New Approach for Combining Probability and Non-Probability Samples

J. Michael Dennis, Ipek Bilgen, David Sterrett, Eric Gober & Caroline Tipler

December 6, 2019 Presentation at the Annual Meeting of the Pacific Chapter of AAPOR

NORC
at the UNIVERSITY of CHICAGO

Outline

- Research Problem

- TrueNorth Method for Combining Probability and Nonprobability Samples

- Consumer Products Case Study

- Future Research Directions and Questions

Research Problem

Data that can inform business decisions

- Advertisers, media companies, and market researchers (among others) are seeking cost-effective consumer survey approaches

- When choosing a survey design, both probability and nonprobability samples have advantages and disadvantages

Cognitive Dissonance
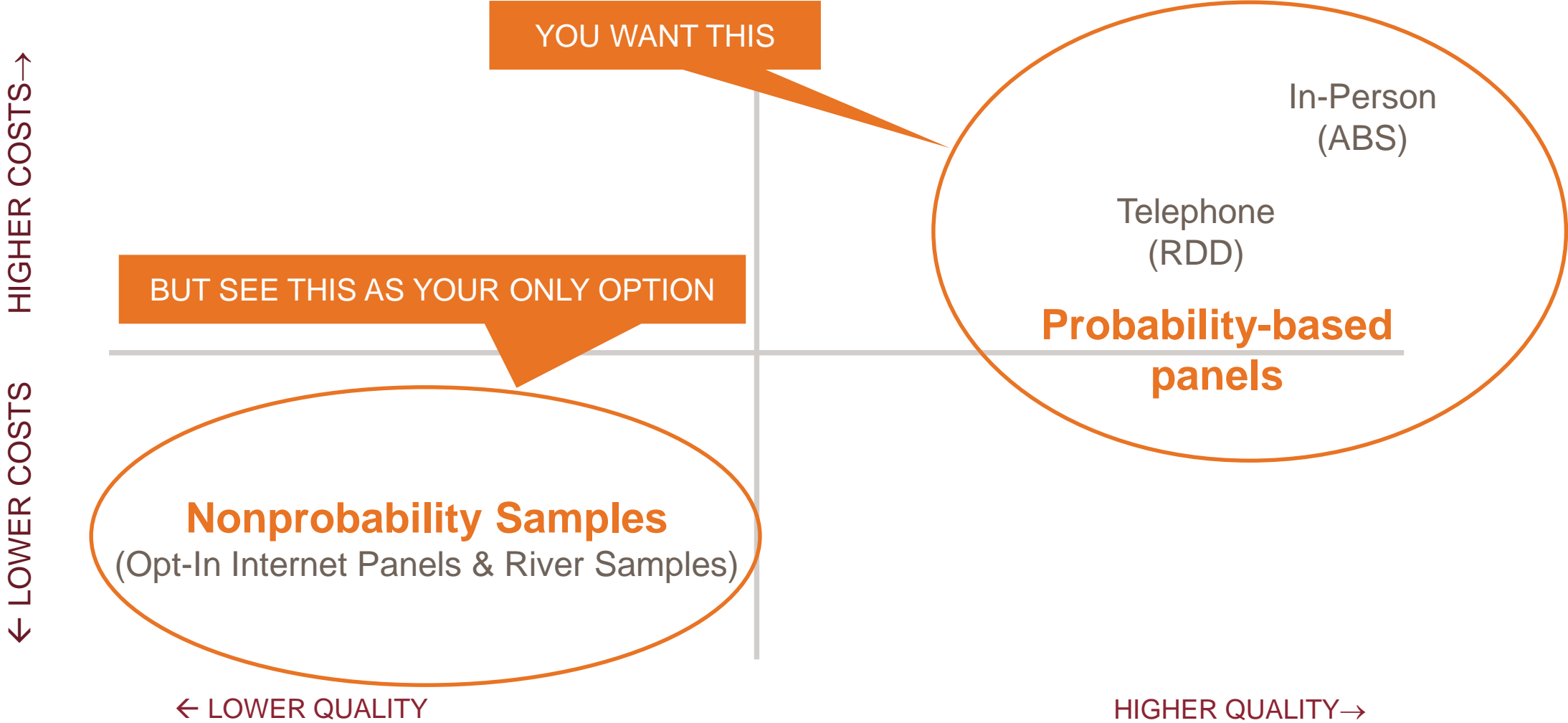
TrueNorth Method for Combining Probability and Nonprobability Samples

