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Investigating Changes in Canadian Consumers' Food Safety Concerns, 2003 and 2005

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Building on the results of an initial analysis of risk ranking data collected from a representative group of some 850 Canadian respondents in early 2003, this study assesses a similar set of risk ranking questions applied to a somewhat larger representative group of some 1500 Canadians in late 2005. We also compare the 2003 and 2005 risk rankings. In both surveys, risk rankings for eight food safety issues (bacteria contamination, pesticide residuals, use of hormones in food production, use of antibiotics in food production, BSE (mad cow disease), food additives, use of genetic modification/engineering in food production, fat and cholesterol in food) and six environmental safety issues (water pollution by chemical run-offs from agriculture, soil erosion, GM, herbicide/pesticide resistance, adverse effects of agriculture on biodiversity, genetic modification/engineering, and agricultural waste disposal) were queried. These were ranked by respondents from 1(high risk) to 4(almost no risk) and 5(don't know). The order of questions was randomized across respondents. Attitudinal and demographic information were also collected in each survey. Respondents' risk perceptions did change appreciably for some of the food safety issues in 2005, compared with 2003; there were less changes for environmental safety issues. Pesticide residuals were rated as less of a "high risk" issue in 2005 than in 2003, while the use of food additives was indicated as "high risk" by more respondents in 2005 than in 2003. Econometric analysis based on ordered probit models suggests that women, older respondents and residents of Quebec were still the populations tending to give high-risk ratings in 2005. Comparing the data sets from the two periods suggests that a structural break occurred in several of the risk rankings over the two periods as some subgroups of respondents changed attitudes between 2003 and 2005. For example, men and those with university degrees tended to view pesticide residuals to be more risky in 2005 than in 2003, while those with higher incomes and those living in Quebec were less likely to rate pesticide residuals to be highly risky in 2005 than in 2003. The use of GM/GE as a food safety risk was rated higher in 2005 than in 2003—attitudes to this technology may be hardening. However, BSE was rated lower as a high risk food safety issue in 2005 than in 2003, suggesting that

more information and/or effective risk communication may have accompanied the three Canadian BSE incidents that occurred during the time period between the two periods.

Keywords: food safety risks, risk perceptions, environmental risk, Canadian agriculture, ordered probit models

JEL Classification: C25, D12, I 19, Q 18

Objectives

This study of Canadian consumers' preferences for food safety and agricultural environmental safety is built on and extends an initial report to the Consumer and Market Demand Network titled "Canadian Consumers' Preferences for Food Safety and Agricultural Environment Safety" (Veeman and Li, 2006). The current report focuses on analyses of Canadians' risk perceptions based on data from a national survey that was conducted in late 2005. In this final report to the Consumer and Market Demand Network, the 2005 survey results are assessed and compared to the results of an earlier similar survey that had been conducted in early 2003 through analyses that incorporate both sets of data. Several food safety incidents, (including cases of Bovine Spongiform Encephalopathy (BSE), had occurred between the time period of the first survey (January 2003) and the second survey (October and November 2005)). Consequently, this paper focuses on whether changes in risk perceptions have occurred during this period.

Overall, the objectives of this project are: 1. To analyze data on concern rankings expressed by Canadians for food risks and environmental issues associated with agriculture in 2005. 2. To assess differences in these rankings between the similar data set collected in 2003. 3. To identify whether the concern rankings are associated with socio-economic characteristics of respondents and whether and how these have changed.

The 2005 Survey Data

Canada-wide data on a representative sample of adults' opinions of risks issues associated with specified food and agricultural issues were collected in October/November 2005, as part of a study of public opinions on plant molecular farming that had been funded by grants, held by Michele Veeman and Wiktor Adamowicz, from Genome Canada, Genome Alberta and the Alberta Agricultural Research Institute in cooperation with the Alberta Crop Industry Development Fund. This web-based survey, administered by a market research company, included a block of questions on risk perceptions that were largely identical to those queried in a 2003 survey. Both surveys

included a focus on issues associated with modern biotechnology.[1] The first component in this block of questions asks respondents to indicate the level of risks believed to apply to each of the issues listed below: "Bacteria contamination of food"; "Pesticide residuals in food"; "Use of hormones in food production"; "Use of antibiotics in food production"; "Genetically modified/engineered crops to increase crop production"; "BSE (mad cow disease)"; "Use of food additives"; "Fat and cholesterol content of food". These issues were presented in random order and respondents were asked to choose in each case from the following risk categories: "High risk"; "Moderate risk"; "Slight risk"; "Almost no risk"; and "Don't know/ unsure".

