of Bale Facilities (County)	-62%	95%

Results – Total Litter (State Highways)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Persons Per HH (County)	368%	89%
Grass Height > 6 Inches (Binary, Sample)	130%	95%
Proximity to Park(s) (Binary, Sample)	79%	89%
# of Traffic Lights (Sample)	71%	84%
Manufacturing Est. per 1,000 ppl. (County)	69%	85%
Damaged Buildings (Binary, Sample)	63%	89%
Paved Road (Binary, Sample)	50%	90%
Tree-Lined Roads (Binary, Sample)	-30%	87%
Forestry/Fishing Employment (Thousands, County)	-79%	79%

Results – Visible Litter (US Highways)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Anti-Littering Signage (Binary, Sample)	343%	95%
Maintained Shoulder - Gravel (Binary, Sample)	103%	95%
Visible Fast Food Est. (1 miles, Sample)	73%	95%
Distance of Buildings/Structures from Road (<50 ft. to >100 ft., Sample)	72%	95%
Federally Designated Truck Route (Binary, Sample)	27%	90%
# of Stop Signs (1,000 ft., Sample)	25%	95%
# of Lanes (Sample)	17%	95%
Population Ages 15-17 (Thousands, County)	5%	78%
Roadway Speed Limit (MPH, Sample)	4%	95%
Population Ages 85 or Over (Thousands, County)	-6%	60%
Curbside MSW Collection (Binary, County)	-16%	85%
Grass Height > 6 Inches (Binary, Sample)	-46%	95%
Tree-Lined Roads (Binary, Sample)	-60%	95%

Results – Total Litter (US Highways)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Management of Companies Est. per 1,000 ppl. (County)	699%	90%
Murals/Fancy Landscape (Binary, Sample)	160%	95%
Distance of Buildings/Structures from Road (<50 ft. to >100 ft., Sample)	44%	95%
Proximity to an On-Ramp/Exit-Ramp (Binary, Sample)	27%	61%
# of Fast Food Est. Nearby (GPS, 1 mile, Sample)	7%	95%
Percent Self-Employed (Tract)	5%	90%
Percent Construction Employment (Tract)	5%	90%
Roadway Speed Limit (MPH, Sample)	2%	90%

Results – Visible Litter (Local Roads)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Mining/Oil & Gas Extraction Est. per 1,000 ppl. (County)	2578%	83%
Empty Commercial Buildings (Binary, Sample)	165%	95%
Low Income Housing Tax Credit Qualified (Binary, Tract)	85%	95%
# of Multi- Occupant Vehicles (Count, Sample)	49%	90%
# of Trash Cans (1,000 ft., Sample)	19%	95%
Average Home List Price ($, County)	0%	90%
# of Single Occupant Vehicles (Count, Sample)	-6%	90%
Grass Height 3 to 6 Inches (Binary, Sample)	-48%	95%
Older Concrete (Binary, Sample)	-51%	95%
Murals/Fancy Landscape (Binary, Sample)	-51%	95%
New Building/Work Zone (Binary, Sample)	-66%	95%

Note: Mining/Oil Establishments are relatively rare, which results in a small value per 1,000 ppl. Impact should be interpreted accordingly.

Results – Total Litter (Local Roads)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Mining/Oil & Gas Extraction Est. per 1,000 ppl. (County)	14239%	90%
Fresh Concrete (Binary, Sample)	194%	95%
Graffiti (Binary, Sample)	194%	95%
Damaged Buildings (Binary, Sample)	105%	95%
# of Visible Hardware Stores/Self-Storage (1 mile, Sample)	98%	89%
Low Income Housing Tax Credit Qualified (Binary, Tract)	71%	95%
Distance of Buildings/Structures from Road (<50 ft. to >100 ft., Sample)	22%	87%
# of Convenience Stores Nearby (GPS, 1 mile, Sample)	6%	82%
Murals/Fancy Landscape (Binary, Sample)	-49%	95%

Note: Mining/Oil Establishments are relatively rare, which results in a small value per 1,000 ppl. Impact should be interpreted accordingly.

Results – Pct. Negligent (Total)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Paving/Lane Closure (Binary, Sample)	179%	95%
Graffiti (Binary, Sample)	124%	95%
STRAHNET TDOT Designation (Binary, Sample)	51%	95%
AAH (Binary, Sample)	28%	90%
Empty Commercial Buildings (Binary, Sample)	27%	95%
Street Lights (Binary, Sample)	15%	95%
Transportation & Warehousing Est. per 1,000 ppl. (County)	15%	80%
# Of Recycling Vehicles (Count, Sample)	5%	81%
% of Total Housing Units Built in 1970s (Tract)	-1%	95%
# of Storm water Runoff Basins (Sample)	-7%	95%
Curbside Recycling (Binary, County)	-8%	86%
# of Visible Fast Food Est. (1 mile, Sample)	-8%	95%
Local Road (Binary, Sample)	-18%	95%
Construction Est. per 1,000 ppl. (County)	-20%	95%
TN Scenic Highway (Binary, Sample)	-42%	95%
New Building/Work Zone (Binary, Sample)	-58%	95%
No Grass (Binary, Sample)	-58%	95%
Murals/Fancy Landscape (Binary, Sample)	-58%	95%

Results – Cig Count (Total)