Exemplary Projects

- Consumer tracking studies requiring large sample sizes
- Consumer surveys for niche products and services
- Metropolitan transportation policy studies
- Epidemiology studies measuring prevalence (e.g., food specific allergies)
- Health insurance and health policy studies of the uninsured or under-insured
- Special populations (parents of young children, brand- loyalists, small business owners, targeted consumer segments, high net worth segment, etc.)

OUR CASE STUDIES

- State-level Voter Surveys (AP VoteCast) – Available upon request
- Teen/Young Adult Consumer Survey – Available upon request
- Consumer Behavior Surveys

Combining Probability and Nonprobability Samples

- Probability sample is anchor to reduce potential bias in the nonprobability sample.

- Nonprobability sample is a low-cost supplement to increase sample size, reduce variance, and support small domain estimation.

- Small area models reduce bias among demographic subgroups for key questions

- Establish 20-40 domains where each domain is a specific demographic subgroup.

- For example, could have 36 domains divided based on age, race/ethnicity, gender, and education
  - Define domains based on: 3 age groups (18-34, 35-59, 60 plus) * 3 racial/ethnic groups (African American, Hispanic, white/other races) * 2 gender groups (male, female) * 2 education groups (college degree, non-college)
  - African American males 18-34 with a college degree
  - White women 35-59 without a college degree
  - Hispanic women 60 plus with a college degree

Step 2. Identify key survey variables to target for bias reduction

- Select 2-4 key variables that will be used to reduce bias in the nonprobability sample.

- Use random forest models to determine what questions have the largest differences in estimates between the probability and nonprobability samples

- Select variables key to the survey in which there are differences between probability and nonprobability sample

Step 3. Use small area estimation models to reduce bias
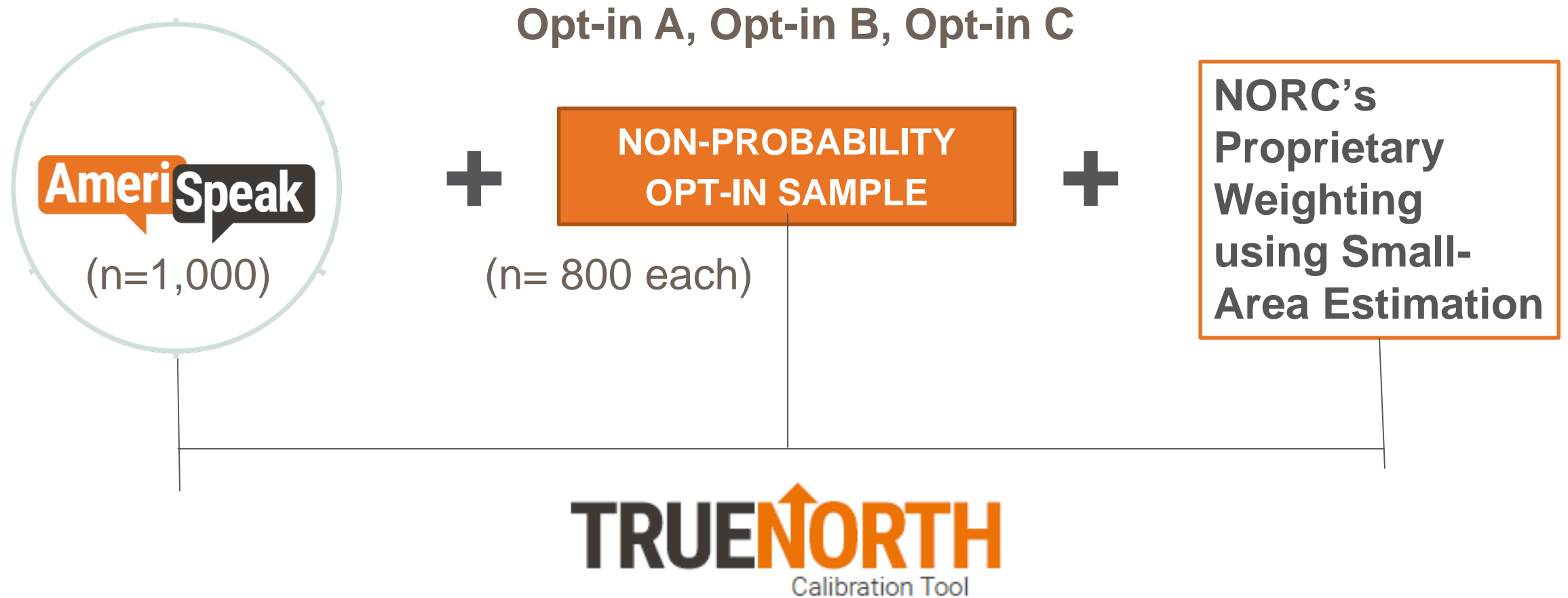
- For each domain, a small area model is run for each key question and a benchmark is derived
    - Example: Benchmark for Q1 among Hispanic women 18-34 with a college degree
- Rake each domain to these derived benchmarks to reduce bias within the domain.
- Using multiple items reduces bias across multiple dimensions
- Using domains reduces bias within key subgroups

