Economics Bulletin

# Volume 30, Issue 2

## Welfare Impact of Information with Experiments: The Crucial Role of the Price Elasticity of Demand

Stéphan Marette
*INRA UMR Economie Publique*

Jayson L. Lusk
*Oklahoma State University*

Jutta Roosen
*Technische Universitaet Muenchen*

## Abstract

This paper focuses on the welfare effects of information computed from experimental methods eliciting willingness-to-pay. First, a theoretical model shows that the size of the welfare variation is related to the elasticity of the demand under the absence of information about a characteristic. Second, our estimates indicate that consumer demand from a laboratory auction is more price-elastic than time-series demand for similar products. As a result, the welfare change directly derived from individual willingness-to-pay is overestimated compared to the welfare change linked to an approach combining time-series demand with the mean willingness-to-pay premium.

**Citation:** Stéphan Marette and Jayson L. Lusk and Jutta Roosen, (2010) "Welfare Impact of Information with Experiments: The Crucial Role of the Price Elasticity of Demand", *Economics Bulletin*, Vol. 30 no.2 pp. 1585-1593.
**Submitted:** Apr 03 2010. **Published:** May 27, 2010.

## 1. Introduction

It has become regular practice to elicit consumer willingness-to-pay (WTP) values to make inferences about the effectiveness of policies such as product bans, safety/quality standards, mandatory labeling, and taxes. However, many experimental papers that provide WTP estimates do not actually derive welfare measures associated with such policies. Good policy requires not only good estimates of WTP, but also requires reliable welfare estimation for measuring the impacts of regulatory tools.

Some recent studies have begun to estimate value of information about a product characteristic (or welfare variation linked to additional information) from experimental auction approaches that provide estimates of each participating individual's WTP. Examples include Colson et al. (2008), Huffman et al. (2003 and 2007), Lusk et al. (2005), Lusk and Marette (2010), Masters and Sanogo (2002), Rousu et al. (2004 and 2007), Rousu and Shogren (2006) and Marette et al. (2008a and 2008b). These studies are important for public debate, but there has yet to be much work examining the validity of the approach used by these authors to calculate the welfare effects of public policies. The limited number of papers on the topic makes it difficult to reach any conclusion regarding the validity of the welfare measures.

Our paper contributes to the literature by questioning the robustness of welfare estimation from two different approaches using WTPs from the same experiment. First, a theoretical model shows that the size of welfare variation is related to the elasticity of the demand under the absence of information about a characteristic. We then discuss how welfare effects of an information revelation policy can be derived from different approaches for the same data set coming from an experiment.

We compare these approaches in terms of the consumer surplus changes linked to information revelation about a characteristic. We show that welfare variations derived directly from individual WTP values are likely to be overestimated compared to the ones combining a times-series demand and the mean willingness-to-pay premium from the laboratory. Indeed, our estimates show that individual WTPs derived from experimental auctions suggest a more price-elastic demand curve than the one implied from time-series data of similar products. The price-elasticity of the initial demand before the revelation of any information is an important determinant of the size of the welfare change.

The paper is organized as follows. We first introduce a theoretical model showing the relationship between the elasticity of the demand and changes in consumer welfare resulting from an information provision policy. The next section introduces the methods to estimate welfare changes. Then, an application is presented. The last section concludes.

## 2. A Simple Theoretical Model

This section introduces a simple theoretical model to illustrate the role of the demand elasticity in determining the welfare effects of a particular regulation. The regulatory scenario focuses on the value of information revelation via a mandatory label. The label conveys information about a risk linked to a product, when consumers are initially unaware of a problem before the implementation of the mandatory label. It is assumed that there are no close substitutes to the product if consumers want to avoid the product concerned by the risk. The results of this section could be extended to other information contexts for consumers, other regulatory instruments (like the Pigouvian tax) and/or other consumption possibilities with substitutes.

Demand of a representative consumer is derived from a quasi-linear utility function that consists of quadratic preferences for the market good of interest and an additive numeraire:

$$U(Q, v, I) = aQ - bQ^2/2 - IeQ + v. \quad (1)$$

The terms $a, b > 0$ capture the immediate satisfaction from consuming quantities of the good, $Q$, and $v$ is the numeraire. The parameter $e$ represents the additional disutility (or the utility gain with *e<0* linked to a product with a positive characteristic) linked to product consumption. The effects of this disutility is captured by the term $-IeQ$. The parameter $I$ represents knowledge of the specific characteristic. If consumers are not informed of the specific characteristic then $I$ = 0. Conversely, $I$ = 1 implies that consumers are informed of the specific characteristic and can internalize the quality change and adjust consumption accordingly.

