The ex-ante evaluation of policies: The case of food safety regulations

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Corso per dottorandi Economia e Statistica Agro-alimentare
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Quantitative methods: literary review

a. Cost of illness
b. WTP methods (contingent valuation, conjoint analysis, experimental auction markets, hedonic pricing)
c. Accountancy methods
d. Equilibrium models (general, partial)
e. Micro-econometric models
f. Macro-econometric models (gravity models)
RIA – key analytical steps

• Identifying the problem
• Defining the objectives
• Selecting the policy options
• Analyzing the impacts of the options
• Comparing the options
• Outlining policy monitoring and evaluation

EC (2009a)
Do nothing
*Option 1*

- Impact 1
- Impact 2
- Impact n

Regulatory option
*Option 2*

- Impact 1
- Impact 2
- Impact n

Alternative option
*Option 3*

- Impact 1
- Impact n

Quantitative methodologies (macroeconometric models)

Qualitative methodologies (competitiveness test)

Cost-Benefit Analysis (CBA)
Multi-Criteria Analysis (MCA)
Impacts of food safety regulations

- Public health
- Societal concerns
- Conduct of businesses
- Firm competition
- Administrative burdens on businesses
- Public authorities
- Innovation & research
- International trade
- Macroeconomic environment
- Labour market
- Distributive effects
- Environment
- Consumers

Food safety regulations
Types of impacts (1)

1. Public health
   ✓ Sub-impact: Acute effects on public health
   ✓ Sub-impact: Chronic effects on public health

2. Firm competition
   ✓ Sub-impact: creation of barriers for new suppliers and service providers
   ✓ Sub-impact: facilitation of anti-competitive behaviour or emergence of monopolies
   ✓ Sub-impact: market segmentation
   ✓ Sub-impact: global competitive position of EU firms
   ✓ Sub-impact: trade barriers

3. Conduct of businesses/SMEs (Compliance costs)
   ✓ Sub-impact: Additional adjustment, compliance, transaction costs
   ✓ Sub-impact: Cost or availability of essential inputs
   ✓ Sub-impact: Access to finance
   ✓ Sub-impact: Investment cycle
   ✓ Sub-impact: Stricter regulation of the conduct of a particular business
   ✓ Sub-impact: New or closing down of businesses
   ✓ Sub-impact: Products or businesses treated differently
   ✓ Sub-impact: Impact on SMEs

4. Administrative burdens on businesses
5. Public authorities (administrative burden, monitoring costs)
   ✓ Sub-impact: budgetary consequences
   ✓ Sub-impact: administrative burden

6. Innovation and research
   ✓ Sub-impact: academic or industrial/public or private R&D
   ✓ Sub-impact: introduction and dissemination of new production methods, technologies and products
   ✓ Sub-impact: productivity/resource efficiency
7. Consumers (prices, but also quality, taste, variety of choice, etc.)
   ✓ Sub-impact: prices
   ✓ Sub-impact: organoleptic characteristics
   ✓ Sub-impact: consumer choice
   ✓ Sub-impact: consumer preferences
   ✓ Sub-impact: provision of affiliated public goods (i.e. ethical value)

8. International trade and third countries
   ✓ Sub-impact: trade or investment flows between the EU and third countries
   ✓ Sub-impact: EU trade policy and its international obligations, including in the WTO
   ✓ Sub-impact: specific groups (foreign food businesses and consumers)
   ✓ Sub-impact: third countries with which the EU has preferential trade arrangements
   ✓ Sub-impact: adjustment costs on developing countries
   ✓ Sub-impact: goods or services that are produced or consumed by developing countries

9. Macroeconomic environment (growth, inflation, etc.)
   ✓ Sub-impact: economic growth
   ✓ Sub-impact: conditions for investment and the proper functioning of markets

10. Labour markets (jobs)
    ✓ Sub-impact: new job creation/loss of jobs
    ✓ Sub-impact: particular professions, groups of workers, or self-employed persons

11. Environment (transport and use of energy, etc.)

12 & 13. Positive and negative distributional effects

14. Societal concerns (e.g. ethical concerns, media attention, social awareness, etc.)
<table>
<thead>
<tr>
<th>Impact on:</th>
<th>Methods in the literature:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public health and security</td>
<td>Cost of illness</td>
</tr>
<tr>
<td></td>
<td>Contingent valuation (wtp)</td>
</tr>
<tr>
<td></td>
<td>Experimental auction (wtp)</td>
</tr>
<tr>
<td>Consumers and households</td>
<td>Conjoint analysis (wtp)</td>
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<td></td>
<td>Hedonic pricing (wtp)</td>
</tr>
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<td></td>
<td>Microeconometric demand m.</td>
</tr>
<tr>
<td></td>
<td>Partial equilibrium model</td>
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<tr>
<td>International trade and third countries</td>
<td>Macroeconometric models (gravity)</td>
</tr>
<tr>
<td>Firm competition</td>
<td>Direct accountancy</td>
</tr>
<tr>
<td></td>
<td>Microeconometric models</td>
</tr>
<tr>
<td></td>
<td>Partial equilibrium model</td>
</tr>
<tr>
<td></td>
<td>Linear programming model</td>
</tr>
<tr>
<td></td>
<td>General equilibrium m. (SAM)</td>
</tr>
<tr>
<td>Conduct of businesses</td>
<td>Liability costs</td>
</tr>
<tr>
<td></td>
<td>Direct accountancy</td>
</tr>
<tr>
<td></td>
<td>Partial equilibrium model</td>
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<tr>
<td></td>
<td>Linear programming model</td>
</tr>
<tr>
<td></td>
<td>Microeconometric models</td>
</tr>
<tr>
<td>Innovation and research</td>
<td>Direct accountancy</td>
</tr>
<tr>
<td>Public sector</td>
<td>Direct accountancy</td>
</tr>
<tr>
<td>Environment</td>
<td>Direct accountancy</td>
</tr>
<tr>
<td></td>
<td>Life-cycle analysis</td>
</tr>
<tr>
<td>Other effects on the economy</td>
<td>General equilibrium m. (SAM)</td>
</tr>
<tr>
<td></td>
<td>Macroeconometric model</td>
</tr>
</tbody>
</table>