Consumer Products Case Study

Why use TrueNorth in Consumer Product Studies?

- Consumer market research companies typically use non-probability online samples
  - Market research organizations using non-probability samples experience overstatement of consumer purchase behavior
- Accurate survey data is paramount to inform business decisions
  - Non-probability surveys can be made more accurate when combined with probability sample and calibration adjustments (NORC's TrueNorth)

TrueNorth Case Study: Sample Sources

AmeriSpeak

(n=1,000)

+

Opt-in A, Opt-in B, Opt-in C

NON-PROBABILITY OPT-IN SAMPLE

(n= 800 each)

+

NORC's Proprietary Weighting using Small-Area Estimation

TRUENORTH
Calibration Tool

Two opt-in samples are from panel companies, and the other is from an aggregator of online panels

Data and Methods: Consumer Products Case Study

- **Measure Consumer Product Purchase Behavior**
  - Food product purchases
    - Almond oil, Hemp oil, Saffron spice, Shrimp paste, Szechuan Peppercorns, Truffles, Turmeric spice, Vanilla extract, and Wasabi root
  - New and used car purchases
  - Other consumers products tested (beverages, energy bars, personal care)

- **Survey length: 5 minute survey**

- **Target population: General U.S. Population (18+)**

Food Purchases

Have you purchased, or not purchased, any of these food products for your personal use in the last 12 months? (% of "Yes")

Food Product	ALMOND OIL	HEMP OIL	SAFFRON SPICE	SHRIMP PASTE	SZECHUAN PEPPERCORNS	TRUFFLES	TURMERIC SPICE	VANILLA EXTRACT	WASABI ROOT
AmeriSpeak	11.6%	9.2%	8.6%	4.0%	3.9%	6.1%	28.6%	60.2%	4.0%
UNWEIGHTED									
Opt-in A	22.5%	14.9%	16.3%	12.4%	9.4%	17.4%	27.8%	58.9%	10.4%
Opt-in B	25.1%	23.7%	17.4%	12.4%	13.0%	20.4%	34.6%	62.5%	13.5%
Opt-in C	26.0%	22.2%	16.0%	13.7%	10.5%	18.0%	35.8%	67.4%	13.4%
WEIGHTED (CONVENTIONAL WEIGHTING PROCEDURES APPLIED)									
Opt-in A	22.6%	15.5%	16.4%	12.2%	9.3%	16.6%	27.5%	58.7%	10.4%
Opt-in B	25.1%	22.6%	16.3%	11.9%	12.9%	20.9%	33.9%	61.3%	12.2%
Opt-in C	24.7%	21.5%	15.1%	13.2%	10.7%	16.9%	34.3%	66.9%	13.2%
TRUENORTH ADJUSTMENT									
TrueNorth A	14.4%	10.3%	10.4%	6.3%	4.9%	5.7%	27.3%	58.8%	5.4%
TrueNorth B	14.6%	14.0%	9.6%	5.6%	6.1%	5.9%	28.8%	59.3%	5.9%
TrueNorth C	11.8%	12.8%	9.0%	6.1%	5.4%	8.4%	29.0%	60.9%	6.3%

