# Benefit-Cost Analysis, Food Safety, and Traceability

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# Outline

- Benefit-cost analysis & risk management
  - BCA principles & justification
  - Information & uncertainty
- Valuing health risk
  - Risk perception
  - Valuation methods
  - GM and other examples

# Risk Assessment & Risk Management

## Risk Assessment

- Identify and characterize risk
  - Probability and consequences
  - Endpoint: human health, ecosystems
- Dependence on exposure to hazardous agent
  - Quantity, timing, exposure to other agents
- Variability (differential susceptibility of target)
- Uncertainty

## Risk management

- Decision making, recognizing tradeoffs
  - Improvement on some attributes (risk reduction), decrements on others (costs)
  - Benefits to some, harms (forgone benefits) to others

# The Risk-Management Problem

## Balance

- Benefits of action
  - Reduced target risk (avoided damages)
  - Ancillary benefits
- Costs of action
  - Opportunity cost = forgone benefits
  - Countervailing risks

## Complications

- Uncertainty
  - Weigh benefits and costs by probability of occurrence
  - Value of information – increase chance of choosing decision that is best for actual conditions
- Distribution across population

# Distribution: Tradeoffs Among People

Fundamental question of social policy:

When is it permissible to impose harms on some (or to forgo benefits to some) to benefit others?

Economics assumes there is no objective method to compare effects on individual utility or well-being

- Who suffers more from the "same" level of pain?

Practical methods for interpersonal comparison

- Money → Benefit-cost analysis (BCA)
- QALYs → Cost-effectiveness analysis (CEA)

# Justifications for BCA or CEA

## Kaldor-Hicks compensation test

- If value of benefits exceeds value of harms, winners could compensate losers leaving everyone better off
- Compensation not necessary; better accomplished through tax & welfare system
- Design regulations to expand "social pie," allocate shares using other means

## Utilitarian

- Monetary values (or QALYs) approximate equivalent changes in utility
- Improve approximation by weighting (e.g., less weight on effects to more advantaged people)

## Consistency

- If BCA or CEA routinely used, winners and losers average out and all are better off in long run
- Compared with what alternative decision rule?

# Description v. Prescription

- BCA justified as describing whether a population judges itself better off with, or without, a project
  - Benefits & costs based on individual preferences
  - "Objective" risk assessment
- Individual behavior and perceptions sometimes inconsistent with economic model
  - Cognitive errors or richer conception of issue?
- How should BCA incorporate departures from model?
  - Populism v. paternalism
- Examples
  - Information disclosure
  - Ambiguity aversion

# Information Disclosure

Provision of accurate information generally viewed as

- Not harmful
- Possibly beneficial

Individuals may be misled

- Over-emphasize salient attributes (e.g., possibility of carcinogenesis, neglect of probability)
- Aversion to irrelevant(?) attributes (e.g., synthetic v. natural chemicals, GMOs)

Prohibiting (accurate) information disclosure may be appropriate

- Probative v. prejudicial value of evidence

# Risk, Uncertainty, & Ambiguity Aversion

Humans dislike risk, uncertainty, ambiguity, ignorance

- Risk: "objective" probabilities
- Uncertainty: subjective probabilities
- Ambiguity: unknown probabilities
- Ignorance: unknown possible outcomes

Should we take greater precaution when risks are more uncertain?

# Perils of Prudence
## (Nichols & Zeckhauser 1986)

Conservative assumptions, worst-case analysis, ambiguity aversion can increase risk

| Food type | Cases | Probability | Expected cases |
|---|---|---|---|
| Ambiguous | 1 | 0.99 | |
| | 1,000 | 0.01 | 11 |
| Certain | 101 | 1.0 | 101 |

Using upper-bound risk estimates, Certain would be preferred to Ambiguous

# Perils of Prudence

If decision is repeated for 10 foods (and risks are independent)

| Food type | Cases | Probability |
|---|---|---|
| Ambiguous | 10 | 0.904 |
| | < 1,010 | 0.996 |
| Certain | 1, 010 | 1.0 |

