# Ambiguity, Date Labels, and Food Waste

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## Motivation

- About 30-40% of all food produced in the US being wasted
- Causing tremendous economic, environmental, and social consequences
- UK's WRAP calculates that 20% of consumer food waste results from confusion over date labels (Use by; Best by; Fresh by; Best if use by; Enjoy by; Sell by …)
- Research questions:
  - ✓ What is the effect of date labels on food waste?
  - ✓ Does ambiguity preference shape valuation in light of date labels?
  - ✓ Do date labels and ambiguity preference affect products differently?

## Conceptual framework: An α-MaxMin model

- A food item that has two states:
  'Bad' state (with prob. $p \in [0,1]$ ): consumption generates utility $\underline{u} < 0$
  'Good' state (with prob. $1-p$ ): consumption generates utility $\bar{u} = 0$
- If discarding the food item: utility $u_0 \in (\underline{u}, \bar{u})$.
- Ambiguity: The consumer does not know the value of $p$.
- She believes that $p \in C_\delta \equiv [(1-\delta)\pi, (1-\delta)\pi + \delta]$, where
  $\pi \in [0,1]$ reflects perceived level of ambiguity;
  $\delta \in [0,1]$ is the reference probability that the state is 'Bad.'
- Utility from consuming the food item:

$$V(\alpha,\delta,\pi) = \alpha \min_{p\in C_\delta}\{p\underline{u} + (1-p)\bar{u}\} + (1-\alpha)\max_{p\in C_\delta}\{p\underline{u} + (1-p)\bar{u}\}$$
$$= \alpha \min_{p\in C_\delta}\{p\underline{u}\} + (1-\alpha)\max_{p\in C_\delta}\{p\underline{u}\},$$

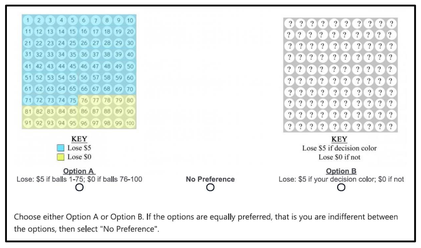
  where $\alpha \in [0,1]$ measures ambiguity aversion,
  $\alpha = 1$: max. ambi. aver.; $\alpha = 0$: max. ambi. seeking.
- The consumer will discard the food item if $V(\alpha,\delta,\pi) < u_0$.

## Hypotheses:

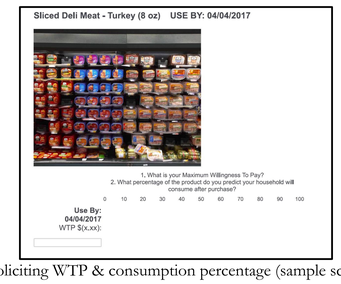
- **Hypothesis 1.** If **a**mbi. aversion index ↑ then value of the food item ↓ and waste ↑.
- **Hypothesis 2.** When consumers are ambi. averse or ambi. neutral, then a 'best by' (relative to 'date only') date label causes value of the food item ↑ and waste ↓.
- **Hypothesis 3.** When consumers are ambi. seeking or ambi. neutral, then 'use by' (relative to 'date only') date label causes value of the food item ↓ and waste ↑.

## Experiment

- 210 non-student participants; 16 sessions; Auburn, AL, and Ithaca, NY;
- Nov. 2016 – Mar. 2017;
- Four gambling series to solicit ambiguity, risk, loss, and probability weighting parameters;
- Six Becker-DeGroot-Marschak (BDM) auction series to solicit WTP and expected consumption percentage of:
  - ✓ two food items: spaghetti sauce and turkey deli meat,
  - ✓ three date labels: 'date only', 'best by', 'use by;'
- One between-subject survey about participants' consumption decision about food item (eggs, turkey deli meat, and spaghetti sauce) one day passes the posted date;