Ragona and Mazzocchi (2008)

Analysis of impacts: various methods...

Impact on public health

✓ COI
✓ WTP
✓ QALYs
✓ DALYs
a. See text for a discussion of cost elements. The cost components above are associated with contracting a disease. People who avoid disease by employing averting behavior may incur other costs (e.g., the cost of buying bottled water). Both the cost components listed above, and those associated with risk avoidance would be reduced or eliminated if the risks were reduced or eliminated.

b. Heightened morbidity or other adverse effects associated with a lack of treatment (e.g., due to insufficient resources) may increase pain and suffering. This indirect cost category is very difficult to measure.

c. Lost time includes a partial or complete loss of the ability to carry out activities (paid or unpaid).

d. Includes special education (children); worker retraining (adults); workers’ disability; and/or specialized equipment, transportation, and other services required due to the illness.

Source: EPA, COI Handbook
Total Willingness to Pay (WTP)\textsuperscript{a}

**INDIRECT COSTS**

- **WTP to Avoid Pain and Suffering\textsuperscript{b}**
  - family and community
  - patient

- **Value of Lost Productive Time\textsuperscript{c}**
  - patient

- **Value of Lost Leisure Time**
  - caregiver (unpaid)

**DIRECT COSTS**

- **for Medical Services**
  - paid directly by patient
  - paid indirectly by patient and rest of public through insurance premiums, taxes, etc. (see text for additional detail)

- **for Special Services\textsuperscript{d}**
  - paid by hospital or MD

Source: EPA, COI Handbook
the occurrence of foodborne illnesses essentially leads to increasing medical expenses and decreasing productivity

Indicator: \textit{total incremental costs due to food-borne disease} = total medical costs + total productivity losses
COI – direct costs

\[ PVC = \sum_{n=l}^{99} \frac{P_{l,s}^i(n) \cdot DC_{l,s}^i(n - l + 1)}{(1 + r)^{n-l}} \]

Source: EPA, COI Handbook

- \( n \) = the various ages of the individual,
- \( l \) = the age at impairment onset,
- \( P'_{l,s}(n) \) = the probability that a person of sex \( s \) who acquires condition \( i \) at age \( l \) will survive to age \( n \),
- \( DC_{l,s}^i(n-l+1) \) = the dollar value of the average annual incremental direct costs generated by such persons during year \( n-l+1 \) following impairment onset, and
- \( r \) = the discount rate.
COI – indirect costs

\[ \sum_{t=0}^{\infty} \frac{P_t E_t}{(1+r)^t} \]

Source: Kuchler and Golan, 1999

- \( E_t \) individuals earnings in year \( t \)
- \( P_t \) probability of surviving until year \( t \)
- \( t \) interest rate (opportunity cost of lost earnings)
- \( 1 + r \) discount rate (future losses into today’s euros)
One of the mostly debated issues among economists and non-economists

- Moralist vision: we cannot give an economic value to human life
- Economic vision: life is a good and has a value like all other goods

Measure of VSL indicates willingness to pay (WTP) for small reductions of death risk (e.g. 1 out of 10,000)

Definition: amount of money that a specific community is WTP for having a reduction of a small probability of death such that the death of an individual is prevented. The individual has no identity, but pertains to the community

Regulations reduce mortality risks in the population affected by the regulation

Regulations are said to save “statistical lives” as opposed to identified lives
COI – indirect costs – human capital approach

- Costs to society of adverse health outcome is the impact that such outcomes have on national income
- The value of life is measured in terms of its contribution to national income
- Social welfare is diminished by illness, disability, and premature death to the extent that these outcomes diminish national income
  - Changes in health status are reflected in changes in earnings and national income
  - National income is a valid measure of social welfare
- …not appropriate for CBA
  (Kuchler and Golan, 1999)
## COI – indirect costs – value of life

