On the Economics of Traceability: A Survey of Recent Results and their Policy Implications

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What is traceability?

- Traceability is the ability to document the movement of products through a supply chain.
- Golan et al. (2004) defines traceability as *recordkeeping systems designed to track the flow of product or product attributes through the production process or supply chain.*
- Resolves an asymmetric information problem (Hobbs, 2004).

Motives for traceability

- The control of animal diseases;
- Compliance with importing countries requirements;
- The differentiation of products by suppliers who provide traceability;
- Isolate losses from a food safety or product quality problem;
- Protecting or regaining the general reputation of a product, a firm, an industry or a country.

Examples of traceability

- Some systems are very basic like the markings on this cow;

Examples of traceability

- Some systems are more advanced (e.g. traceability for cattle in Quebec and Alberta);

Examples of traceability

- Country Of Origin Labeling (COOL) is also an example of traceability;

Examples of traceability

- Private companies also provide traceability for their products;

Examples of traceability

- Private companies also provide traceability for their products;

Follow Us To The Farm

About Your Product:
Strawberries, 16 oz, 9010 3363 0283 DSA9
Aptos Berry Farms, Inc.. Watsonville – Salinas Growing Region

Map

Watsonville - Salinas Growing Region
Watsonville is located in the Pajaro Valley of California, about 95 miles south of San Francisco. This small valley in Santa Cruz County runs west to east, from Monterey Bay to the Gabilan Mountain range, over an area which spans 50 miles. At an elevation of only 33 ft (10m), this region is close to sea level. Cool, foggy mornings give way to warm, sunny afternoons.

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The model

- Consider that the profit of a firm is given by

$$\Pi_i = P(Q, s_i, s_{-i}, T_i)q_i - C(q_i, s_i, s_{-i}, T_i);$$

  where:
  - P is the price;
  - q_i is the output of firm i;
  - s_i is the safety of food of firm i;
  - s_{-i} is the safety of food of other firms;
  - T_i is traceability to firm i;
  - C is the cost.
- The cost function includes expected costs of recalls for the delivery of unsafe food by firm i or by other firms. The cost is convex with respect to the firm own food safety, $\partial^2 C/\partial s_i^2 > 0$, but strictly decreasing with respect to other firms food safety, $\partial C/\partial s_{-i}$.
- The profit expression may also apply to livestock production.

First order conditions for profit maximization

- The first order conditions for profit maximization are

$$\begin{aligned}
\frac{d\Pi_i}{dq_i} &= \frac{dP}{dq_i}q_i + P - \frac{dC}{dq_i}; \\
\frac{d\Pi_i}{ds_i} &= \frac{dP}{ds_i}q_i - \frac{dC}{ds_i}; \\
\frac{d\Pi_i}{dT_i} &= \frac{dP}{dT_i}q_i - \frac{dC}{dT_i}.
\end{aligned}$$

- We will focus on the third expression for profit maximization with respect to traceability.

Willingness to pay for traceability

- Lets begin with consumers' willingness to pay for traceability:

$$\frac{dP}{dT_i} > 0?$$

- Dickinson and Bailey (2002) and Hobbs (2004) find in laboratory experiment that consumers are not willing to pay a premium for traceability.
- Kellom et al. (2008) find a 1.8% premium for age- and origin-verified calves in auction markets.
- Pouliot (2011a) finds a small premium for cattle traceability, 2-3%.
- American consumers are not willing to pay more for Country of Origin Labeling for products from Canada.
- Higher willingness to pay for traceability in developing countries where food safety is a problem.
- Exporting firms may capture a premium when exporting to a country that requires traceability.

Willingness to pay for traceability

- More evidence: Driscoll's does not sell its product as traceable;

Cost of traceability

- Let's now look at the cost of traceability:

$$\frac{dC}{dT_i}.$$

- It is convenient to expand the expression for the cost as such

$$\frac{dC}{dT_i} = \frac{\partial C}{\partial T_i} + \frac{\partial C}{\partial s_i}\frac{\partial s_i}{\partial T_i} + \frac{\partial C}{\partial s_{-i}}\frac{\partial s_{-i}}{\partial T_i}.$$

Cost of traceability

- $\frac{\partial C}{\partial T_i}$ is the direct cost effect of traceability.
  - Implementing traceability requires buying new physical inputs and more labor.
  - Cost of traceability has been going down significantly.