In the subsequent question respondents were also queried as follows: "We would also like to have your opinion on possible environmental safety issues that may result from modern agriculture. Please indicate the risk that you believe applies to each issue". The issues cited here specify[2]: "Water pollution by chemical run-off from agriculture"; "Use of genetically modified/engineered crops to increase crop production"; "Agricultural waste disposal (e.g., animal manure disposal)"; "Soil erosion from agricultural activity"; "Use of herbicides and pesticides"; "Adverse effects of agriculture on biodiversity". Again, the ordering of the issues was randomised and respondents chose between: High risk; Moderate risk; Slight risk; Almost no risk; Don't know/ unsure.

Data Description: 2005 Survey

Table 1 provides summary statistics indicating the distribution of the concern ratings relative to the various cited food safety issues. Table 2 reports the percentages of

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[1] Reflecting the focus of its purpose, the 2005 survey also queried opinions on food safety risks associated with "Drugs (i.e., medicine) made from plant molecular farming through genetic modification/ engineering"; "Genetically modified/engineered crops to increase nutritional qualities of food"; and "Genetically modified/engineered crops to produce industrial products like plastics, fuel or industrial enzymes". These had not been queried in 2003 and are not discussed here.

[2] Similarly, questions relating to environmental safety that were put in 2005 but not in 2003 included: Use of genetically modified/engineered crops for drug (i.e., medicine) production," "Use of genetically modified/engineered crops to increase nutritional qualities of food" and "Use of genetically modified/engineered crops for industrial products like plastics, fuel or industrial enzymes."

respondents who chose "High risk" ratings for the various food issues and also includes (in brackets) the corresponding percentages based on the 2003 survey data. Table 3 indicates the distribution of the concern ratings relative to the cited environmental safety questions. In turn, Table 4 provides the percentages of respondents who chose "High risk" ratings for the various environmental safety issues and also includes similar percentages based on the 2003 survey data. The demographic characteristics of the 2005 sample, including gender (Male), respondents' age (AGE), employment status (EMPLOY) and education level (UNIVERSITY),   whether the household includes children (CHILD); household income (INCOME) and the regional location of residence are given in Table 5, which also includes the series of variables indicating whether the respondent indicated that s/he trusted various sources of information (as listed the cited sources are: "Friends and family", "Newspapers and magazines", "The internet", "Doctors and nurses", "University research scientists", and "Federal or provincial government").

Commenting briefly on the concern ratings in 2005 relative to 2003 (presented in Tables 1 through 4): overall, levels of concern for the cited risks were slightly less in 2005. "Slight risk" and "Almost no risk" ratings changed little. Changes mostly involved shifts from "high" to "moderate risk." The order of food issues rated "high risk" did change: according to this measure, hormones, antibiotics, fat and cholesterol were seen as the highest of the cited food risk issues in 2005. Concern increased for fat and cholesterol, food additives and GM/GE but decreased for bacteria, pesticides, and BSE. In contrast, there was relatively less change in environmental risk ratings between 2003 and 2005 than in the food risk rankings. The 2005 ratings indicate that water pollution concern had fallen but still was ranked highest, while risk ratings for adverse effects of agriculture on biodiversity fell appreciably. These issues are analyzed in more detail in the later sections of this paper.

In Table 6 the basic socioeconomic and demographic characteristics of the 2003 and 2005 samples are listed, as are data from Statistics Canada based on the 2001 and 2006 Censuses of Population. Similar to the 2003 data, the 2005 data somewhat over-represent respondents with higher educational backgrounds. Overall, however, the major demographic characteristics for the survey sample appear to be reasonably representative

of the Canadian adult population. Other features of these data are discussed in the subsequent section on results and conclusions.

Table 1: Summary Statistics of Concern Responses on Food Safety Issues, 2005 (Percentages of responses; N=1574)

	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
Use of hormones	33.4	34.4	21.2	6.5	4.6
Use of antibiotics	31.3	31.6	22.7	8.0	6.3
Fat and cholesterol	30.5	37.0	24.3	6.3	1.9
Pesticide residuals	29.2	36.1	27.2	5.7	1.8
Use of GM/GE in crop production	28.6	27.9	26.0	13.1	4.4
Food additives	25.1	33.4	30.8	7.9	2.7
BSE(mad cow disease	24.1	26.7	28.4	18.6	2.2
Bacteria contamination	18.4	36.0	35.3	8.0	2.3

Table 2: Order of 2005 Food Safety Concerns Based on Percentages of Respondents Citing Issues as High Risk in 2005 and 2003 (2003 percentages are in brackets)