The maximization of the utility function subject to a budget constraint (defined by $R=pQ+v$, where $R$ is the income and $p$ is the price of the $Q$) yields a demand function for the representative consumer. When the consumer is ignorant with $I$ = 0, the inverse demand for the regular product is given by

$$p_0(Q) = a - bQ, \quad (2)$$

where $b$ is the slope of the inverse demand. Assuming perfectly elastic supply at a price $P_1$, (which implies constant return to scale and zero profits for producers), the equilibrium quantity is $Q^A = (a - P_1)/b$. The consumer' surplus is given by $U(Q^A, R - P_1Q^A, 0) =$ $(a - P_1)^2/(2b)$. By taking into account the cost of ignorance defined by $-eQ^A$ (see Foster and Just, 1989), welfare is

$$W_0 = \frac{(a - P_1)^2}{2b} - e\frac{a - P_1}{b}. \quad (3)$$

When the consumer is informed with $I$ = 1, the inverse demand for the regular product is given by

$$p_1(Q) = a - e - bQ. \quad (4)$$

For an equilibrium price $P_1$, the equilibrium quantity is $Q^B = (a - e - P_1)/b$. Under the absence of ignorance, the consumer' surplus is defined by $U(Q^B, R - P_1Q^B, 1)$ and equal to the welfare given by

$$W_1 = \frac{(a - e - P_1)^2}{2b}. \quad (5)$$

With *I=1*, the per-unit damage from consumption is internalized. The welfare variation linked to the information revealed to consumers can be measure by the welfare comparison, $W_1 - W_0$, with

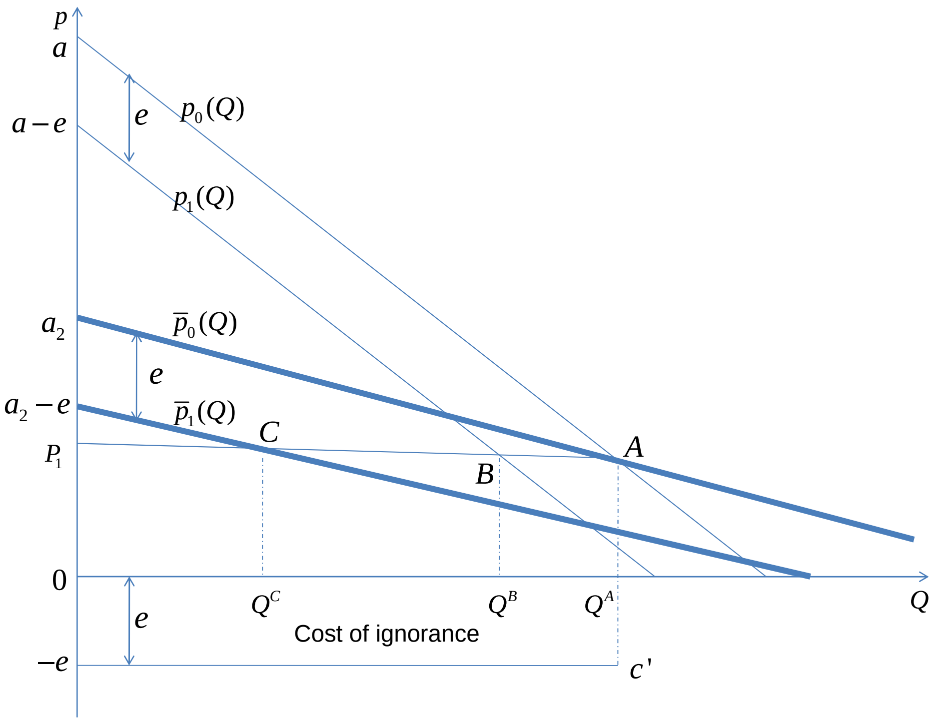
$$W_1 - W_0 = \frac{e^2}{2b} \quad . \quad (6)$$

The equation (6) shows that revealing information leads to a social benefit because consumers internalize the risk $e$ in their consumption decisions. This simple expression shows that only the per-unit damage $e$ and the slope $b$ of the demand influence the size of the welfare variation. The more inelastic the demand at price $P_1$ (namely, the larger the parameter $b$), the lower is the welfare variation, $W_1 - W_0$, since the internalization of the damage (with *I=1*) leads to a relatively low reaction with an inelastic demand curve. [1]