<table>
<thead>
<tr>
<th>Method</th>
<th>Expression</th>
<th>Comments</th>
</tr>
</thead>
</table>
| (1) Human Capital                   | \( \sum_{t}^{T} \frac{L_t}{(1 + i)^t} \)                                 | \( T \) = remaining lifetime  
\( L_t \) = labor income\(^a\)  
\( i \) = social discount rate; opportunity cost of society investing in life-saving programs |
|                                    |                                                                           |                                                                                                                                                                                            |
| (2) Revealed-Preference             | \( \left( \sum_{t}^{T} \frac{B_t}{(1 + \rho)^t} \right)^{\alpha} \)      | \( T \) = remaining lifetime  
\( B_t \) = benefits of living  
\( \rho \) = individual rate of time preference  
\( \alpha \) = risk-aversion factor |
| Willingness to Pay                  |                                                                           | \( L_t \) = labor income\(^a\)  
\( NL_t \) = non-labor income  
\( NM_t \) = nonmarket activities and leisure  
\( P_t \) = premium for pain and suffering |
|                                    |                                                                           |                                                                                                                                                                                            |
| (3) Adjusted Willingness-to-Pay     | \( \left( \sum_{t}^{T} \frac{Y_t}{(1 + \gamma)^t} \right)^{\alpha} \)    | \( T \) = remaining lifetime  
\( Y_t \) = after-tax income  
\( \gamma \) = individual's opportunity cost of investing in risk-reducing activities  
\( \alpha \) = risk-aversion factor |
| Human Capital                       |                                                                           | \( L_t \) = labor income\(^a\)  
\( NL_t \) = non-linear income |
|                                    |                                                                           |                                                                                                                                                                                            |

\(^a\)May include the imputed value of nonmarket time spent on housekeeping activities.

Source: Landefeld and Seskin, 1982
COI – indirect costs - value of life

\[
\left[ \sum_{t=0}^{T} \frac{Y_t}{(1 + r)^t} \right] \alpha
\]

- \( T \) = remaining lifetime
- \( Y_t \) = after-tax income
  = \( L_t + NL_t \)
  where \( L_t \) = labor income\(^a\)
  \( NL_t \) = non-linear income
- \( r \) = individual’s opportunity cost of investing in risk-reducing activities
- \( \alpha \) = risk-aversion factor
### TABLE 9.2 Annual Incidence of *Escherichia coli* 0157:H7 and Severity of Illness, U.S.

<table>
<thead>
<tr>
<th>Severity of Illness</th>
<th>Percent of Cases (%)</th>
<th>Low (#)</th>
<th>High (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No physician visit</td>
<td>50.00</td>
<td>3,834</td>
<td>10,224</td>
</tr>
<tr>
<td>Visited physician</td>
<td>32.00</td>
<td>2,454</td>
<td>6,543</td>
</tr>
<tr>
<td><strong>Hospitalized</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemorrhagic colitis&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.02</td>
<td>1,075</td>
<td>2,867</td>
</tr>
<tr>
<td>Recovery</td>
<td></td>
<td>29</td>
<td>78</td>
</tr>
<tr>
<td>Acute illness death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>1,104</td>
<td>2,945</td>
</tr>
<tr>
<td><strong>HUS&lt;sup&gt;b&lt;/sup&gt;</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>1.77</td>
<td>136</td>
<td>362</td>
</tr>
<tr>
<td>Chronic illness</td>
<td>0.31</td>
<td>24</td>
<td>63</td>
</tr>
<tr>
<td>Acute illness death&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.52</td>
<td>116</td>
<td>311</td>
</tr>
<tr>
<td>Subtotal</td>
<td>100.00</td>
<td>276</td>
<td>736</td>
</tr>
<tr>
<td><strong>Total U.S. incidence/year&lt;sup&gt;d&lt;/sup&gt;</strong></td>
<td>3-8/100,000</td>
<td>7,668</td>
<td>20,448</td>
</tr>
</tbody>
</table>

<sup>a</sup> Assumes no chronic conditions resulted from hemorrhagic colitis.

<sup>b</sup> Assumes both chronic and acute conditions resulted from HUS.

<sup>c</sup> During the chronic phase, using the low estimate of 24 chronic cases, 17 die, and using the high estimate of 63 chronic cases, 42 die before the average life expectancy of 77 years.

<sup>d</sup> U.S. residential population in 1992 = 255,600,000.
### TABLE 9.3 Medical Costs of Acute Illness from *Escherichia coli* 0157:H7 by Severity Category, 1992 Dollars, Typical Year

<table>
<thead>
<tr>
<th>Severity Category</th>
<th>Base Rate</th>
<th>Frequency/Case</th>
<th>Rate/Case</th>
<th>Cases</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($$)</td>
<td>(#)</td>
<td>($)</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>No physician visit</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3,834</td>
<td>10,224</td>
</tr>
<tr>
<td>Visited physician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician visits$^a$</td>
<td>$101/visit</td>
<td>1-2</td>
<td>101-202</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Laboratory tests</td>
<td>$500/visit</td>
<td>1-2</td>
<td>50-100</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Costs per case</td>
<td>N/A</td>
<td>N/A</td>
<td>151-302</td>
<td>2,454</td>
<td>6,543</td>
</tr>
<tr>
<td>Hospitalized$^b$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemorrhagic colitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital room$^c$</td>
<td>817/day</td>
<td>6.5</td>
<td>5,313</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Physician fees, lab tests, etc.$^d$</td>
<td>817/day</td>
<td>6.5</td>
<td>5,313</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Costs per case</td>
<td>N/A</td>
<td>N/A</td>
<td>10,627</td>
<td>1,104</td>
<td>2,945</td>
</tr>
<tr>
<td>HUS$^e$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital rooms$^f$</td>
<td>1,090/day</td>
<td>15</td>
<td>16,349</td>
<td>276</td>
<td>736</td>
</tr>
<tr>
<td>Physician fees, lab tests, etc.$^d$</td>
<td>1,090/day</td>
<td>15</td>
<td>16,349</td>
<td>276</td>
<td>736</td>
</tr>
<tr>
<td>Dialysis and medication$^g$</td>
<td>123/day</td>
<td>12</td>
<td>1,478</td>
<td>130</td>
<td>346</td>
</tr>
<tr>
<td>Costs per case</td>
<td>N/A</td>
<td>N/A</td>
<td>34,176</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>21.3</strong></td>
<td><strong>57.8</strong></td>
</tr>
</tbody>
</table>