1	Use of hormones in food production	33% (30%)
2	Use of antibiotics in food production	31% (34%)
3	Fat and cholesterol in food	30% (24%)
4	Pesticide residuals	29% (40%)
5	Use of GM/GE in food production	28% (20%)
6	Use of food additives	25% (13%)
7	BSE (mad cow disease)	24% (31%)
8	Bacterial contamination	18% (39%)

Table 3: Summary Statistics of Concern Responses on Environmental Safety Issues, 2005 (Percentage of responses; N=1574)

	High risk	Moderate risk	Slight risk	Almost no risk	Don't know
Water pollution	47.6	35.2	14.0	2.0	1.2
Resistance to herbicide& pesticides	46.8	34.2	15.2	2.5	1.3
Waste disposal	26.5	33.5	25.7	11.9	2.4
Soil erosion	24.1	36.3	28.5	8.1	3.0
GM/GE of environment	23.3	34.2	26.2	11.5	4.8
Adverse effects on biodiversity	21.6	32.2	28.6	6.8	10.8

Table 4: Order of 2005 Environmental Concerns Based on Respondent Percentages Citing Issues as High Risk in 2005 and 2003 (2003 percentages are in brackets

1	Water pollution by agricultural chemicals	47%	(61%)
2	Resistance to herbicides & pesticides	46%	(49%)
3	Agricultural waste disposal	26%	(28%)
4	soil erosion	24%	(27%)
5	GM/GE effect on environment	23%	(26%)
6	Adverse effects of agriculture on biodiversity	21%	(40%)

Table 5: Summary Statistics for 2005 Survey Respondents: Socio-Economic, Demographic and Selected Attitudinal Data (N=1574)

Variable Name	Variable Definition	Mean	Standard Deviation	Minimum	Maximum
MALE	1-male; 0-female	0.49	0.5	0	1
AGE	Age in years	43.53	14.73	18	82
CHILD	Number of children in household	0.73	1.21	0	10
UNIVER	1-university degree or graduate, 0-less than university degree	0.24	0.43	0	1
EMPLOY	Employment status, 1-working full or part time, 0 -otherwise	0.6	0.49	0	1
INCOME	2-10,000-19,999; 3-20,000-29,999; 4-30,000-39,999; 5-40,000-49,999; 6-50,000-59,999; 7- 60,000-69,999; 8-70,000-79,999; 9- 80,000-89,999; 10-90,000-99,999; 11-More than $100,000	5.56	2.63	1	11
BC	1-resident of British Columbia; 0-otherwise	0.12	0.33	0	1
PRAIRIE	1-resident of Alberta, Saskatchewan or Manitoba; 0-otherwise	0.17	0.38	0	1
ON	1-resident of Ontario; 0-otherwise	0.39	0.49	0	1
QC	1-resident of Quebec; 0-otherwise	0.25	0.43	0	1
ATLAN	1-resident of Atlantic Provinces(New Brunswick, Newfoundland, Nova Scotia, Prince Edward Island) ; 0-otherwise	0.07	0.25	0	1
TFRIEND	Trustworthy: friend and family, 1-trust, 0-not trust	0.07	0.26	0	1
TNEWS	Trustworthy: newspaper and magazines, 1-trust, 0-not trust	0.22	0.42	0	1
TRADIO	Trustworthy: radio and TV. 1-trust, 0-not trust	0.14	0.35	0	1
TINTER	Trustworthy: The internet. 1-trust, 0-not trust	0.5	0.5	0	1
TDOCTOR	Trustworthy: doctor. 1-trust, 0-not trust	0.18	0.38	0	1
TUNIVER	Trustworthy: university. 1-trust, 0-not trust	0.53	0.5	0	1
TGOV	Trustworthy: government. 1-trust, 0-not trust	0.21	0.41	0	1

