Mixing messages

Browning, Martin; Smed, Sinne; Hansen, Lars Gårn

Publication date:
2010

Document version
Early version, also known as pre-print

Citation for published version (APA):
Browning, M., Smed, S., & Hansen, L. G. (2010). *Mixing messages: health scares and consumption reaction*. Paper presented at Conference in Econometric Analysis of Scanner data, London, United Kingdom.

Mixing messages: health news and consumer reactions

Martin Browning, Oxford University
Lars Gårn Hansen, FOI Copenhagen
Sinne Smed, FOI Copenhagen

December 2010

Broad question

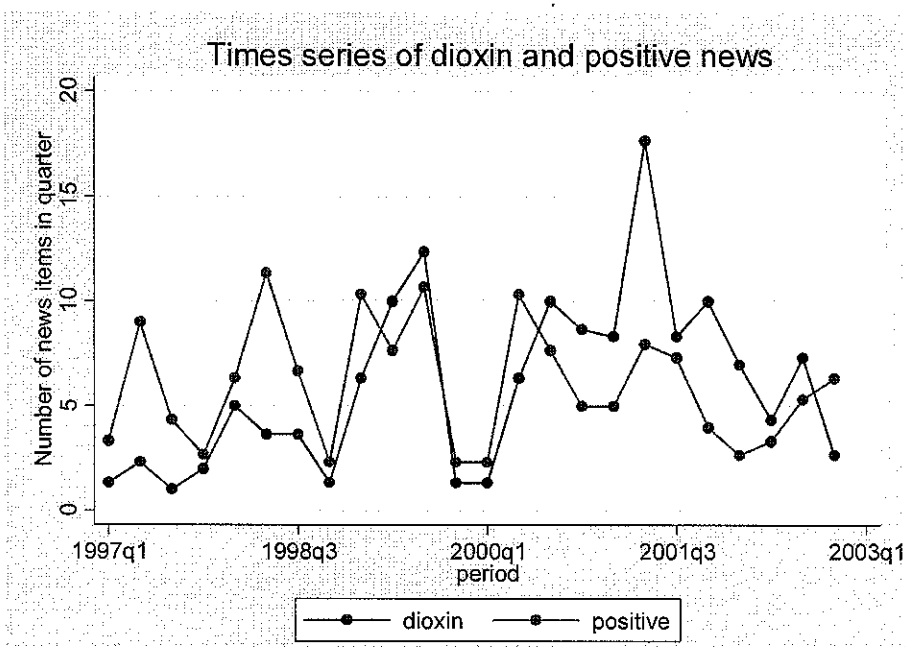
- How do consumers use government and research based information on nutrition and health?
- Large empirical literature.
- Almost all studies use aggregated data.
- Our interest: using micro data to examine heterogeneity in responses to nutrition and health information.
- Who processes information well, who gets it wrong and who simply ignores it?
- Focus of this study: fish and meat.

Good news and bad news

- Lean fish: shrimps, plaice, cod, lobster, caviar etc..
- Fatty fish: salmon, herring, mackerel, eel etc..
- Good news on fish: nutritional advantages of fish (generally) relative to meat.
- Good news on fatty fish: 'omega-3 fatty acids' in fatty fish. Fish oil.
- Bad news on fatty fish: dioxins and mercury - accumulates much more in fatty fish.
- Sometimes good news and bad news about fatty fish is reported at the same time.
- Issues for consumers: distinguishing lean/fatty fish; using information.
- Broad hypothesis: there are several types of consumers: sophisticated, inattentive and confused.

Our health indices

- Extensive literature on constructing health information (BSE, cholesterol) indices. Including simple counts of news items; cumulated counts; weighted counts; stock with decay etc..
- We construct counts of fish and health related information in Denmark from 1996, $Q1$ to 2002, $Q4$.
- Two types of news: 'dioxins' and 'positive' (general or fatty fish specific).
- Based on a search of main newspapers and the main TV channels.
- The index for a given quarter is information from that quarter and the previous quarter with weights that are at a maximum in the week before the quarter and decline symmetrically for one quarter each side.
- Common to all consumers.
- (Work in progress). Constructing an alternative (household specific) index that captures updating of information in a coherent way.