AmeriSpeak Benchmark =   11.6%
Opt-In A unweighted =   22.5%
Opt-In A weighted =   22.6%
TrueNorth =   14.4%

- Definition of Absolute Error
  - Absolute Error = ABS (Opt-in Estimate – AmeriSpeak Estimate)

- Almond Oil Estimates (Opt-in A)
  - Unweighted Opt-in Error =   10.9%
  - Weighted Error =   11.0%
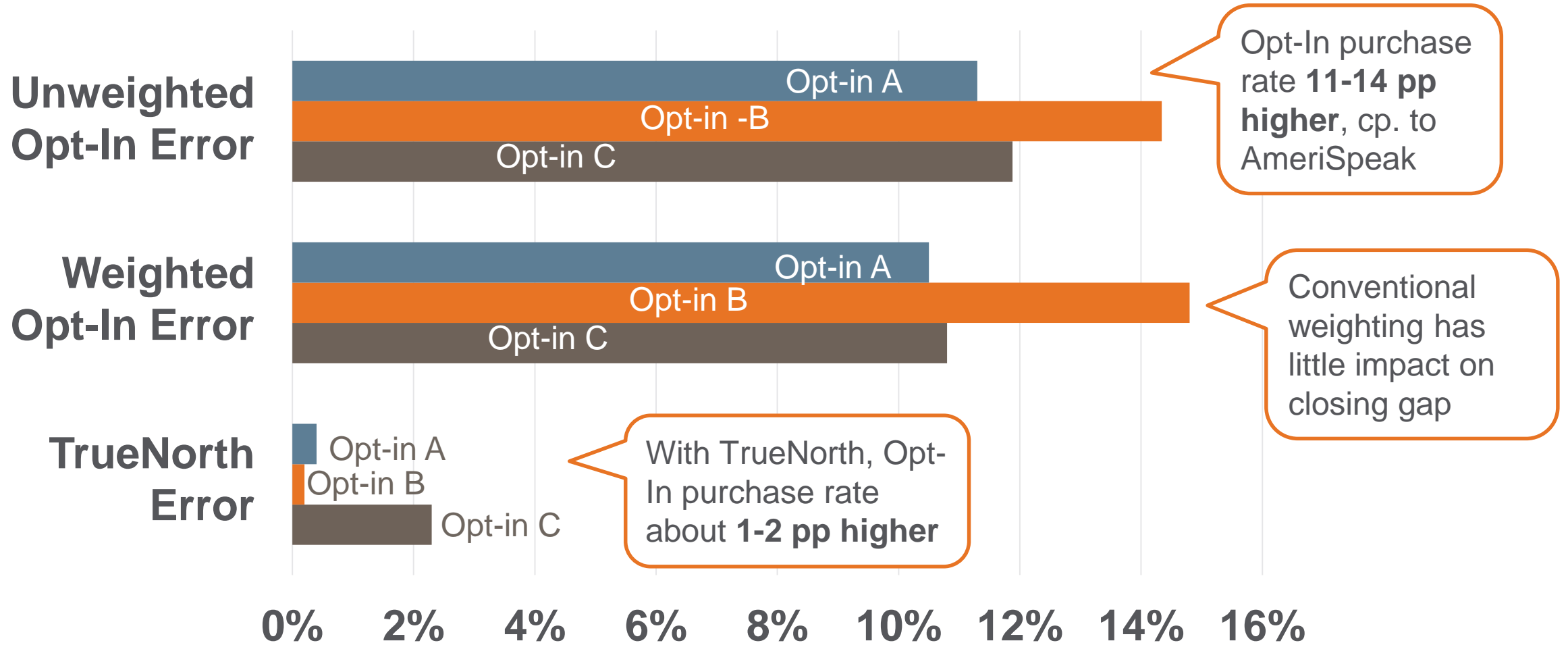 - TrueNorth Error =   2.8%

Have you purchased, or not purchased, any of these food products for your personal use in the last 12 months?