Policy of choosing Certain (with smaller upper-bound risk) is almost sure to cause more cases

# Value of Information

For each of 10 foods, learn true number of cases for ambiguous type

- Choose ambiguous if it causes 1 case
- Choose certain otherwise

| Choice | Expected cases |
|---|---|
| Perfect information | 20 |
| Ambiguous (always) | 110 |
| Certain (always) | 1,010 |
| Expected value of information | 90 cases prevented |

# Value(s) of Information

- Increase chance of choosing decision that is best (or not bad) for actual conditions
  - "Expected value of information" in decision theory
- Overcome burden of proof needed to depart from status quo policy or default assumption
  - Compensate for decision rule that does not maximize expected value of outcome
- Reassure decision makers and affected public that decision is appropriate
  - Enhance compliance, minimize opposition & legal challenges
  - Incorporate compliance and challenges as factors in analysis?

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- Information & uncertainty

Valuing health risk

- Risk perception
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# Risk Perception & Tolerance

Health risks differ in ways that affect perception & tolerance

Fatalities: not all modes of death are equivalent

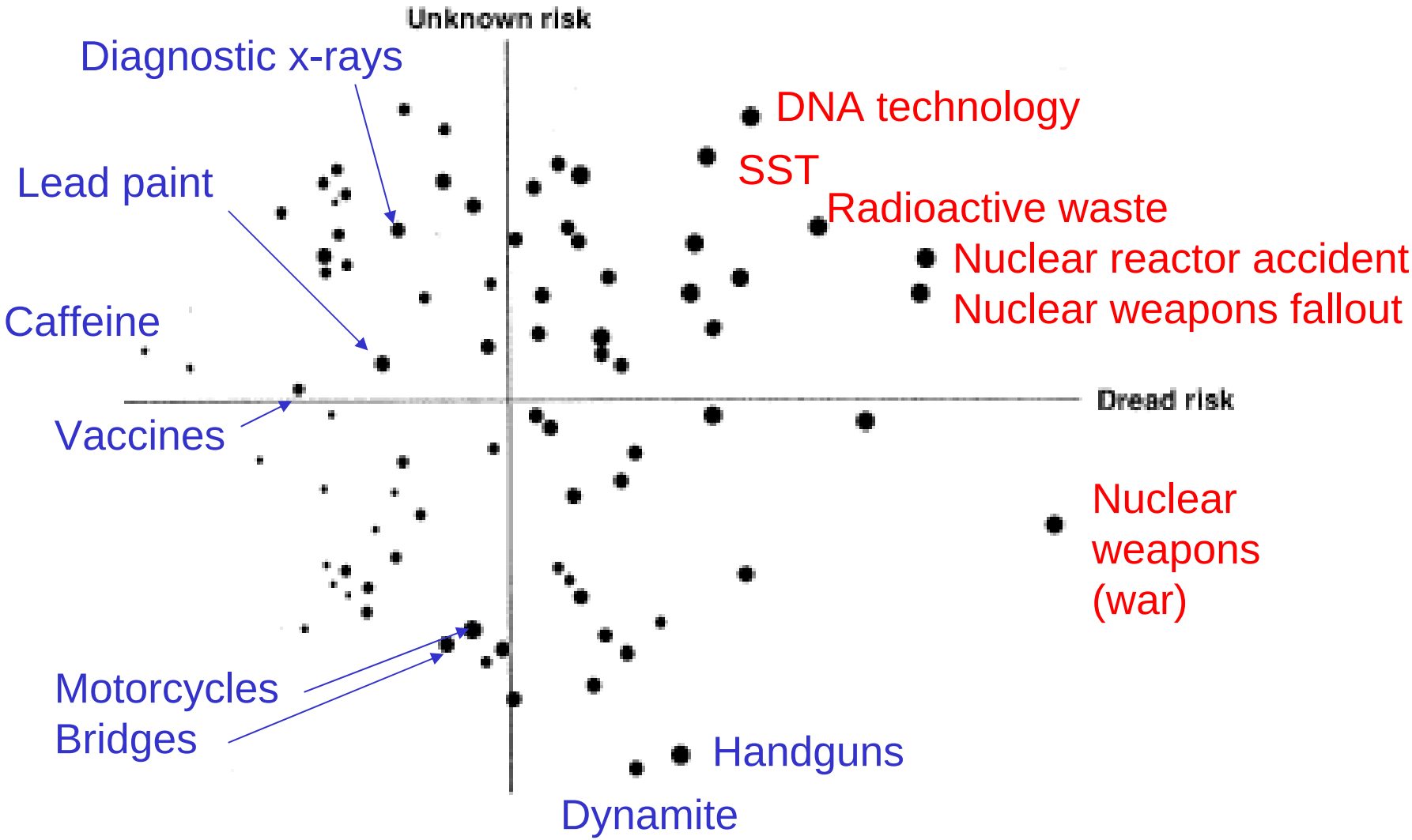
- Morbidity, time to prepare, gruesomeness