[1] The demand defined in (2) and used in figure 1 is linear, where the estimate of the elasticity is a local approximation. An alternative specification could be to consider non-linear demand, $Q = \beta p_1^{\varepsilon}(1 + Ie)^{\phi}$,

Figure 1 illustrates the result of implied by equation (6), with two types of demand curves $p_0(Q)$ and $\overline{p}_0(Q)$ for which slope *b* varies. In the initial situation *A* without information (*I=0*), there is a similar level of consumption $Q^A$ for both demands with $p_0(Q^A) = \overline{p}_0(Q^A) = P_1$, and a similar cost of ignorance represented by the area (-$e0Q^A c$'). The initial welfare before the revelation of information is defined by the area ($aAP_1$-$e0Q^A c$') for the thin curve ($p_0(Q)$) and by the area ($a_2AP_1$-$e0Q^A c$') for the bold curve ($\overline{p}_0(Q)$).The welfare after the revelation of information is defined by the area (($a$-$e$)$BP_1$) for the new-thin curve ($p_1(Q)$) and by the area (($a_2$ -$e$)$CP_1$) for the new-bold curve ($\overline{p}_1(Q)$). The welfare variation brought by the information revelation is defined by the area ($e0Q^A c$'- $aAB(a$-$e)$) for the thin curve ($p_0(Q)$) and by the area ($e0Q^A c$'- $a_2AC(a_2$-$e)$) for the bold curve ($\overline{p}_0(Q)$). As the area $aAB(a$-$e)$ is larger than the area ($a_2AC(a_2$-$e)$), the positive-welfare variation with the bold curve is higher than the welfare variation with the thin curve.

**Figure 1. Welfare effects of information revelation**




At point A, the bold curve ($\overline{p}_0(Q)$) is more elastic compared to the thin curve ($p_0(Q)$), which leads to a larger reduction in consumption with $Q^C$ greater than $Q^B$ when the information is revealed and leads to a similar damage *e* internalized in demand. The resulting welfare variation is higher with the bold curve than with the thin curve.

Figure 1 confirms the result given by equation (6). The question now relates to how one can estimate the size of the risk, *e*, and the slope of the demand curve. The parameter *e* in equation (6) can be estimated by using experimental economics approaches in which

---

where $\phi$ is the information elasticity and $\varepsilon$ is the price elasticity of demand and e is the value given to the additional characteristic.

consumer WTP is compared in conditions with and without information. The equation (6) also indicates that something must be known about the slope of the demand curve, *b*, to arrive at welfare estimates. This slope can be estimated using WTP data from the experiment itself or can be used using more traditional econometric approaches in relying on time series data.

## 3. Two Approaches for Estimating Surplus Changes

In this section, we compare two approaches using WTPs from the same experiment for estimating the welfare effects of information revelation presented in figure 1.

*Approach 1*

Approach 1 directly uses individual estimates of WTP. Let $WTP_{i,0}$ and $WTP_{i,1}$ indicate individual *i*'s willingness-to-pay for a product before and after the revelation of information, respectively. For a price $P_1$, consumer *i* derives utility, $WTP_{i,0} - P_1$, under the absence of information, $WTP_{i,1} - P_1$, with full information, and zero otherwise (i.e., the utility of non-purchase is normalized to zero).

Under the absence of information, the consumer chooses the option generating the highest utility, namely

$$CS_{i,0} = \max\{WTP_{i,0} - P_1, 0\} \tag{7}$$

After taking into account the cost of ignorance, $J_i(WTP_{i,1} - WTP_{i,0})$ where $J_i$ is an indicator variable taking the value of 1 if individual *i* is predicted to have chosen the product at $P_1$, the total welfare without information is

$$\overline{CS}_{i,0} = \max\{WTP_{i,0} - P_1, 0\} + J_i(WTP_{i,1} - WTP_{i,0}) \tag{8}$$

With the information revealed about a characteristic, the consumer chooses the option generating the highest utility, namely

$$CS_{i,1} = \max\{WTP_{i,1} - P_1, 0\}\ . \tag{9}$$

In the latter case, there is no cost of ignorance. The welfare variation linked to the information provision is defined by $CS_{i,1} - \overline{CS}_{i,0}$. By taking into account the *L* participants to an experiment and *N* the number of unit purchased over a period of time in a country, the welfare is equal to

$$\Delta CS_1 = (N/L)\sum_{i=1}^{L}[\max\{WTP_{i,1} - P_1, 0\} - \max\{WTP_{i,0} - P_1, 0\} - J_i(WTP_{i,1} - WTP_{i,0})]. \tag{10}$$