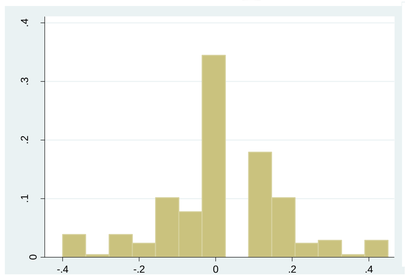

Soliciting ambiguity preferences (sample screenshot)



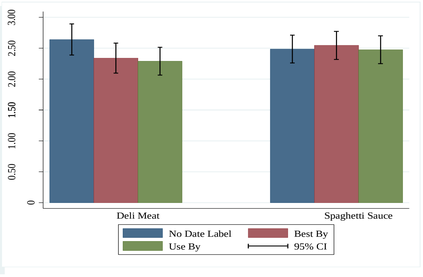

Soliciting WTP & consumption percentage (sample screenshot)


Sample survey questions soliciting uses of food items that one-day pass date on the label

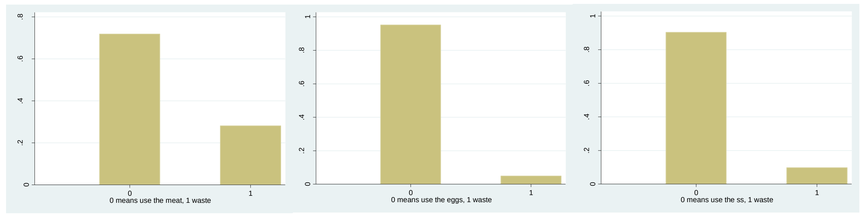
## Experiment data




Ambiguity aversion index (>0: averse; =0: neutral; <0 loving)




Data: WTP by food item by date label




deli meat eggs spaghetti sauce

Survey of food consumption decision

## Empirics

### Results based on auction data

| Variables | Waste (%) | WTP | Waste(%)×WTP |
|---|---|---|---|
| Ambiguity aversion index (AAI) | -0.388 | -3.142 | -0.174 |
| AAI × Spaghetti sauce | -0.350 | -0.590 | -0.976 |
| AAI × Best by | -0.111 | -0.113 | -0.779*** |
| AAI × Use by | -0.266 | -0.101 | -0.897** |
| Best by | 0.0192 | -0.297*** | -0.101*** |
| Use by | 0.153 | -0.360*** | -0.0673* |
| Spaghetti sauce | -1.040*** | -0.244* | -0.414*** |
| Spaghetti sauce × Best by | -0.402** | 0.449*** | 0.197** |
| Spaghetti sauce × Use by | -0.417** | 0.488*** | 0.109 |
| Socio-economic variables | Yes | Yes | Yes |
| Observations | 1,056 | 1,056 | 1,056 |
| Number of groups | 16 | 16 | 16 |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

### Results based on survey data

| Variables | Deli meat (1: discard) | Eggs (1: discard) | Spaghetti sauce (1: discard) |
|---|---|---|---|
| Ambi. aversion index | -3.478* | 2.086 | 0.974 |
| | (1.821) | (1.919) | (1.809) |
| Use by (1: use by; 0: best by) | 0.918** | -2.349 | 1.675** |
| | (0.396) | (1.705) | (0.733) |
| Use by × ambi. aversion index | 3.887** | 2.870 | -1.116 |
| | (1.911) | (2.932) | (2.590) |
| Price (1: high price; 0: low price) | 0.102 | -1.771* | 0.995 |
| | (0.376) | (1.036) | (0.859) |
| Socio-economic variables | Yes | Yes | Yes |
| Observations | 176 | 150 | 176 |
| Number of groups | 16 | 16 | 16 |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

## Conclusions & discussion

- Date labels and ambiguity preference appear to shape food waste, with impact differ across food items with different shelf lives.
- For deli meat, a more ambiguity averse consumer is more likely to throw out the meat if the label is 'Use by' than 'Best by'. Change 'Use by' to 'Best if used by' may reduce food waste.
- For spaghetti sauce, 'Use by' increases waste but ambiguity aversion does not affect waste.
- Consumers are generally insensitive to food prices when discarding food (except eggs).
- 'Use by' and 'Best by' reduce WTP for deli meat but increase WTP for spaghetti sauce.