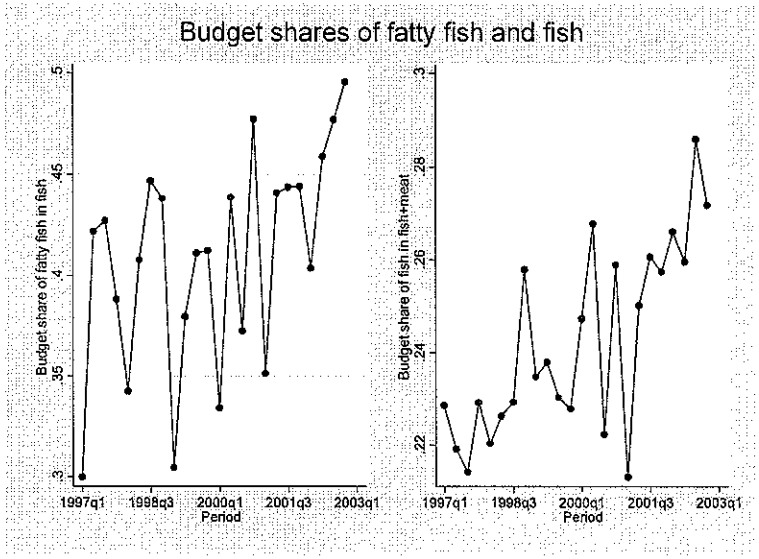

Times series of dioxin and positive news
Number of news items in quarter
0
5
10
15
20
1997q1
1998q3
2000q1
2001q3
2003q1
period
dioxin
positive

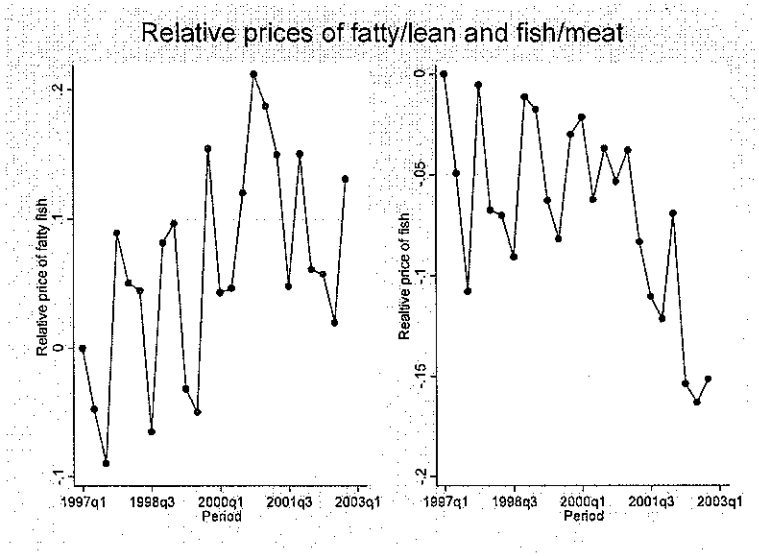
Features of news indices

- Highly jointly correlated - $\rho = 0.42$
- Dioxin is trending upwards.
- Positive news shows no trend.
- Distinct quarterly pattern.