One way to make a possible link between equations (6) and (10) is to estimate a price elasticity of the demand implied by the auction data before the revelation of information. A demand function in the form of a histogram may be defined by taking a decreasing order of the $WTP_{i,0}$ for $i=1,..,L$ with the cumulative quantity $Q_n$ equal to *n* for the $n^{th}$-highest WTP. From this ordered cumulative distribution of WTP, an estimation of the elasticity $\widehat{\beta}$ can be determined with the econometric model,

$$\ln(WTP_0) = \alpha + \beta \ln(Q) + \xi\ , \tag{11}$$

where $WTP_0$ is the vector of all ordered $WTP_{i,0} > 0$ with $i=1,..,L$, *Q* is the corresponding the cumulative quantity $Q_n$ and $\xi$ is the term of errors assumed uncorrelated across observations. Note that the estimation of (11) focus on the slope of the curve fitted to the histogram with the horizontal axis representing quantities and a vertical axis representing the ordered WTP.[2] Of course the calculation of the welfare change in (10) does not actually rely on the elasticity

[2] Lusk and Schroeder (2006) provide an alternative way to estimate elasticities from experiments.

estimate $\hat{\beta}$ given by equation (11). However, by estimating equation (11), we can gain insight into the extent to which the elasticity of demand is driving the welfare estimate given by (10).

*Approach 2*

The approach 2 relies on a combination of an elasticity of demand obtained from times-series economics and the average WTP value obtained from the experiment. For the demand elasticity, we use "well established" estimates of aggregate demand estimated via traditional time-series econometrics. Average WTP by the experimental auctions can be used to calculate the parameter $e$ defined in (1), which in turn can be used to determine the welfare effects of information or public policy.

In particular, with approach 2, the parameter *a* and *b* in (2) can be determined by classical calibration methods using existing data on the price elasticity of the demand and equilibrium prices and quantities of the product. Using existing data on the quantity $\hat{Q}$ of the product sold over a period, the average price $P_1$ observed over the period, and the direct price elasticity $\hat{\varepsilon} = (dQ/dp)(p/Q)$ ) obtained from time-series econometric estimates, the calibration leads to estimated values for the demand equal to $1/\tilde{b} = -\hat{\varepsilon}\hat{Q}/P_1$ and $\tilde{a} = \tilde{b}\hat{Q} + P_1$. Note that the parameter $\tilde{b}$ is inversely related to the elasticity, $\hat{\varepsilon}$.

Empirically, the parameter $e$ is determined by WTP data coming from the experiment with values $WTP_{i,0}$ and $WTP_{i,1}$ indicating individual *i*'s willingness-to-pay for the product before and after the revelation of information as described for the approach 1. The relative variation in WTP based on the experiment provides a measure of the inverse demand shift, $\delta = [E(WTP_1) - E(WTP_0)]/E(WTP_0)$, where *E* denotes the expected value or the average. Now, note that the inverse demand curves can be viewed conceptually as WTP curves, where the price can be replaced with WTP. Thus, using the inverse demands in equations (2) and (4), the relative price variation is equal to the inverse demand shift defined by $[p_1(Q^A) - p_0(Q^A)]/p_0(Q^A) = \delta$, which, after manipulating equations (2) and (4) leads to the estimation $\tilde{e} = -\delta P_1$. By using $1/\tilde{b} = -\hat{\varepsilon}\hat{Q}/P_1$, the welfare variation given by (6) can be rewritten by

$$\Delta CS_2 = \frac{\tilde{e}^2}{2\tilde{b}} = \frac{-\hat{\varepsilon}\hat{Q}P_1}{2} . \left( \frac{E(WTP_1) - E(WTP_0)}{E(WTP_0)} \right)^2 . \qquad (12)$$

The higher the elasticity in absolute value, the higher is the welfare variation linked to the information. Despite differences, equations (10) and (12) can be estimated by using data linked to the same experiment providing information about $WTP_0$ and $WTP_1$. Equation (10) uses $WTP_0$ , $WTP_1$, *N* and $P_1$, while equation (12) uses $WTP_0$ , $WTP_1$, and $\hat{\varepsilon}, \hat{Q}, P_1$.