Source: Roberts and Marks, 1995
### TABLE 9.4 Productivity Loss During Acute Illness from *Escherichia coli* 0157:H7 by Severity Category, 1992 Dollars, New Cases in Typical Year

<table>
<thead>
<tr>
<th>Severity Category</th>
<th>Base Rate</th>
<th>Work Days Missed</th>
<th>Rate/Case</th>
<th>Cases Low</th>
<th>Cases High</th>
<th>Total Costs Low</th>
<th>Total Costs High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($)</td>
<td>(#)</td>
<td>($)</td>
<td>(#)</td>
<td>(#)</td>
<td>(million $)</td>
<td></td>
</tr>
<tr>
<td>No physician visit&lt;sup&gt;a&lt;/sup&gt;</td>
<td>84</td>
<td>2</td>
<td>169</td>
<td>3,834</td>
<td>10,224</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Visited physician&lt;sup&gt;a&lt;/sup&gt;</td>
<td>84</td>
<td>4</td>
<td>338</td>
<td>2,454</td>
<td>6,543</td>
<td>0.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Hospitalized&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemorrhagic colitis</td>
<td>84</td>
<td>14</td>
<td>1,176</td>
<td>1,104</td>
<td>2,945</td>
<td>1.3</td>
<td>3.5</td>
</tr>
<tr>
<td>HUS</td>
<td>84</td>
<td>32</td>
<td>2,715</td>
<td>276</td>
<td>736</td>
<td>0.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Death during acute illness&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1,178,280</td>
<td>all</td>
<td>1,178,280</td>
<td>146</td>
<td>389</td>
<td>171.7</td>
<td>457.8</td>
</tr>
</tbody>
</table>

### Notes

<sup>a</sup>Average duration of illness 6-8 days; (Griffin and Tauxe 1991) assume miss work half that time—2 days for mild cases with no physician visit and 4 days for moderate cases with physician visit. Average weekly earnings for all private, nonagricultural jobs divided by 5 days and adjusted to 1992 prices.

<sup>b</sup>Assumes work missed for 3 times the number of days hospitalized adjusted for weekends by multiplying by 5/7.

<sup>c</sup>Landefeld and Seskina's (1982) adjusted willingness to pay/human capital estimate for 4 year olds, updated to 1992 prices using the change in average weekly earnings (U.S. BLS).
### TABLE 9.5 Summary of Costs for Disease Caused by *Escherichia coli* 0157:H7, 1992

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimated Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million $)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Medical Costs

<table>
<thead>
<tr>
<th>Acute illness medical costs³</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild case/no physician visit</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Moderate case/physician visit</td>
<td>0.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Hospitalized with hemorrhagic colitis</td>
<td>11.7</td>
<td>31.3</td>
</tr>
<tr>
<td>Hospitalized with HUS</td>
<td>2.2</td>
<td>24.5</td>
</tr>
<tr>
<td>Subtotal</td>
<td>21.3</td>
<td>57.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chronic illness medical costs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic HUS cases (present value)</td>
<td>7.5</td>
<td>19.1</td>
</tr>
<tr>
<td>Total medical costs</td>
<td>28.8</td>
<td>76.9</td>
</tr>
</tbody>
</table>

#### Productivity Losses

<table>
<thead>
<tr>
<th>Acute illness productivity losses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild case/no physician visit</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Moderate case/visited physician</td>
<td>0.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Hospitalized with hemorrhagic colitis</td>
<td>1.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Hospitalized with HUS</td>
<td>0.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Deaths (present value)</td>
<td>171.7</td>
<td>457.8</td>
</tr>
<tr>
<td>Subtotal</td>
<td>175.1</td>
<td>467.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chronic illness productivity losses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic HUS survivors-present value</td>
<td>1.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Chronic HUS subsequent deaths-present value</td>
<td>11.1</td>
<td>30.3</td>
</tr>
<tr>
<td>Subtotal</td>
<td>12.8</td>
<td>34.6</td>
</tr>
</tbody>
</table>

| Total productivity losses         | 187.9 | 501.8 |

**TOTAL COSTS**                  | 217   | 579   |

Source: Roberts and Marks, 1995
COI - strengths and weaknesses

Advantages:
- simple, concrete and easily understood
- aggregations and comparisons are relatively straightforward