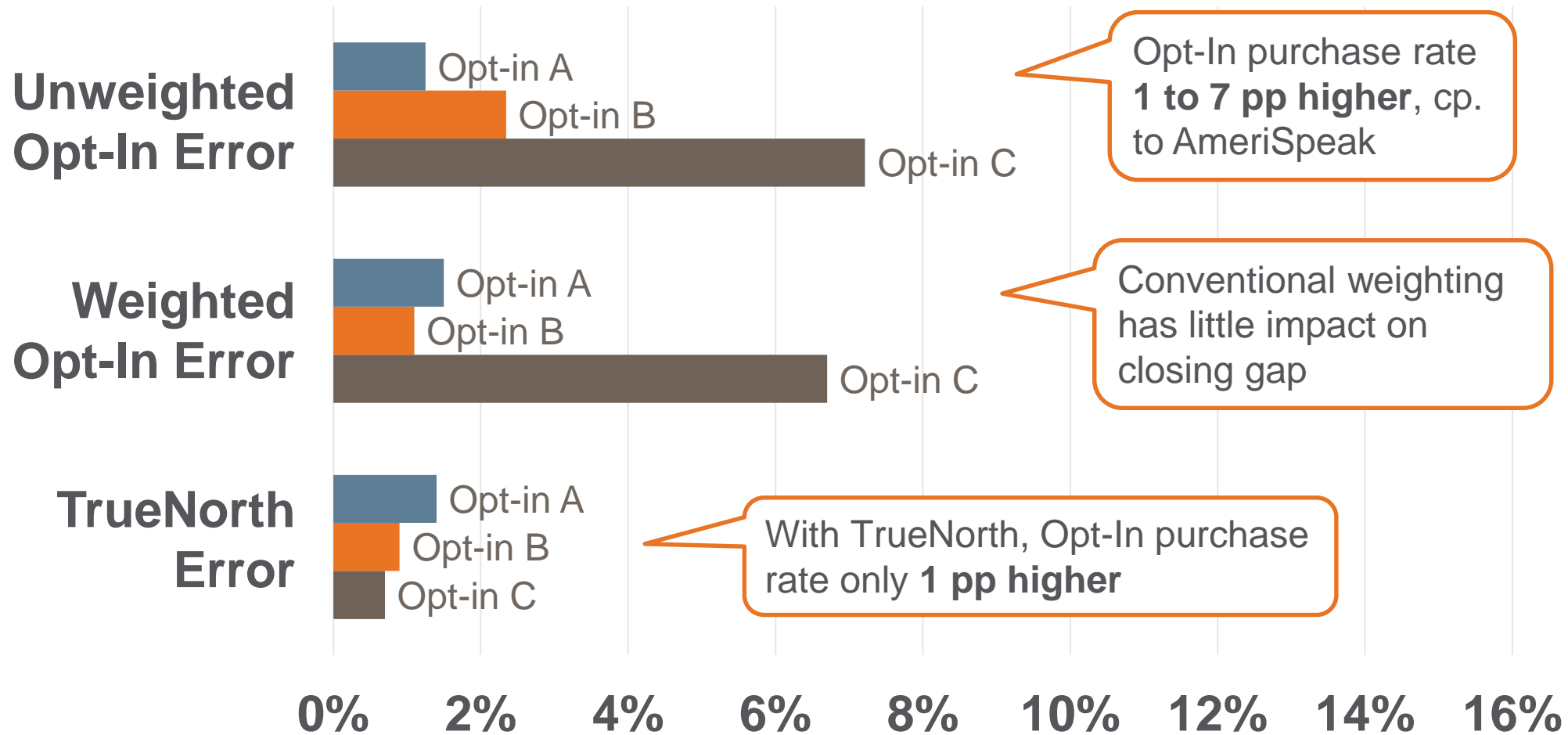Average Absolute Error Across All Food Categories
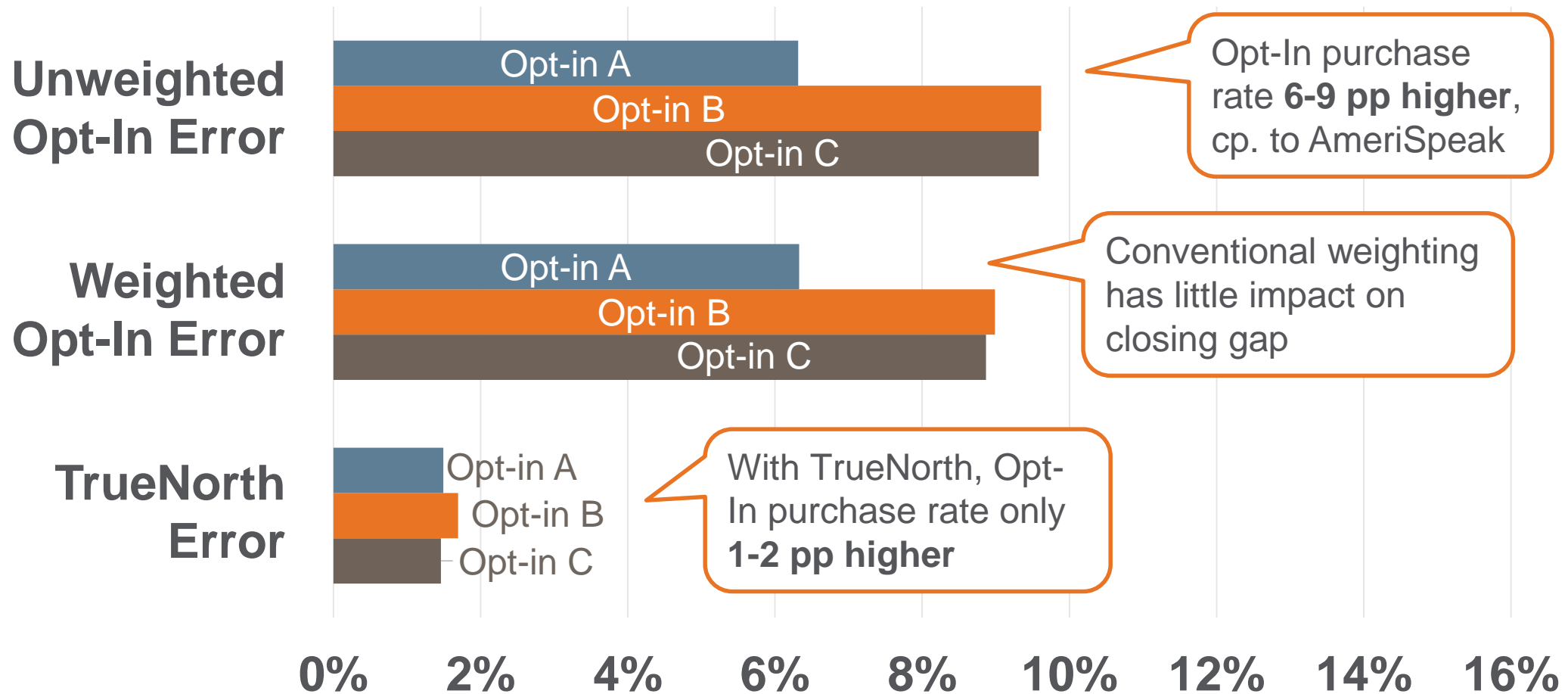
Food Product w/ **Highest** Absolute Error Truffles