Probabilities: ambiguity aversion

- People prefer known to unknown probabilities

"Psychometric attributes"

- Dread
  - Uncontrollable, involuntary, catastrophic, inequitable distribution of benefits, affects future generations
- Uncertain
  - Unobservable, not understood scientifically, delayed consequences, newly recognized




Demand for regulation indicated by size of dot (Slovic 1987)

# Valuing Human Health Risk

Willingness to pay (WTP) to reduce risk

Value per statistical case (VSC)

= WTP / change in risk

Mortality risk → value per statistical life (VSL)

WTP and WTA should be proportional to change in risk (for small changes) → value per statistical case should be independent of magnitude of risk change

Less tolerance of a risk suggests greater WTP to reduce it, but limited & conflicting evidence

# Valuation Methods

## Revealed preference

- Observe behavior, assume people choose the option they prefer
- May not know what options they reject
- Applicable only to contexts where choices are made

## Stated preference

- Survey people about what choices they would make
- Responses to hypothetical questions may not predict consequential behavior
- Can be applied broadly, e.g., for hypothetical situations, future products
- Respondents often do not attend to small changes in probabilities – test for proportionality of WTP to risk change to assess validity

# Valuing Risk of Foodborne Illness (Hammitt & Haninger 2007)

Risk of illness from microbial pathogens on food

Survey internet panel (representative of US population)

Intervention: choose food produced by "superior safety system" (safer, more expensive) or conventional

Each respondent values two changes

- Own risk
- Risk to child (2 – 18 yrs) in household (if applicable)
- Choice described as "food only [you / your child] will eat"

# Risk Attributes

Risk reduction: [4 or 2] to 1 per 10,000 per meal

Duration: 1, 3, 7 days

Severity: mild, moderate, severe

Mortality risk conditional on illness: 0, 1/10,000, 1/1,000

Food: chicken, ground beef, packaged deli meat

Initial bid: between $0.04 and $4.00 per meal

# Severity

1. You will have an upset stomach and will feel tired, but these symptoms will not prevent you from going to work or from doing most of your regular activities.

2. You will have an upset stomach, fever, and will need to lie down most of the time. You will be tired and will not feel like eating or drinking much. Occasionally, you will have painful cramps in your stomach. In addition, you will have some diarrhea and will need to stay close to a bathroom. While you are sick, you will not be able to go to work or do most of your regular activities.

3. You will have to be admitted to a hospital. You will have painful cramps in your stomach, fever, and will need to spend most of your time lying in bed. You will need to vomit and will have severe diarrhea that will leave you seriously dehydrated. Because you will be unable to eat or drink much, you will need to have intravenous tubes put in your arm to provide nourishment.