Disadvantages:
- lack of adequate data
- lower bound of actual costs (lost of leisure time, legal costs for lawsuits, prevention and averting costs not considered)
- value of life of better paid individuals higher than those with lower wages
✓ Contingent Valuation  →  stated preference
✓ Experimental Auction Markets
✓ Conjoint Analysis  →  stated preference
✓ Hedonic Pricing  →  revealed preference
WTP – contingent valuation

✓ Survey method
✓ Respondents are asked to state their preferences in hypothetical or contingent markets
✓ Asked:
  • about a change in government policy
  • to imagine there is a market in which they could buy ‘food safety’
  • the price they would pay to receive that ‘food safety’ level
✓ Asked demographic and socio-economic characteristics to draw inferences about entire population and aggregate demand for food safety → aggregate WTP
✓ If preferences for food safety are systematic and not random → aggregate demand can be forecast
✓ Compensating surplus (Hicks) → WTP = change in income that leaves the respondent’s utility level unchanged
WTP – contingent valuation

✓ Study: Buzby et al. (1995)
✓ Purpose: to elicit consumers’ WTP for reduced risk from pesticide residues on fresh grapefruit
✓ Theory: asking respondents what is the maximum price – above the normal price - they would be willing to pay for a food product to reduce a particular food safety risk
✓ Data: 3,228 phone interviews (information on consumers attitudes on food safety and demographic characteristics)
   1,671 mail surveys (information on individual WTP)
✓ Application: 4 mail survey versions:
   2 different risk reduction levels (50 and 99+) with 2 types of payment vehicles (payment card method (PC) and dichotomous choice question followed by and open-ended question (DC))
✓ 99+ % → decrease in risk from switching from consuming fresh grapefruit treated with widely-used postharvest pesticide (SOPP), which has a low food safety risk, to consuming grapefruit treated with a ‘safer’ pesticide (TBZ), over a lifetime
WTP – contingent valuation

✓ 50% → TBZ replaced by a hypothetical pesticide with a 50 % lower food safety risk than SOPP

✓ Consumers presented with the baseline “grapefruit A” which was treated with pesticide A (SOPP).
   Purchase price → 50 cents per grapefruit
   “Grapefruit B” was treated with pesticide B (TBZ or the hypothetical pesticide)

✓ PC method → asks respondents to select the amount they are wtp from a checklist of payment amounts

✓ DC method → mimics a normal market where consumers either buy a product at a given price or they do not.
   The surveys asked respondents which grapefruit they would buy, Grapefruit A or B, given prices and the food safety risk reduction
   For each questionnaire, 1 of 10 starting prices (bids) was randomly assigned to grapefruit B
   The DC question was followed by a question asking what was the most they would pay to buy grapefruit B
WTP – contingent valuation

✓ Findings: corrected mean WTPs:
  • $ .15 for PC50
  • $ .19 for PC99
  • $ .67 for DC50
  • $ .69 for DC99

✓ DC method pushes the respondents harder in evaluating potential purchasing behaviour

✓ Consumers tend to be wtp a small percentage above the normal purchase price of the product to avoid some risk
Study: Fox et al. (1995)

Purpose:
- to value consumers’ WTP for reduced risk of Salmonella in chicken
- to explore whether there exists evidence of regional differences (USA) in the demand for food safety

Method: Vickrey auction method

Data: Experiments conducted at 4 universities
- 15 undergraduate students in each experiment
WTP – experimental auction markets

✓ Application: experimental design (3 stages):

1. (pre-auction stage)
   each subject is given a identification number and asked to sign a consent form
   asked to complete a short questionnaire on dietary habits, attitudes and beliefs about food safety, and some demographic information

2. (familiarisation with the Vickrey auction)
   each auction is endowed with a candy bar (brand X)

3. (food safety auction)
   objective: how much subjects are wtp to upgrade from a ‘typical’ chicken sandwich to a sandwich that has been screened for Salmonella
WTP – experimental auction markets

 ✓ Application: experimental design (3 stages):

   3. (food safety auction) (ctd.)

   The auction consists of 20 bidding trials:

   • the first 10 are based on the participants’ subjective assessments of the risk of contamination of the ‘typical’ sandwich.

   • subjects are provided with the information about the objective risk of contracting salmonellosis from eating the typical sandwich.

   • subjects are asked to rank their subjective assessment of the annual probability of becoming ill from Salmonella.

   • each participant is endowed with a Type I (typical) chicken sandwich and $15.

   • a Type II (stringently screened) chicken sandwich is offered for auction.

   • participants are provided with the description of the 2 sandwiches.
WTP – experimental auction markets

✓ Application: experimental design (3 stages):

3. (food safety auction) (ctd.)
  • For the first 10 trials, participants bids are based on these descriptions and their subjective perceptions of the typical chance contamination from Type I sandwich
  • subjects are provided with identification number of the highest bidder and the amount of the 2nd highest bid following each trial
  • after the tenth trial, the scientific description of salmonellosis symptoms and the ‘objective’ risk of salmonellosis associated with the Type I sandwich they own are provided
  • after all 20 trials are completed, one trial is randomly drawn to be bidding to determine who purchases the Type II sandwich
  • participants are required to eat their sandwich in order to leave with their take-home pay ($ 18)
Results: Most participants underestimated the real risk of salmonellosis