Have you purchased, or not purchased, any of these food products for your personal use in the last 12 months? Vanilla Extract

Food Product w/ **Lowest** Absolute Error Vanilla Extract

Unweighted Opt-In Error
- Opt-in A
- Opt-in B
- Opt-in C

Opt-In purchase rate **1 to 7 pp higher**, cp. to AmeriSpeak

Weighted Opt-In Error
- Opt-in A
- Opt-in B
- Opt-in C

Conventional weighting has little impact on closing gap

TrueNorth Error
- Opt-in A
- Opt-in B
- Opt-in C

With TrueNorth, Opt-In purchase rate only **1 pp higher**

0% 2% 4% 6% 8% 10% 12% 14% 16%

- Compared to AmeriSpeak benchmarks for the Nine Food Products, Average Overstatement of Past-Year Purchasing for Opt-Ins A, B, and C:

	Opt-In A	Opt-In B	Opt-In C
Before Weighting	105%	146%	137%
W/ Conventional Weighting	104%	139%	129%
W/ TrueNorth Weighting	21%	27%	26%

- For instance Opt-In A Over-Stated Purchase Behavior Twice (105%) on Average for Each of the Nine Products (compared to AmeriSpeak benchmark)

New and Used Car Purchases

How likely are you to purchase a new/used car or light truck in the next 12 months?