Cost of traceability

- $\frac{\partial C}{\partial s_i}\frac{\partial s_i}{\partial T_i}$ is the cost increase because a firm is more subject to liability with a traceability system.
  - Concern for upstream firms.
  - Pouliot and Sumner (2008) show how traceability in a supply can shift liability to upstream firms.
  - Does traceability really matter when it comes to large food safety incidents? Probably not because food safety authorities undertake intensive investigation and virtually always find the firm source of contamination.
  - If s_i is animal health, traceability can help trace infected animals to the farm.

Cost of traceability

- $\frac{\partial C}{\partial s_{-i}} \frac{\partial s_{-i}}{\partial T_i}$ is saving in cost because a firm is less likely to be subject to a recall because of other firms' unsafe food delivery.
  - Some claim that traceability can help exonerate firms for a quality incident.
  - Maybe true for "small" incidents.
  - For large incidents where the product is health hazard, food suppliers and food safety authorities are precautious and recall all food related to the contaminated food item. Thus, large recalls still occur even with traceability.
  - If s_i is animal health, traceability can help trace infected animals to the farm of origin and possibly save farm i herd (Gilbert et al., 2005).

Profit maximizing traceability

- A competitive firm is likely to have no incentives to invest in traceability

$$\frac{\partial P}{\partial T_i} q_i - \frac{\partial C}{\partial T_i} - \frac{\partial C}{\partial s_i}\frac{\partial s_i}{\partial T_i} - \frac{\partial C}{\partial s_{-i}}\frac{\partial s_{-i}}{\partial T_i} < 0.$$

  - Likely Small premium for traceability;
  - Cost of maintaining traceability through a supply chain may be large;
  - Increased exposure to lawsuits;
  - Small gain from potential exoneration.
  - Low participation in voluntary system like the NAIS in the United States (Schulz and Tonsor, 2010).

Profit maximizing traceability

- For a large firm or an industry organization

$$\frac{\partial P}{\partial T_i} q_i - \frac{\partial C}{\partial T_i} - \frac{\partial C}{\partial s_i}\frac{\partial s_i}{\partial T_i} - \frac{\partial C}{\partial s_{-i}}\frac{\partial s_{-i}}{\partial T_i} = 0.$$

  - Likely a small premium for traceability;
  - Cost of maintaining traceability is small;
  - Increased exposure to lawsuits;
  - Large gain from better management of supply chain (e.g. management of animal diseases).
  - Justification for mandatory traceability in some sectors where quality has public good characteristics.

Traceability and profits

- Individual firms of course implement traceability only if its profit maximizing for them.
- If traceability is mandatory, then it is likely that some firms loose while other gain (Pouliot, 2011b).
- Blasi et al. (2009) find that the total cost of implementing traceability in the US cattle industry is about $140 million. Given those costs, Pendell et al. (2010) calculate that a permanent domestic demand increase of 0.96% is required in order for every sector of the US beef industry at least break over a ten-year period.
- In Pendell et al. (2010) most of the benefits are from better access to foreign markets.
- Still unknown whether cattle traceability increases consumer surplus and producer surplus.

Effects of traceability on food safety

- Comparative statics shows that

$$\frac{ds_i^*}{dT_i} > 0$$

  - By removing anonymity, traceability increases incentives for firms to deliver a quality output.
  - Pouliot (2011a) cannot disentangle willingness to pay for traceability from the induced increased provision of other quality attributes.
  - Traceability therefore may be a tool in food policy to increase food safety.

Conclusion

- Traceability is likely to remain an important topic in food policy in Canada:
  - Importing countries requiring cattle traceability (Japan, Korea).
  - Canada and Mexico won at the WTO in a case against the US regarding COOL.
  - FDA Food Safety Modernization ACT in the United States requires some traceability.
- Traceability will remain in the agricultural economics research agenda
  - Little is known of the effect of traceability on the public good problem in food quality.
  - Empirical evidence is scarce, especially evidence from market data.
- Are traceability regulations welfare maximizing?

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