Table 6 Comparisons of the two Data Sets to Canadian Population Statistics

	Sample 2003	Sample 2005	Canadian Population 2001* & 2003	Canadian Population 2005 & 2006**	Sample 2003 percentages	Sample 2005 percentages	Canadian Population 2001* & 2003 (percentages)	Canadian Population 2005 & 2006** (percentages)
Male	285	768	15,688,977	15,995,582	44.10	48.80	49.5	49.5
Female	361	806	15,987,100	16,303,914	55.90	51.20	50.5	50.5
No university (15 years and over)	400	1198	19612285*		61.90	76.10	82.05*	
University (15 years and over)	246	376	4289070*		38.10	23.90	17.95*	
Not employed (15 years and over) ***	240	625	1286200	1172800	37.20***	39.70***	7.58	6.76
Employed (15 years and over)	406	949	15672300	16169700	62.90	60.30	92.42	93.24
Av. income $	66532	54145	66300		0.00	0.00		
BC Residence	70	193	4,155400	4,257800	10.80	12.30	13.16	13.22
PRAIRIE Residence	84	273	5318000	5441700	13.00	17.30	16.84	16.90
ON Residence	251	607	12,262.600	12,558700	38.90	38.60	38.82	38.99
QC Residence	190	392	7,494.700	7,597800	29.40	24.90	23.73	23.59
ALANTIC Residence	51	107	2343400	2339800	7.90	6.80	7.42	7.27
NWT Residence		2	10200	10370	0.00	0.10	0.03	0.03
AGE18-19	0	23		-	0.00	1.50		-
AGE 20-29	97	294	3854010*	4495400**	15.00	18.70	17.44*	18.25**
AGE 30-39	167	388	4619595*	4581800**	25.90	24.70	20.91*	18.60**
AGE 40-49	147	327	4912295*	5380200**	22.80	20.80	22.23*	21.84**
AGE 50-59	127	291	3679995*	4452900**	19.70	18.50	16.66*	18.08**
AGE 60-69	88	168	2407405*	2812400**	13.60	10.70	10.90*	11.08**
AGE 70-79	20	78	1822880*	1924000**	3.10	5.00	8.25*	7.8*
AGE 80-89		5	797925*	983800**	0.00	0.30	3.61*	4.57**

Note: * Demographic data for Canada as reported by Statistics Canada from the 2001 Census of Canada
   ** Demographic data for Canada as reported by Statistics Canada from the 2006 Census of Canada
   * ** "Not employed" figures may differ due to the different definition used in the survey than is reported by Statistics Canada
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Canadian Population data Sources for Table 6

1. Population by gender
http://www40.statcan.ca/l01/cst01/famil01.htm?sdi=population
2. Population 15 years and over by highest degree, certificate or diploma
http://www40.statcan.ca/l01/cst01/educ42.htm?sdi=population
3.Labour force characteristics
http://www40.statcan.ca/l01/cst01/econ10.htm?sdi=population
4. Average market income
http://www40.statcan.ca/l01/cst01/famil22a.htm?sdi=family
5. Population by year, by province and territory
http://www40.statcan.ca/l01/cst01/demo02a.htm
6. 2001 population by age groups
http://www12.statcan.ca/english/census01/products/standard/themes/RetrieveProductTabl
e.cfm?Temporal=2001&PID=55437&APATH=3&GID=431515&METH=1&PTYPE=55
430&THEME=37&FOCUS=0&AID=0&PLACENAME=0&PROVINCE=0&SEARCH
=0&GC=0&GK=0&VID=0&VNAMEE=&VNAMEF=&FL=0&RL=0&FREE=0
7. 2006 population by age groups
http://www40.statcan.ca/l01/cst01/demo10a.htm?searchstrdisabled=2006%20population
%20%20by%20age&filename=demo10a.htm&lan=eng

<u>Statistical Analysis</u>

A series of Ordered Probit models were applied to explain Canadian consumers'
risk perceptions in 2005 in terms of postulated socio-economic, demographic and
attitudinal variables. These explain   the dependent variable, y, in terms of the postulated
demographic and socioeconomic variables, where y takes the form of four categorical
values that represent the latent variable y^* and the associated threshold variables μ_0,
μ_1, μ_2, and μ_3, which each relate to the four values 0, 1, 2 and 3, representing the
rankings for high risk, moderate risk, slight risk and almost no risk, respectively. Thus the
relationship between y and y^* is:

$y = 0$ if $y^* < \mu_0$ (where μ_0 equals zero)

$y = 1$ if $\mu_0 \leq y^* < \mu_1$

$y = 2$ if $\mu_1 \leq y^* < \mu_2$

$y = 3$ if $\mu_2 \leq y^* < \mu_3$

The estimated coefficients and the marginal effects of significant variables for data based on the full set of data from the 2005 survey are reported in Appendix 1. In order to compare whether and how risk perceptions changed during the two time periods considered, Chow-type tests are applied. For this purpose, data from the two years were pooled after deleting those variables that differed in each of the original (2003 and 2005) data sets. Therefore, the same set of explanatory variables applies in each of the two different years (the trust variable differs slightly due to different wordings in the two surveys). Thus the restricted model which is required for the Chow tests is based on pooled data sets of the observations from the 2003 and 2005 surveys. Following Greene (2000, p. 826), the Chi-square statistics for these tests are calculated as:

$$\chi^2 = 2 * (\text{ Unrestricted log likelihood-restricted log likelihood})$$

 The unrestricted log likelihood statistics are obtained from the separate estimations based on the common set (ie censored) 2003 and 2005 data sets. From the Chi-square statistic results, given in Tables 7 and 8, the hypothesis that the parameters of the independent variables for each of the two years 2003 and 2005, for each issue queried, are the same is rejected at the 99 percent confidence level.