Car Product	NEW CAR					USED CAR				
Response	1 Not at all likely	2	3	4	5 Very likely	1 Not at all likely	2	3	4	5 Very likely
AmeriSpeak	58.0%	13.1%	14.1%	6.5%	7.9%	54.7%	14.5%	14.5%	7.6%	8.0%
UNWEIGHTED										
Opt-in A	41.3%	13.9%	17.6%	12.6%	13.8%	42.6%	12.1%	19.6%	12.4%	11.5%
Opt-in B	38.2%	13.3%	16.6%	13.3%	17.7%	38.2%	12.7%	19.5%	15.5%	13.5%
Opt-in C	37.7%	13.1%	17.6%	15.0%	16.5%	40.2%	13.2%	17.7%	15.1%	12.1%
WEIGHTED (CONVENTIONAL WEIGHTING PROCEDURES APPLIED)										
Opt-in A	42.2%	13.8%	17.8%	11.4%	14.1%	43.4%	12.4%	18.9%	12.3%	11.4%
Opt-in B	41.2%	12.2%	16.2%	12.1%	17.6%	40.5%	12.9%	19.1%	13.9%	13.7%
Opt-in C	38.8%	12.4%	17.7%	14.4%	16.6%	40.6%	12.7%	17.6%	15.4%	12.2%
TRUENORTH ADJUSTMENT										
TrueNorth A	52.5%	13.5%	15.6%	7.6%	10.3%	50.7%	14.4%	15.8%	8.7%	9.1%
TrueNorth B	51.4%	13.6%	15.3%	8.4%	10.6%	48.9%	14.5%	17.0%	9.9%	9.1%
TrueNorth C	57.2%	14.7%	13.7%	6.6%	7.5%	52.9%	15.4%	14.4%	8.5%	7.8%

Example of New Car Purchase Intent for AmeriSpeak vs. Opt-In A

Purchase Intentions (Likely/Very Likely)

AmeriSpeak Benchmark =	14.4%
Opt-In A unweighted =	26.4%
Opt-In A weighted =	25.5%
TrueNorth =	18.0%

Absolute Error: New Car Purchase Estimates (Opt-in A)

- Unweighted Opt-in Error =   12.0%
- Weighted Error =   11.1%
- TrueNorth Error =   3.6%

How likely are you to purchase a new/used car or light truck in the next 12 months?

Average Absolute Error Across All Items on Car Purchase (New or Used)

Unweighted Opt-In Error
- Opt-in A
- Opt-in B
- Opt-in C

Opt-In purchase rate **6-7 pp higher**, cp. to AmeriSpeak

Weighted Opt-In Error
- Opt-in A
- Opt-in B
- Opt-in C

Conventional weighting has little impact on closing gap

TrueNorth Error
- Opt-in A
- Opt-in B
- Opt-in C

With TrueNorth, Opt-In purchase rate only **1-2 pp higher**

0% 2% 4% 6% 8% 10% 12% 14% 16%

26

- Compared to AmeriSpeak Top-2 Box Benchmarks for the New Car Purchase Intentions, Overstatement of Average Purchase Intentions for Opt-Ins:

	Opt-In A	Opt-In B	Opt-In C
Before Weighting	83%	116%	118%
W/ Conventional Weighting	77%	106%	115%
After TrueNorth Weighting	25%	32%	3%

- E.g., Opt-In B Over-Stated Purchase Behavior More Than Twice (116%) on Average for Car Purchase Intentions (compared to AmeriSpeak benchmark)

Final Comment

- Non-probability surveys can be made more accurate when combined with probability sample and calibration adjustments (TrueNorth)

- Makes possible the use of probability sample in new research contexts where previously only non-probability samples might have been considered

- Lowering TrueNorth implementation costs: opportunities for automation

- Recommendation: Include probability sampling and calibration weighting to assure accuracy in marketing surveys

Thank You!

Innovation DAYS

insight for informed decisions™