Categories of goods

- Danish micro panel (GfK-Denmark): January 1997 to December 2002.
- *Not* based on home use scanners. Supermarket receipts and written records of volume and value.
- We take a sample of 176 households that are followed for all 24 periods and buy fish in almost every quarter.
- Layers of categories of goods: groceries; food, meat; fish; fatty fish; lean fish.
Budget share for	10%	25%	50%	75%	90%
food/groceries	0.33	0.40	0.46	0.54	0.62
(meat + fish)/food	0.15	0.20	0.27	0.34	0.42
fish/(meat + fish)	0.11	0.18	0.27	0.39	0.53
fatty fish/fish	0.12	0.21	0.41	0.59	0.74
- Food as a share of groceries not very dispersed and low. Possible recording problems.
- Good deal of heterogeneity in budget shares for fish and fatty fish.


Budget shares of fatty fish and fish
Budget share of fatty fish in fish
.3
.35
.4
.45
.5
1997q1
1998q3
2000q1
2001q3
2003q1
Period
Budget share of fish in fish+meat
.22
.24
.26
.28
.3
1997q1
1998q3
2000q1
2001q3
2003q1
Period


Relative prices of fatty/lean and fish/meat
Relative price of fatty fish
-.1
0
.1
.2
1997q1
1998q3
2000q1
2001q3
2003q1
Period
Relative price of fish
-.2
-.15
-.1
-.05
0
1997q1
1998q3
2000q1
2001q3
2003q1
Period

- Even though we have a balanced sample of households who generally eat fish, the mean budget shares are highly volatile.
- Both budget shares display a considerable upwards trend.
- The relative price of fatty fish trending upwards. The relative price of fish is trending downwards.
- The budget share for fatty fish is low in quarter 1.
- We have to include relative prices, trends and seasonal dummies in any budget share equations.

A three stage budgeting scheme

- We assume that preferences over fatty fish (a), lean fish (l), meat (m) and other foods (r) can be represented by the separable utility function:

$$U = F\left(G\left(v\left(q_a, q_l\right), q_m\right), q_r\right)$$

- We model two equations. The bottom stage is for the budget share of fatty fish in all fish. The intermediate stage is for fish as a share of meat plus fish.
- The budget share fatty fish relative to total fish is modelled as a (quasi-AI) function of the prices p_a and p_l and deflated total expenditure on fish, x_f:

$$\begin{aligned}\omega_a &= \alpha_a + \theta_a \ln\left(\frac{p_a}{p_l}\right) + \beta_a\left\{\ln x - \alpha_a \ln p_a - (1-\alpha_a)\ln p_l\right\} \\ &= \alpha_a + (\theta_a - \beta_a\alpha_a)\ln\left(\frac{p_a}{p_l}\right) + \beta_a \ln\left(\frac{x_f}{p_l}\right)\end{aligned}$$

A three stage budgeting scheme

- We assume that preferences over fatty fish (a), lean fish (l), meat (m) and other foods (r) can be represented by the separable utility function:

$$U = F\left(G\left(v\left(q_a, q_l\right), q_m\right), q_r\right)$$

- We model two equations. The bottom stage is for the budget share of fatty fish in all fish. The intermediate stage is for fish as a share of meat plus fish.
- The budget share fatty fish relative to total fish is modelled as a (quasi-AI) function of the prices p_a and p_l and deflated total expenditure on fish, x_f:

$$\begin{aligned}\omega_a &= \alpha_a + \theta_a \ln\left(\frac{p_a}{p_l}\right) + \beta_a \left\{\ln x - \alpha_a \ln p_a - (1-\alpha_a)\ln p_l\right\} \\ &= \alpha_a + (\theta_a - \beta_a\alpha_a)\ln\left(\frac{p_a}{p_l}\right) + \beta_a \ln\left(\frac{x_f}{p_l}\right)\end{aligned}$$

- If $(\theta_a - \beta_a\alpha_a) = 0$ then the Marshallian own price elasticity is -1.