# Conclusion: WTP per Case of Acute Food-borne Illness

Varies with potential victim

- $8,000 – 16,000 for adult respondent
- $24,000 – 31,000 for his/her child

Varies with food type, respondent characteristics

- Higher for chicken than ground beef, packaged deli meat
- Higher for women, blacks, Hispanics, & less educated
- Increases with perceived risk and confidence in intervention

Largely insensitive to duration & severity

- ≤ 30% larger for a week than a day
- ≤ 50% larger for severe than mild
- Less sensitive for risk to child than to adult

# Valuing Chronic Fatal Disease Risk
## (Hammitt & Liu 2004)

Telephone survey, Taiwan

WTP to reduce [lung / liver] [cancer / disease] from [air / drinking water]

30% premium for fatal cancer over similar non-cancer illness

100% premium for air/lung v. drinking water/liver

# Ambiguity Aversion
## (Shogren 2005)

WTP to eliminate risk of salmonella-induced illness at 2 restaurants (open-ended response)

Two inspectors agree or disagree (+/- 50%) about risk

- Mean WTP larger (usually 1.5 – 2 x) for ambiguous risk
- Median WTP larger in only 3 / 7 cases

WTP grossly insensitive to risk magnitude

- Risk varies from 1/10 to 1/10 million
- Mean WTP varies from $50 to $13 (unambiguous) and $75 to $50 (ambiguous)
  - VSC varies from $500 to $130 million (unambiguous)

# Valuing GM & non-GM Foods

Meta-analysis (Lusk et al., 2005)

Experiment (Noussair et al., 2004)

Market purchase (Kalaitzandonakes et al. 2005)

# Meta-analysis
## (Lusk et al. 2005)

25 studies, 57 estimates

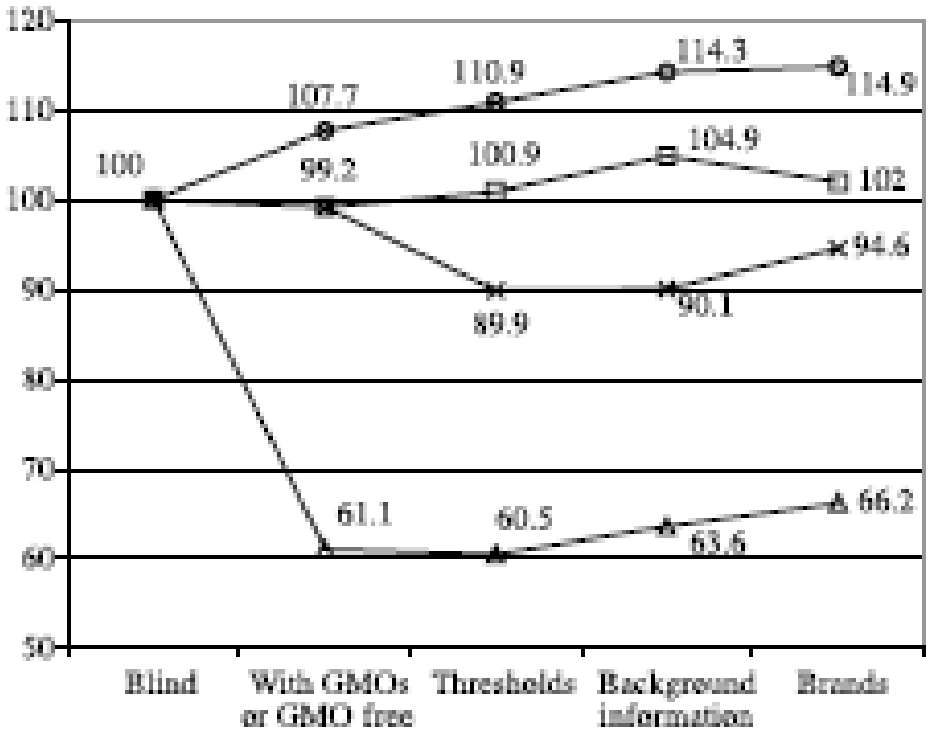
Premium for non-GM:

- Range: -70% to +170% (plus outlier at 800%)
- Average: +29% (+42% including outlier)
- Higher for meat, lower for corn & soybean oil
- Higher in Europe than in North America