Mean bids over all trials:
- $0.93 in Arkansas,
- $0.88 in Massachusetts,
- $0.52 in Iowa,
- $0.45 in California

Following trial 11, marked difference between regions
- in Arkansas and Massachusetts the average bids continued their upward trend
- in Iowa and California appeared to stabilize at a slightly higher level than the one prevailed for the first 10 trials
WTP – conjoint analysis

✓ Study: Halbrendt et al. (1995)
✓ Purpose: to evaluate the acceptance of pST-produced pork versus conventionally-produced pork. Fat reduction ranging from 10 to 40% was attainable using technology pST.
✓ Method: allows to respondents to choose among several products, each being a unique combination of attributes
  • 2-way (not 3-way) interaction among attributes
  • Qualitative attributes held constant
  • 2 technology levels (current, pST)
  • 2 levels of price ($ 6.99, $ 8.99 per kg)
  • 4 levels of fat reduction (0, 10, 20% for current, 10, 20, 40 % for pST)
  • 2x2x4= 16 product profiles → 6 deleted → 10 profiles
### WTP – conjoint analysis

<table>
<thead>
<tr>
<th>Profile #</th>
<th>Technology</th>
<th>Fat Reduction</th>
<th>Price/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Current</td>
<td>0 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>2</td>
<td>Current</td>
<td>0 percent</td>
<td>$8.99</td>
</tr>
<tr>
<td>3</td>
<td>Current</td>
<td>10 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>4</td>
<td>Current</td>
<td>20 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>5</td>
<td>Current</td>
<td>20 percent</td>
<td>$8.99</td>
</tr>
<tr>
<td>6</td>
<td>pST</td>
<td>10 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>7</td>
<td>pST</td>
<td>20 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>8</td>
<td>pST</td>
<td>20 percent</td>
<td>$8.99</td>
</tr>
<tr>
<td>9</td>
<td>pST</td>
<td>40 percent</td>
<td>$6.99</td>
</tr>
<tr>
<td>10</td>
<td>pST</td>
<td>40 percent</td>
<td>$8.99</td>
</tr>
</tbody>
</table>
✓ Method (ctd.)

• A conjoint experiment is a repeated measures design: the same respondent is measured (asked to rate product profiles) several times
  Advantages: lower costs and variance reduction
• Before the interview, respondents were presented with 2 pieces of information:
  • (1) a photograph comparing pST-supplemented pork with currently-available pork, and
  • (2) a few paragraphs explaining traditional and genetically-engineered pST, and its effect of making leaner pork
✓ Method (ctd.)

- Model for consumer preference of pST-supplemented pork products: include interactions among the attributes
  - Dependent variable: respondent’s rating for product profile
  - Independent variables: product attributes
  - Regression technique: Weighed Least Squares

\[
\text{Rating}_j = \beta_0 + \beta_1 pST + \beta_2 RED + \beta_3 RED^2 + \beta_4 pST*RED \\
+ \beta_5 pST*RED^2 + \beta_6 PRICE + \beta_7 pST*PRICE \\
+ \beta_8 PRICE*RED + \beta_9 PRICE*RED^2
\]
WTP – conjoint analysis

Data:

- Face-to-face survey interviews (557) in 3 cities, in 15 different shopping centres
- Sample representative of the population except for gender

Results:

1. profile no. 9, pST-supplemented, $6.99/kg, 40% fat reduction level
2. profile no. 10 (pST-supplemented, $8.99/kg, 40% fat reduction level
3. profile no. 4 (current technology, $6.99/kg, 20% fat reduction level

- Profiles with no fat reduction received the lowest ratings. Respondents considered leanness an important attribute in pork products
Results (ctd.):

Results of the estimated conjoint model

- The estimated pST parameter was negative, but when pST interacts with leanness and price, the overall effect was positive indicating pST that could produce leaner pork at a competitive price increases the respondent’s rating.

- So, consumers will be willing to consume pST pork, but not willing to pay a premium unless they achieve leanness beyond what current technology can achieve.

- Policy implication: for a successful adoption of pST, the price pST-supplemented pork products will have to remain very competitive, and the level of fat reduction will have to be higher than current technology can attain.
Indirect method

- Relies on observed market price differentials across foods with different safety levels (after accounting for any other product characteristics)
- Hedonic function estimated with market price and consumption data and characteristics observable in the consumption decision
- More suitable for nutrition attributes than for food safety
- Typically estimated with historical data (no survey data)
1. regression techniques to estimate the Hedonic Price Function
   - \( (P) = f (s_1, s_2, s_3...s_j; n_1, n_2, n_3,...n_j; e_1, e_2, e_3,...e_j) \)
   - This function could be linear or non-linear
   - The prices may change at an increasing or decreasing rate when the characteristics change

Differentiate the price function with respect to any one of the above characteristics, the implicit price function for that particular characteristic is yielded.

- implicit because the price function is indirectly revealed to us by what the people are willing to pay in order to obtain better quality or quantities of the characteristic.
2. The implicit prices are regressed against the actual quantities/qualities chosen by the people in order to attain the marginal WTP for the characteristic.