Variable Name	% Impact of 1-Unit Change	Statistical Significance Level
Paved Road (Binary, Sample)	125%	95%
# of Visible Hardware Stores/Self-Storage (1 mile, Sample)	69%	95%
Empty Commercial Buildings (Binary, Sample)	69%	95%
TN Bicycle Route (Binary, Sample)	49%	90%
% Excessive Drinking (County)	21%	95%
% Families with PY $25K - $35K (Tract)	4%	95%
Roadway Speed Limit (MPH, Sample)	1%	90%
# of Open Bed Vehicles (Count, Sample)	1%	95%
Unemployment % (Tract)	1%	89%
High-Rent as % of Family PY (>35%, Tract)	-2%	95%
Overpass Intersecting Site (Binary, Sample)	-36%	90%

Policy Implications – Prevailing Themes

- Abatement Messaging and Policy should take a compartmentalized, prioritized approach
  - Factors that impact litter are clearly different in magnitude and make-up by roadway classification
- Ownership is the meta-theme – there is a strong relationship between variables that define ownership and the state of a roadway
- Socioeconomics matters, but primarily closer to home
  - Far less influential for interstates as compared to local roads
  - Demographics has limited significance (impact/influence of younger cohorts was mixed to insignificant)

Policy Implications – All Samples

- Advertising and messaging should solicit the same sense of respect/ownership for interstates as the street you live on
  - Building distance, residential areas, and localities have dramatically less litter
- Low-Income and public housing neighborhoods should be targeted for strategies
  - Corresponds to limited ownership theme
- Target certain types of businesses in messaging to engage in ways to improve ownership of areas

Policy Implications – All Samples

- Rest Stops
  - Littering Signage (littering fine notice, check truck beds for loose trash, etc.)
  - Adequate and maintained trash/recycling receptacles (among parking lots and not just by restrooms/indoor facilities)
  - Overall rest stop maintenance
- On/Ramps and Exit Ramps
  - Excellent target for ad messaging in terms of location/context
- General Aesthetics
  - Broken windows theory – community condition begets litter; i.e., maintain roadside, fine derelict buildings, incentivize re-development of brownfield sites, etc.
- Truck Routes – what can TDOT control?

Policy Implications – All Samples

- Proximity to littered material sources (on-ramps, fast food est.)
  - Creation and enforcement of rules associated with trash receptacles at fast food/convenience stores (e.g. outdoor receptacles must be available by building egress points and in parking lot and maintained)
  - Targeted campaign re: littering in concert with fast food providers (e.g., drive-through packaging with anti-littering messaging)
- Other Categories
  - Target AAH and maintenance efforts to high traffic volume roadway stretches (e.g., inside and heading into/out of high density areas) - enforce actual cleanups
  - Targeted anti-littering signage near traffic lights and stop sign intersections heading out of higher density and fast food/convenience store-dense areas
  - Joint effort with waste collection industry to reduce unsecured waste in hauling vehicles

Tactics/Issues - Interstates

- *Negligence from OBVs – top priority*
- Expansion of AAH and examination of accountabilities (some clean-ups not done)
- Management of backups and road expansion
- The usual suspects (fast food, convenience stores)
- No one group is immune from opportunities – focus on conditions that provide opportunities

Tactics/Issues – State & US Highways

- High density (persons per HH) areas may support locational messaging
- Convenience Stores and context/opportunities to litter
- Mow the grass, notably in lower-tier income areas
- Control Blight
- Engage manufacturing establishments for ideas

Tactics/Issues – Local Roads

- Are local roads really a priority?
  - Prioritize resources relative to current prevalence
  - Don't "forget" about local roads, but recognize the imbalance of the abatement problem
- Low income & public housing areas
  - Clearly distinct from other areas, but consistent with the ownership differential theme
  - Tract-level information can optimize resources
- Damaged buildings/graffiti – engage in targeted blight mitigation

Tactics - Cigarettes

- Lower levels of income and lifestyle characteristics (excessive drinking) – contextual ad/messaging target
- Blight/hardware stores
- OBVs strike again
  - Enforcement/monitoring
  - Targeted ad(s) in a manner that doesn't profile but still relays distinction and defines the problem

nFront Review of Attitudinal Survey

- Conclusion that women are the primary target audience appears somewhat tenuous. The basis point differential between women characterized as self-litterers and men in the 16-24 and 25-34 brackets is small (71% and 72% vs 64% and 65%, respectively). Furthermore, as you move down the age ranges, every age range has a minimum of 40% of self-identified "self-litterers", so the differentials are not large enough to suggest that non-female or other age groups should not be targeted.
- All of the data is based on self-reported behavior, which is a fundamental caveat.
- Interesting contrast with the 2008 KAB Study:
  - 2008 study showed that self-litterers were a lower percentage of the pool that was sampled.
  - 2008 study found that men are more likely to litter (as compared to the more recent study). 44.8% of males self-identified as litterers, whereas only 19.9% of females self-identified as litterers.
- There appears to be a mismatch of consequences to actions.
  - The closest thing to consensus from the attitudinal survey relative to the abatement of litter relates to fines/penalties and the notion that existing laws are rarely enforced.

Study Limitations & Caveats

- Data from 3rd party providers assumed accurate
- Cross-sectional analysis – findings reflective of current period in time
  - Longitudinal studies should be considered as a way to track impact of policies/messaging
- Omitted Variables May Result in (minor) bias
- Objective is NOT to "forecast" litter metrics – adjusted R-squared ranges for study are well above average for hypothesis testing (50% to 70% reflects general range)
- Field team QC notwithstanding, small amount of measurement error is possible

Questions?

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