# Experiment
## (Noussair et al. 2004)

97 Grenoble residents

Auction for 4 types of biscuits




GMO free

Threshold 0.1%

Threshold 1%

GM

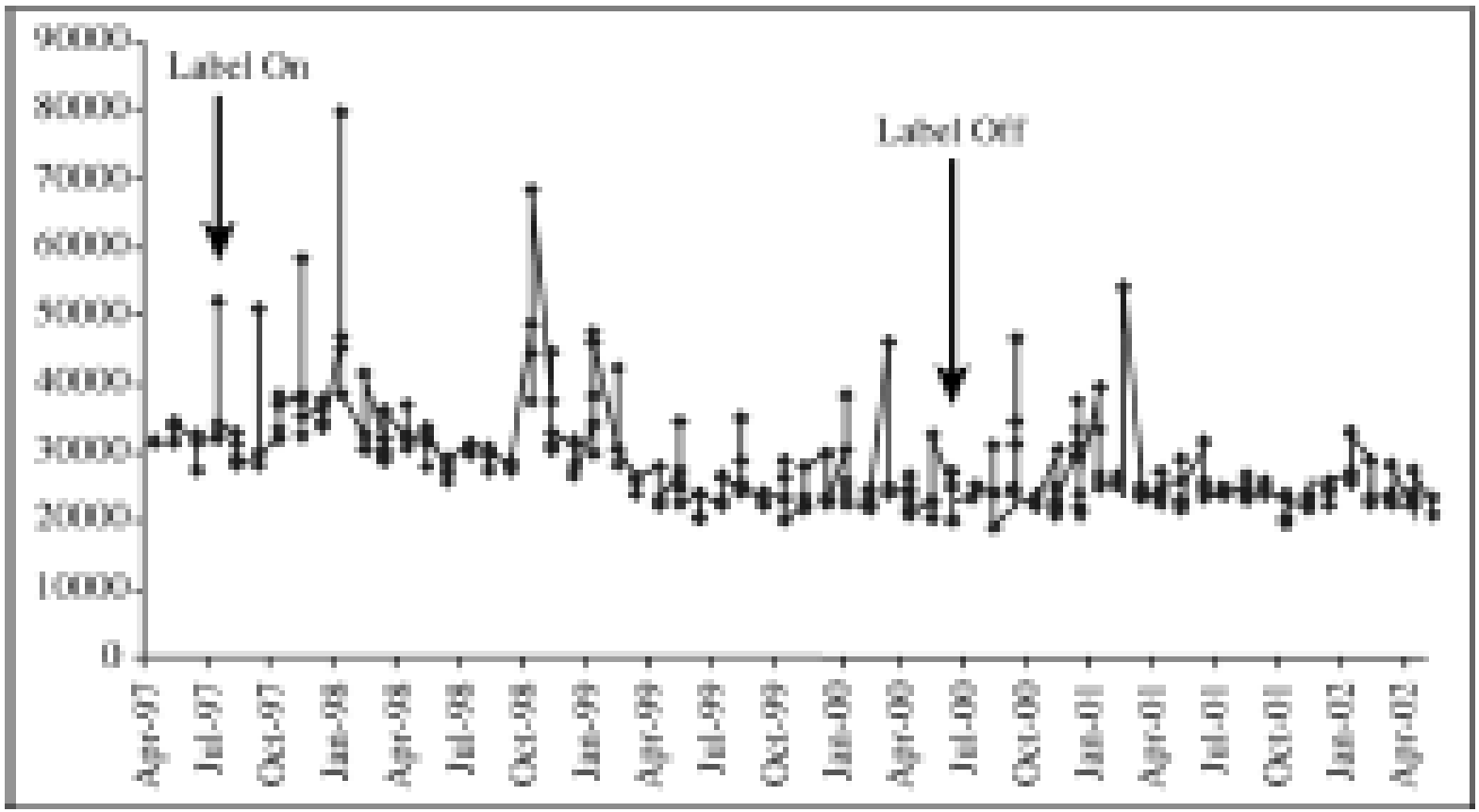
# Market purchase
## (Kalaitzandonakes et al. 2005)