✓ The results will indicate the changes in food values for a unit change in each characteristic, given that all the other characteristics are constant.
✓ Study: Kim and Chern 1995
✓ Purpose:
  • estimate consumer values of various fatty acids
  • examine impact of consumer health information on demand for fats and oils
✓ Method: characteristics demand model (Consumer Good Characteristics Model)
  • Consumer implicit values (hedonic prices) of attributes are estimated for 2 animal fats (lard and tallow) and 6 vegetable oils (coconut, corn, …), further separated into 2 end uses (cooking and salad, baking and frying)
WTP – hedonic pricing

✓ Results:

• Cooking and salad: implicit prices of all fats are significant
  • Implicit values for unsaturated fats >> saturated fat from mid ‘60s to mid ‘80s → changes in consumer preferences
  (increases in available cholesterol info)

• Baking and frying: implicit prices are all significant, but information coefficient are not significant

• Consumers’ health concerns >> food processors and food service outlets
  • Lack of info on snacks, fast food, away-from-home food
<table>
<thead>
<tr>
<th>method</th>
<th>advantages</th>
<th>disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>Flexible and cost-efficient in data collection</td>
<td>- Information bias, Hypothetical bias, Non-response bias, Strategic bias - No market feedback</td>
</tr>
<tr>
<td>EAM</td>
<td>- truthfully reveal preferences - use real food, real money, and repeated market participation - “requirement-to-eat” factor that reinforce the truth-revealing properties - absence of non-response bias</td>
<td>- Endowment effect - Hard to recruit participants - Disinterested participants - hard to explain steps of the method</td>
</tr>
<tr>
<td>CA</td>
<td>new product or changes to existing products can be incorporated into the simulation model to obtain predictions of how consumers will respond to the changes</td>
<td>- Concerns on the viability of disaggregating the product into different attributes (difficult to express preference to new products) - Statistical independence of attributes often difficult</td>
</tr>
<tr>
<td>HP</td>
<td>- everyone should have prior knowledge of the potential risks and benefits of certain characteristics</td>
<td>- Large quantity of data</td>
</tr>
</tbody>
</table>
Advantages:
✓ include pain and suffering
✓ possibility to relate individual WTP to a set of respondent characteristics (e.g. education, income, etc.)
✓ better evaluation of impacts across sub-groups

Disadvantages:
✓ overestimation
✓ discrepancy between individual risk perceptions and objective risk
<table>
<thead>
<tr>
<th>Method</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>COI</td>
<td>COI is simple, concrete, and understood: measures society's resources currently spent on foodborne illness</td>
<td>May not be close association between COI and society's or individuals' willingness to pay to avert illness</td>
</tr>
<tr>
<td></td>
<td>Permits aggregation of the full distribution of illness and death outcomes using $</td>
<td>Depends on incidence and severity data for foodborne illness which are spotty for acute illnesses and almost nonexistent for chronic complications</td>
</tr>
<tr>
<td></td>
<td>Based on market-observed costs of medical services and wages</td>
<td>Difficulty measuring productivity losses for: nonwage earners, undervalued workers, lives lost</td>
</tr>
<tr>
<td></td>
<td>Facilitates comparison of costs across pathogens for prioritization of pathogen intervention efforts</td>
<td>Lower bound since may omit costs of lost leisure, pain and suffering, self-protection actions</td>
</tr>
<tr>
<td></td>
<td>COI useful in Benefits/Cost Analysis evaluating government programs or regulations</td>
<td></td>
</tr>
<tr>
<td>WTP</td>
<td>More consistent with consumer demand theory than COI</td>
<td>Measures what individuals say rather than what they do</td>
</tr>
<tr>
<td></td>
<td>Easy to examine a subsector of the population</td>
<td>Limited studies; results not yet validated by other researchers</td>
</tr>
<tr>
<td></td>
<td>Allows comparison of consumer preferences for different food technologies or reduced risk from specific foodborne pathogens</td>
<td>Potential for sample and question bias: results in questionable generalizability</td>
</tr>
<tr>
<td></td>
<td>Permits gathering of consumer preferences for alternative risk reduction strategies: decreases in consumption, increases in self protection actions, WTP premium for consumption of safer food</td>
<td>Aggregation problem: results of WTP on a population basis may be strange</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Roberts and Marks, 1995
Quality-adjusted life years (QALYs)
Disability-adjusted life years (DALYs)
(a) describing health, i.e. as a health state or as a disease/condition;
(b) developing values or weights for the health state or condition
(c) combining values for different health states or conditions with estimates of life expectancy

Cost-effectiveness analysis

To avoid a monetary value on health...
Quality-adjusted life years

• Incorporates:
  • the **quantity** of life or years of life extension from an intervention
  • the **quality** of life, based on individuals’ preferences over different health states
  • Example: a year of life with a serious illness might be weighted as being as valuable as 0.7 of a year of life with perfect health
QALYs

- QALY lived in one year = \( 1 \times Q \) with \( Q \leq 1 \)
- \( Q \) health-related quality of life weight

- HRQL weights not linked to any particular disease, condition or disability
- issue of what exactly constitutes “health”
QALYs

HRQL weights generated by various techniques:

- standard gamble
- time trade-off
- rating or visual analogue scales
- ask respondents to value health states by making explicit what they would be willing to sacrifice (in terms of time or risk of death) in order to return from the health state being described (or experienced) to perfect health
- respondents must designate a point on a scale, or “feeling thermometer,” that corresponds to the strength of their preference for a given health state
DALYs