## 4. Empirical Application and Results

In this section, we first restrict our attention to an application in which disaggregate data for each individual on WTP was obtained using a multiple choice list. Similar data might also come from an open-ended willingness-to-pay question or from experimental auctions (see Lusk and Shogren (2007) for an in-depth discussion on experimental auctions).

The particular application studied here relates to the presence of methyl-mercury in fish. Methyl-mercury, an organic form of mercury, is a toxic compound that can be found in fish. If significant prenatal exposure occurs, ingestion of methyl-mercury can alter fetal brain development. As such, regulators have considered issuing specific advisories/labels directed toward vulnerable groups (small children, pregnant women, and women of childbearing age) to avoid long-lived, predatory fish because of high levels of mercury contamination.

We used data from the experiments presented in Marette et al. (2008 a, b and c). The data consist of WTP obtained from multiple choice lists from French women for cans of tuna under different information treatments (before and after a message revelation). Conceptually, we are calculating the welfare effects linked to the revelation of information about the mercury in tuna.[3]

Table 1 shows consumer welfare changes from information revelation about methyl-mercury. Estimations of welfare are determined with a similar price $P_1$ for both approaches.

**Table 1. Changes in Welfare from Providing Information (in €)**

| | **Approach 1** | **Approach 2** |
|---|---|---|
| Price elasticity estimation | $\hat{\beta} = -1.08^{***,a}$ | $\hat{\varepsilon} = -0.668^{***,c}$ |
| | $\hat{\beta} = -2.236^{***,b}$ | |
| Changes in welfare [d] | 13,598,098 | 2,659,767 |

Notes: *** marks significance at the 1% level.
[a] With all WTP linked to the experiments.
[b] With all WTP linked to the experiments without a few extreme points, where participants always accepted tuna whatever the offered amount of substitute.
[c] LA/AIDS econometric estimation based on time series demand (see Marette et al, 2008c).
[d] Consumer surplus variation for year 2006 (€). The approach one uses all the WTP linked to the experiment including all the extreme points.

Table 1 shows a positive net welfare gain from informing households of the risk. The difference in welfare estimates between valuation under approaches 1 and 2 is relatively large. The welfare variation is higher under approach 1, because of a higher price-elasticity in absolute value under approach 1 than the one coming from the time-series under approach 2. Indeed, the findings of equation (6) and figure 1 are confirmed by table 1 and the estimations of the price elasticity of demand. Recall that, under approach 1, the computation of the welfare variation given by (10) does not use the elasticity $\hat{\beta}$ computed under alternative possibilities (see the notes of table 1), but these values offer a clue for explaining the result via the elasticity of the initial demand.

To determine the extent to which the results in table 1 might hold up in other applications, it is useful to compare demand elasticities from another experimental study to time-series estimates. In particular, we turn to the obtained from an experimental auction experiment conducted in France conducted in 2008 in which people bid to buy Yogurt by indication their maximum WTP (see details in Marette et al., 2010, and in Roosen et al., 2010). The direct elasticity computed from the equation (11) under approach 1 is equal to $\hat{\beta} =$ -1.669 and statistically significant at 1% level, while price elasticities computed from time-

[3] As this damage concerns 50.5% of consumers (namely, small children, pregnant women, and women of childbearing age), we assume that only these consumers react to the information. The number $N$ of unit purchased over a period by this subgroup (used in equation (10)) is selected to correspond to the overall consumption $\hat{Q}/2$ of the 50.5% of consumers over a year (used in equation (12)). The surplus of non-concerned consumers (49.5% of consumers) does not change since the price $P_1$ is constant.

series by Bouamra-Mechemache et al. (2008) are equal to $\hat{\varepsilon}$ = -0.126 (in table 6) or $\hat{\varepsilon}$ = -0.188 (in table A4).

These direct-price elasticities confirm the findings of table 1 by suggesting higher elasticities (in absolute value) linked to experimental studies as compared to the time-series estimates of demand for Yogurt in France. Once more, demand coming from the experiment (under the approach 1) seems much more elastic compared to the time-series demand entailing potential-welfare variations higher under approach 1 than under approach 2. Elasticities from experiments or disaggregate scanner data are much more elastic than those from traditional time-series approaches. Disaggregate scanner data concern products that are have many more substitutes, which results in more elastic demand.

## 5. Conclusions

This paper showed that the direct price elasticities of demand are essential determinants of welfare effects of information revelation policies, and that the elasticity of demand seems to systematically differ across experimental studies and more traditional estimates from time-series econometrics. Although suggestive, our study is not exhaustive, which means that we cannot reach a definitive conclusion and more studies are necessary for confirming these findings.