Foods containing GM and non-GM soy and maize co-existed in Dutch markets

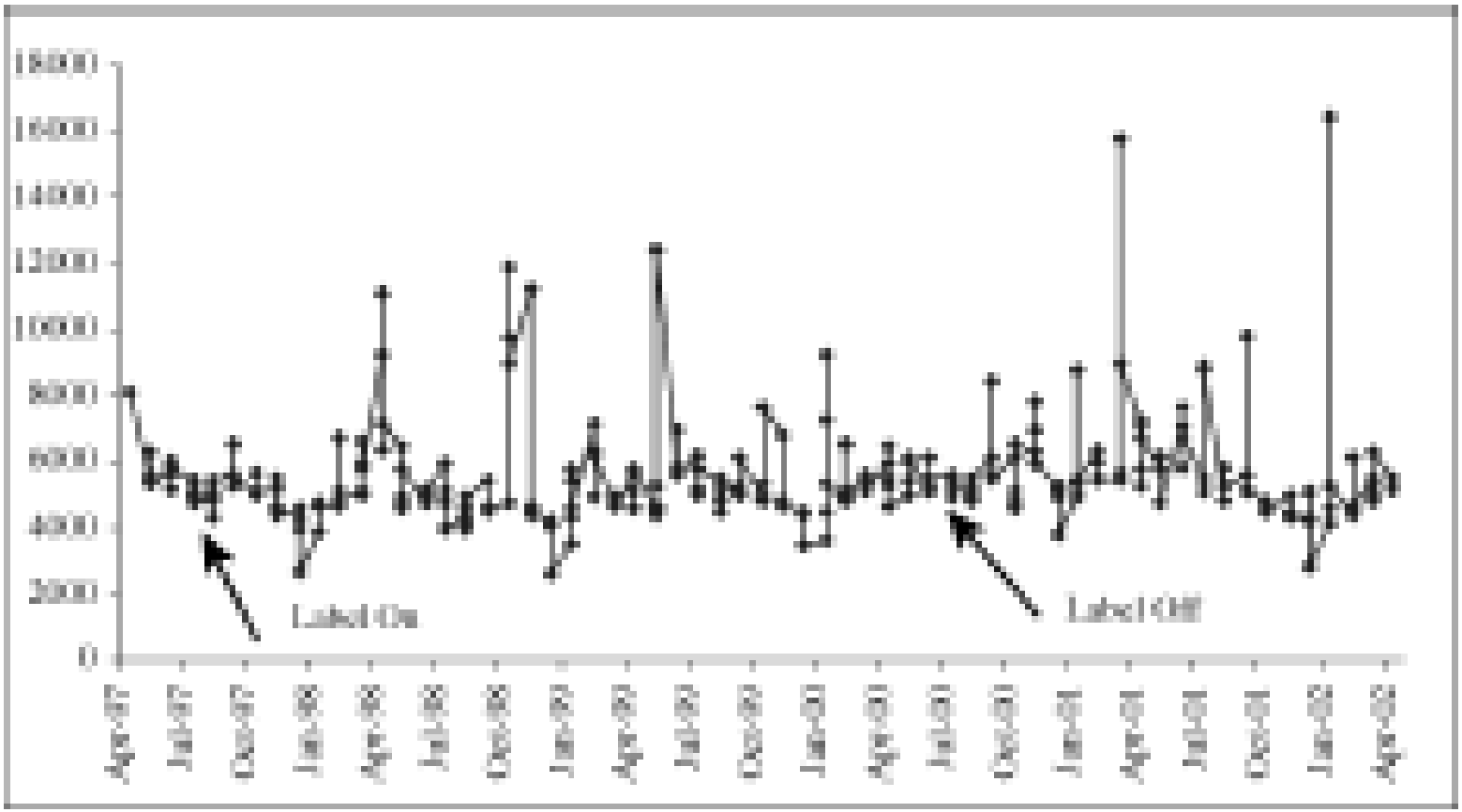
Label required (1997) & abandoned (2000)