Disability-adjusted like years

- DALY = YLL + YLD
- YLL  no. of years of life lost due to mortality
- YLD  no. of years lived with a disability (weighted by a factor (0-1) for the severity of the disability)
DALYs

- $n$ all fatal cases due to health outcomes
- $e$ residual expected individual life span

$$YLL = \sum_{l} n_l \times e_l$$

$n$ no. of cases
$t$ duration of the illness
$w$ disability weight of a specific disease

$$YLD = \sum_{l} n_l \times t_l \times w_l$$
• PTO person trade-off approach
• Global Bruden of Disease Study
• WHO
• Expert group with representatives of each region of the world
• In order to elicit social preferences for different health states
Revised disability classes for the Global Burden Disease Study based on the results of the PTO protocol used at the Geneva meeting on disability weights

<table>
<thead>
<tr>
<th>Disability class</th>
<th>Severity weight</th>
<th>Indicator conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00–0.02</td>
<td>Vitiligo on face, weight-for-height less than 2 SDs</td>
</tr>
<tr>
<td>2</td>
<td>0.02–0.12</td>
<td>Watery diarrhea, severe sore throat, severe anemia</td>
</tr>
<tr>
<td>3</td>
<td>0.12–0.24</td>
<td>Radius fracture in a stiff cast, infertility, erectile dysfunction, rheumatoid arthritis, angina</td>
</tr>
<tr>
<td>4</td>
<td>0.24–0.36</td>
<td>Below-the-knee amputation, deafness</td>
</tr>
<tr>
<td>5</td>
<td>0.36–0.50</td>
<td>Rectovaginal fistula, mild mental retardation, Down-syndrome</td>
</tr>
<tr>
<td>6</td>
<td>0.50–0.70</td>
<td>Unipolar major depression, blindness, paraplegia</td>
</tr>
<tr>
<td>7</td>
<td>0.70–1.00</td>
<td>Active psychosis, dementia, sever migraine, quadriplegia</td>
</tr>
</tbody>
</table>

Source: Murray, 1997
<table>
<thead>
<tr>
<th>Disease</th>
<th>Incidence (Cases per Year)</th>
<th>YLD</th>
<th>YLL</th>
<th>DALYs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacteriosis and sequelae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>123,000</td>
<td>508</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(86,000–177,000)</td>
<td>(438–571)</td>
<td>(3–114)</td>
<td></td>
</tr>
<tr>
<td>GBS</td>
<td>28</td>
<td>186</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(24–32)</td>
<td>(31–432)</td>
<td>(2–82)</td>
<td></td>
</tr>
<tr>
<td>ReA</td>
<td>3,200</td>
<td>290</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2,300–4,200)</td>
<td>(206–388)</td>
<td></td>
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</tr>
<tr>
<td>IBD</td>
<td>49</td>
<td>535</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(36–64)</td>
<td>(376–709)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,520</td>
<td>48</td>
<td>1,568</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(990–1,990)</td>
<td>(9–156)</td>
<td>(1,030–2,060)</td>
</tr>
<tr>
<td>Salmonellosis and sequelae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>16,800</td>
<td>66</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5,100–32,200)</td>
<td>(46–94)</td>
<td>(3–185)</td>
<td></td>
</tr>
<tr>
<td>ReA</td>
<td>365</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(162–631)</td>
<td>(12–50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBD</td>
<td>4</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1–8)</td>
<td>(4–104)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>140</td>
<td>46</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(87–196)</td>
<td>(3–189)</td>
<td>(108–340)</td>
</tr>
</tbody>
</table>

Source: Lake et al., 2010
<table>
<thead>
<tr>
<th>Disease</th>
<th>Food-Attributable DALYs Mean (2.5 and 97.5 Percentiles)</th>
<th>Food-Attributable COI Mean ($NZ 000,000) (2.5 and 97.5 Percentiles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacteriosis and sequelae</td>
<td>880 (550–1,240)</td>
<td>74 (51–102)</td>
</tr>
<tr>
<td>Salmonellosis and sequelae</td>
<td>111 (53–201)</td>
<td>2.8 (1.9–4.0)</td>
</tr>
<tr>
<td>Listeriosis (perinatal)</td>
<td>195 (101–307)</td>
<td>2.3 (0.7–4.8)</td>
</tr>
<tr>
<td>Listeriosis (nonperinatal)</td>
<td>22 (7–54)</td>
<td>0.2 (0.1–0.5)</td>
</tr>
<tr>
<td>STEC infection and sequelae</td>
<td>35 (0.4–109)</td>
<td>1.6 (0.06–4.8)</td>
</tr>
<tr>
<td>Yersiniosis and sequelae</td>
<td>52 (21–93)</td>
<td>1.4 (0.9–2.0)</td>
</tr>
<tr>
<td>Norovirus infection and sequelae</td>
<td>210 (41–546)</td>
<td>3.0 (0.7–11)</td>
</tr>
<tr>
<td>Total</td>
<td>1,510 (740–2,780)</td>
<td>86 (61–115)</td>
</tr>
</tbody>
</table>

Source: Lake et al., 2010
References

References