- For the second stage, the price of fish is defined as:

$$\ln p_f = \alpha_a \ln p_a + (1 - \alpha_a) \ln p_l$$

- The second equation is (where f refers to total fish):

$$\omega_f = \alpha_f + \theta_f \ln \left(\frac{p_f}{p_m} \right) + \beta_f \left\{ \ln x - \alpha_f \ln p_f - (1 - \alpha_f) \ln p_m \right\}$$

- Plugging in from the first equation we have:

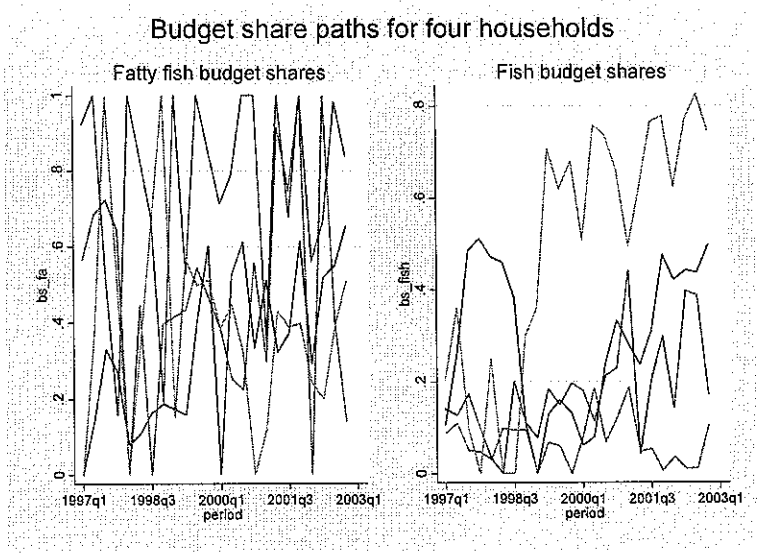
$$\begin{aligned} \omega_f &= \alpha_f + \left[\alpha_a \left(\theta_f - \beta_f \alpha_f \right) \right] \ln \left(\frac{p_a}{p_l} \right) \\ &\quad + \left(\theta_f - \beta_f \alpha_f \right) \ln \left(\frac{p_l}{p_m} \right) + \beta_f \ln \left(\frac{x}{p_m} \right) \end{aligned}$$

Results with homogeneous responses to news

- Panel of households.
- Fixed effect regression result for two budget share equations and dioxin and positive simply added in.
-

Estimates from fixed effects regression		
	Fatty fish	Fish
Dioxin news	-0.87	-0.16
	$[-0.89]$	$[-0.30]$
Positive news	0.41	1.19
	$[+0.31]$	$[+1.59]$

- Mean effects are small, insignificant but the 'right sign'.
- Two problems:
- What does an additive effect for dioxin and positive news mean?
- Perhaps reactions are heterogeneous. Some zero and others non-zero.


Budget share paths for four households
Fatty fish budget shares
Fish budget shares
bs_fa
bs_fish
0
.2
.4
.6
.8
1
1997q1
1998q3
2000q1
2001q3
2003q1
period

Putting news into prices

- *Dioxin news* acts as a multiplicative increase in price of fatty fish.
- *Good news* acts as a multiplicative decrease in the price of fish (relative to meat) and the price of fatty fish (relative to lean fish) because some good news is biased towards fatty fish.
- Let d and g be the dioxin and positive news on fish. A very convenient form is:

$$\begin{aligned} p_a &\rightarrow \tilde{p}_a = p_a (1+d)^{\delta_a} (1+g)^{\gamma_a} \\ p_l &\rightarrow \tilde{p}_l = p_l (1+d)^{\delta_l} (1+g)^{\gamma_l} \end{aligned}$$

  Thus δ_a captures how much the dioxin news impacts on the perceived price of fatty fish.
- An increase of d from 0 to 6 increases the price by $2\delta_a\%$.

- Disadvantages of price adjustment scheme
- Dioxin accumulates slowly and may better be thought of as an additive health stock effect
- Links responses to news to (compensated) price effects.
- Advantages of price adjustment scheme
- Simple and intuitive way to incorporate news into a demand system. Hence its widespread use.
- Gives coherence between fish and fatty fish budget share reactions to news. Effect comes through prices in each equation.
- Allows us to compare directly the effects of news relative to a tax induced change in price.