No discernable effect on sales of GM foods

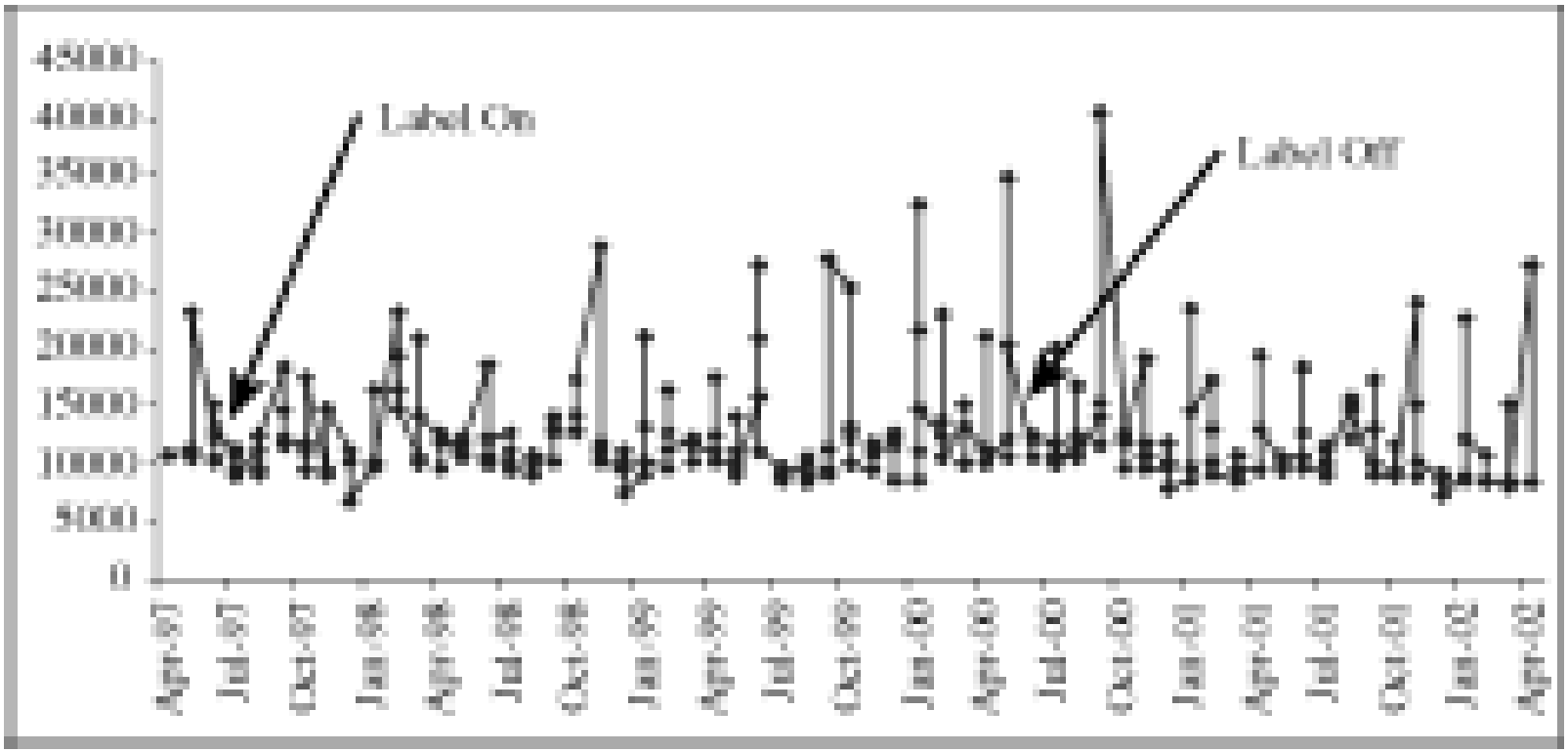
# GM-labeled Soup



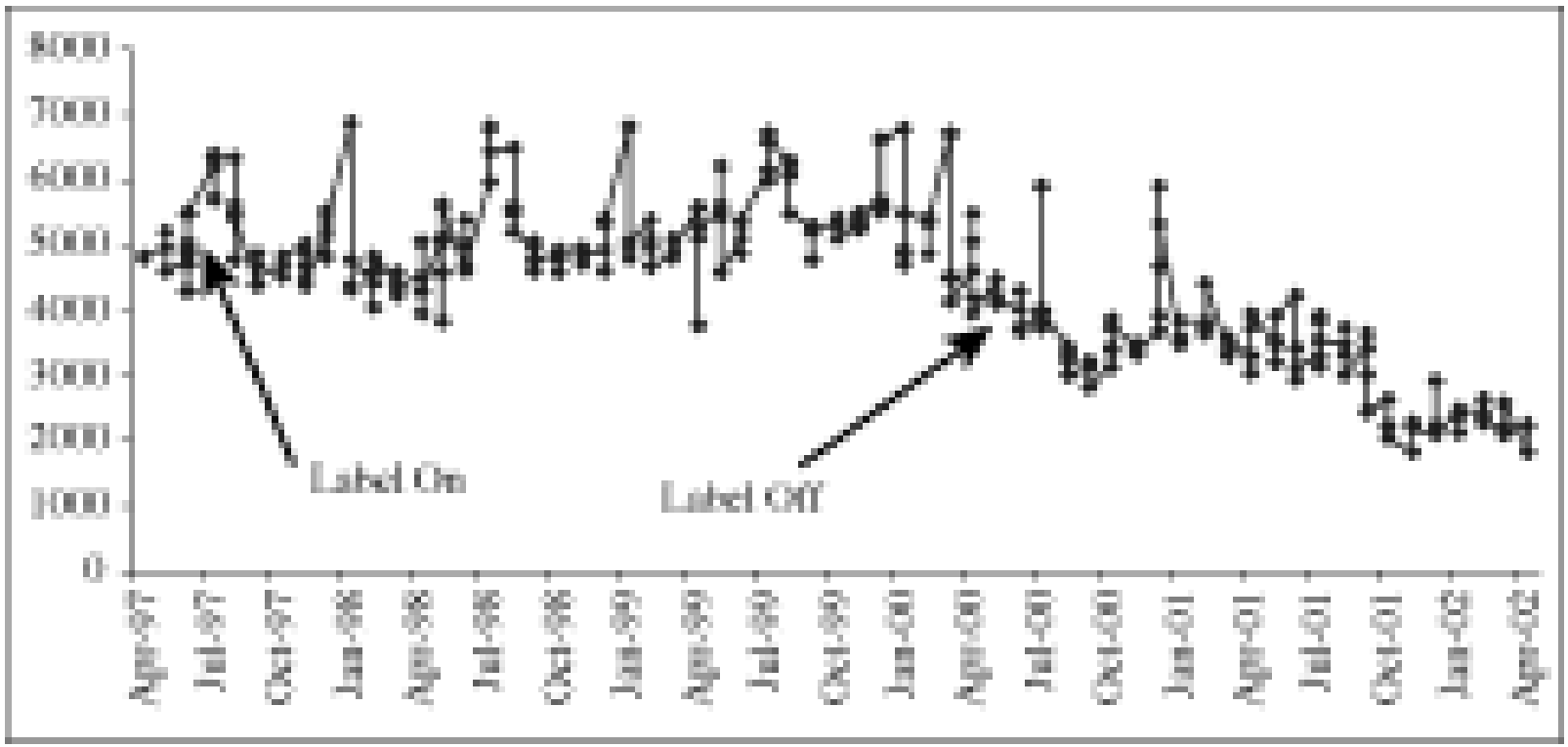
# GM-labeled Frozen Fish



# GM-labeled Frozen Pizza



# GM-labeled Frozen Meatballs



# Conclusions

For social decisions, need to compare benefits to some against harms (or forgone benefits) to others

Benefit-cost analysis relies on preferences of affected population

Elicited preferences may not reflect people's best interests

- When to modify or reject elicited or apparent public preferences?

Value of non-GM v. GM foods

- Many stated-preference studies suggest substantial effect (tens of percent)
- Market experience in Netherlands (& US) suggests little effect