There are two main implications linked to this paper. First, an adequate lab experiment consists in choosing a product "representative" of existing products in supermarkets regarding brands, quality and/or possible substitutes. If market data are available before the experiment, selecting a product with a relative low-price elasticity could help partially impede the (likely) high-price elasticity of the initial demand emerging from the lab.

The other implication is that researchers should consider calculating welfare changes using several approaches in an effort to produce more reliable and robust inferences. Researchers commonly calculate welfare changes from experiments only (according to the approach 1), but our results suggest that they should also consider the range of welfare estimates that result from combining time-series elasticities and experimental data. Several welfare estimates should confer robustness in the conclusions about the merits of public policies.

## References

Bouamra-Mechemache Z, Réquillart V., Soregaroli C. and A. Trévisiol (2008) "Demand for dairy products in the EU" *Food Policy* **33**, 644–656.

Foster W. and R. Just (1989) "Measuring Welfare Effects of Product Contamination with Consumer Uncertainty" *Journal of Environmental Economics and Management* **17**, 266-283.

Huffman W.E, M.C. Rousu, J.F. Shogren, and A. Tegene (2003) "The Public Good Value of Information from Agribusinesses on Genetically Modified Food" *American Journal of Agricultural Economics* **85**, 1309-1315.

Huffman W.E, M.C. Rousu, J.F. Shogren, and A. Tegene (2007) "The Effects of Prior Beliefs and Learning on Consumers' Acceptance of Genetically Modified Food" *Journal of Economic Behavior & Organization* **63**, 193-206.

Lusk, J.L., L.O. House, C. Valli, S.R. Jaeger, M. Moore, B. Morrow and W.B. Traill (2005). "Consumer Welfare Effects of Introducing and Labeling Genetically Modified Food" *Economics Letters* **88**, 382-88.

Lusk J.L. and T.C. Schroeder (2006) "Auction Bids and Shopping Choices" *The B.E. Journal of Economic Analysis & Policy*, **6**, 1, Article 4.

Lusk, J.L. and J.F Shogren (2007). *Experimental Auctions. Methods and Applications in Economic and Marketing Research.* Cambridge University Press, Cambridge, UK.

Lusk J. and S. Marette (2010) “Welfare Effects of Food Labels and Bans with Alternative Willingness to Pay Measures” *Applied Economic Perspectives & Policy*, **32**, 2: 319-337.

Marette S., J. Roosen, S. Blanchemanche and P. Verger (2008a) “The Choice of Fish Species: An Experiment Measuring the Impact of Risk and Benefit Information” *Journal of Agricultural and Resource Economics* **33**, 1-18.

Marette S., J. Roosen and S. Blanchemanche (2008b) “Health Information and Substitution between Fish: Lessons from Laboratory and Field Experiments” *Food Policy* **33**, 197-208.

Marette S., J. Roosen and S. Blanchemanche (2008c) “Taxes and Subsidies to Change Eating Habits when Information is not enough: An Application to Fish Consumption” *Journal of Regulatory Economics* **34**, 119-143.

Marette S., J. Roosen and S. Blanchemanche (2010) “Functional Food, Uncertainty and Consumers’ Choices: A Lab Experiment with Enriched Yogurts for Lowering Cholesterol” forthcoming in *Food Policy*.

Masters, W.A., and D. Sanogo (2002) “Welfare Gains from Quality Certification of Infant Foods: Results from a Market Experiment in Mali” *American Journal of Agricultural Economics* **84**, 974-989.

Roosen, S., Marette S., and S. Blanchemanche (2010) “Value Elicitation using BDM and a Discrete Choice Mechanism” forthcoming in *Economics Bulletin*.

Rousu, M.C., W.E. Huffman, J.F. Shogren and A. Tegene (2004) “Estimating the Public Value of Conflicting Information: The Case of Genetically Modified Foods” *Land Economics* **80**, 125-135.

Rousu, M.C., W.E. Huffman, J.F. Shogren and A. Tegene (2007) “Effects and Value of Verifiable Information in a controversial market: Evidence from Lab Auctions of Genetically Modified Food” *Economic Inquiry* **45**, 409-432.

Rousu, M.C. and J.F. Shogren (2006) “Valuing Conflicting Public Information” *Journal of Agricultural and Resource Economics* **31**, 642-652.