Consumer types

- We allow that different households process information differently. We consider some basic types.

Type	**Name**	Restriction
I	Inattentive, dioxin	$\delta_a = \delta_l = 0$
II	Inattentive, good news	$\gamma_a = \gamma_l = 0$
III	Sophisticated,	$\delta_l = 0, \delta_a > 0,$
	good news generic	$\gamma_a = \gamma_l = \gamma < 0$
IV	Sophisticated,	$\delta_l = 0, \delta_a > 0,$
	good news for fatty fish	$\gamma_l = 0, \gamma_a < 0$

- Confused *I*: dioxin causes consumer to consider fatty fish cheaper ($\delta_a < 0$).
- Confused *II*: good news looks like a higher price for fish ($\gamma_a > 0$ and $\gamma_l > 0$).

Putting news into the fatty fish equation

- Consider a sophisticated household which treats good news as specific to fatty fish (type *IV*).
- For household i in period t and using 'news adjusted' prices we have:
-

$$\begin{aligned}\omega_{ait} &= \alpha_{ai} + \tilde{\theta}_{ai} \ln\left(\frac{p_{at}}{p_{It}}\right) + \beta_{ai} \ln\left(\frac{x_{it}}{p_{It}}\right) \\ &\quad + \left(\tilde{\theta}_{ai}\delta_{ai}\right) \ln\left(1 + d_t\right) - \left(\tilde{\theta}_{ai}\gamma_{ai}\right) \ln\left(1 + g_t\right)\end{aligned}$$

- All parameters $\{\alpha_a, \theta_a, \beta_a, \delta_a, \gamma_a\}$ are heterogeneous.
- Moreover the parameters distributions may be dependent.
- For example, heavy users of fatty fish may be more responsive to good and bad news. Thus we might expect a positive correlation between α_a and δ_a and a negative correlation between α_a and γ_a.
- On the other hand, those who buy a lot of fatty fish may be well informed and news may not shift their beliefs (and behaviour) very much.

Modelling with lots of heterogeneity

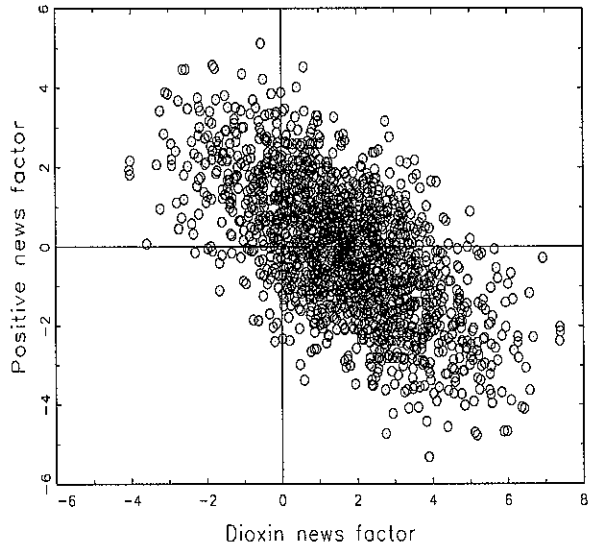
- We have (at least) 5 parameters per household and 24 observations per household. We cannot run a regression for each household separately.
- Use a (random effects) factor model. Let $\eta_1, \eta_2, ...\eta_6$ be a set of independent standard Normals.
-

$$\begin{aligned} \alpha_a &= \phi_a + \psi_{aa}\eta_1 \\ \theta_a &= \phi_\theta + \psi_{\theta a}\eta_1 + \psi_{\theta\theta}\eta_2 \\ \beta_a &= \phi_\beta + \psi_{\beta a}\eta_1 + \psi_{\beta\theta}\eta_2 + \psi_{\beta\beta}\eta_3 \end{aligned}$$

- and so on for δ_a and γ_a.
- This provides a simple and parsimonious way to incorporate heterogeneity into all parameters.

- If the parameters entered the equation of interest in a linear fashion then we have a simple mixed model that could be estimated by maximum likelihood. But our model is nonlinear.
- Moreover, we allow that different households have different variances for period to period shocks. This distribution may be correlated with the other parameters.
- Maximum likelihood estimation infeasible. (The likelihood function is too difficult to write down).
- To deal with the nonlinearities in the parameters we have to use *simulated minimum distance* ('indirect inference').
- This also gives a natural and common goodness of fit measure for any model.

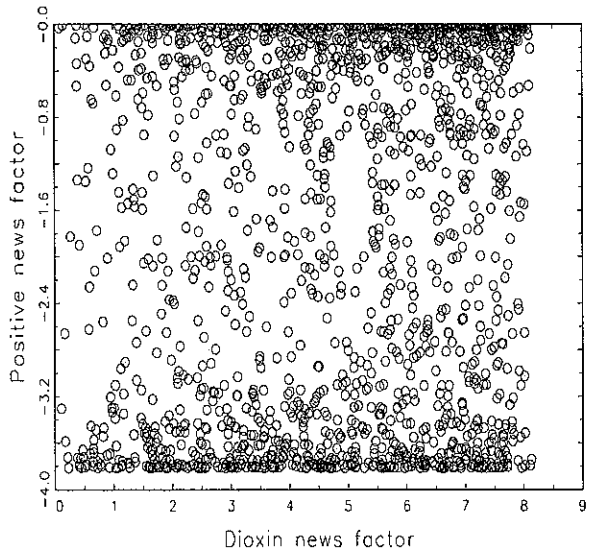
- The first model we consider is for type *IV* (sophisticated with all good news being about fatty fish).
- Dioxin and positive news only affect price of fatty fish.
- Expect dioxin new positive and positive news negative.
- Initially estimate without restrictions on joint distribution of news effect parameters.
- Only show results for fatty fish equation.
- Goodness of fit statistic: $\chi^2(21) = 29.3$


Positive news factor
Dioxin news factor
6
4
2
0
−2
−4
−6
−6
−4
−2
0
2
4
6
8

Proportion with dioxin news positive	83%
Proportion with positive news negative	52%
Proportion with both	50%

Correlations between parameters			
Intercept	1	0.01	-0.77
Dioxin news	0.01	1	-0.63
Positive news	-0.77	-0.63	1

- Now restrict dioxin news to be positive and positive news to be negative.
- Not nested in unrestricted.
- Goodness of fit statistic: $\chi^2(18) = 29.0$.


Positive news factor
−0.0
−0.8
−1.6
−2.4
−3.2
−4.0
0
1
2
3
4
5
6
7
8
9
Dioxin news factor

- Third structure: a mixture model with everyone either both zero (wholly inattentive) or at one point in (δ, γ) plane.
- Fit poor. $\chi^2(18) = 55.7$. Needs more groups.
- Proportion at zero $= 45\%$
- (dioxin,positive) $= (2.65, -1.27)$. 'Correct' signs but small effects
- For sophisticated consumers a increase from 0 to 6 dioxin news items increases the perceived price of fatty fish by 5%.
- The same increase in positive news items decreases the perceived price of fatty fish by 2.5%.

Conclusions

- Methodological: need to model heterogeneity seriously. Not enough to allow for a 'fixed effect' in an intercept. Marginal effects may also be heterogeneous.
- Data: Danish households are very volatile in their monthly spending on different types of fish.
- Inferential: Evidence that when households choose the fatty/lean fish mix, about half take account of contemporary news in a sophisticated way.
- The other half take no notice. Either because they are well informed and the news does not shift their beliefs or because they don't care.