Table 7: Log Likelihood Ratio Tests for Change in Cited Food Safety Issues (Chow-type Test for Ordered Probit Models)

	Bacteria contamination	Pesticide residuals	Use of hormones	Use of antibiotics	Mad cow disease	Food additives	Use of GM/GE	Fat & cholesterol
Unrestricted LL	-2832.03	-2774.46	-2723.52	-2732.95	-2902.35	-2971.94	-2835.03	-2814.18
Restricted LL	-2869.12	-2801.38	-2745.51	-2751.15	-2955.06	-3007.78	-2888.64	-2839.36
Chi-squared	74.18	53.85	43.99	36.39	105.42	71.68	107.21	50.35
Degrees of freedom	11	11	11	11	11	11	11	11
Critical value at 0.01	24.73	24.73	24.73	24.73	24.73	24.73	24.73	24.73

Table 8: Log Likelihood Ratio Tests for Change in the Cited Environmental Issues
(Chow-type Test for Ordered Probit Models)

	Water pollution	Soil erosion	GM/GE	Resistance to herbicides	Adverse effects of agriculture on biodiversity	Agricultural waste disposal
unrestricted LL	-2266.59	-2789.25	-2898.71	-2644.69	-2463.75	-2625.4
restricted LL	-2295.82	-2819.15	-2918.65	-2739.34	-2514.7	-2658.26
Chi-squared	58.46	59.79	39.89	189.31	101.9	65.72
degree of freedom	11	11	11	11	11	11
Critical value at 0.01	24.73	24.73	24.73	24.73	24.73	24.73

Discussion of Results

Estimated Results Based on the 2005 Survey Data

Tables containing the estimated results of the series of postulated models are in Appendix 1. The chi-square statistics for each of the models are statistically significant, confirming the statistical relevance of these models. The estimated coefficients of MALE were significant each of the fourteen models. Men were less likely to choose "high risk" and were more likely to select "almost no risk" than women. This finding is consistent with that found from analysis of the 2003 data, summarized in the previous related report on the initial project to the Consumer and Market Demand Network, that females are more likely to express higher levels of food safety concerns than are males.

The age of respondents was significant in the estimations based on concern rankings for bacteria contamination, pesticide residuals, use of antibiotics, mad cow disease, use of food additives, fat and cholesterol in food, water pollution by agriculture run-off, agricultural waste disposal, soil erosion and resistance to herbicides & pesticides. Older respondents were more likely than those who were younger to indicate these as "high risk" issues. This finding is also consistent with the earlier estimations which were based on the 2003 data.

The presence of children is only significant in the estimation of use of GM/GE (described in the 2005 survey as being to increase food production). From this set of data, the more children there were in the household, the more likely respondents were to view the use of GM/GE in food and agriculture as a "high risk" issue. Education level

9

was also found to be associated with risk perceptions. Respondents with a university degree were more likely to see pesticide residuals in food, use of antibiotics and adverse effects of agriculture on biodiversity as "high risk" issues.

We do not find employment status to be a significant factor in influencing risk perceptions as shown by respondents' choice of risk ratings in 2005. However, income was a factor that appeared to have some effects on risk perceptions. People with higher income were less likely to rate the following issues as "high risk": bacteria contamination in food, pesticides residuals, use of antibiotics, use of GM/GE in food production, mad cow disease, use of food additives, water pollution by agriculture run-offs and the effect of GM/GE in agriculture on the environment. There are some differences from those found in estimations based on the 2003 data and these are outlined in the following section. However, we found one feature of the regional location of respondents' residence to have a continuing and considerable influence on risk perceptions. In both 2003 and 2005, those who lived in Quebec were much more likely than other Canadians to view the following issues to be "high risk": pesticide residuals, use of antibiotics, use of GM/GE in food production, mad cow disease, water pollution by agriculture run-offs, GM/GE effect on environment, and agriculture waste disposal. In contrast, respondents from BC, the Prairie Provinces and Ontario (ON) seemed to have similar lower risk perceptions relative to food and agriculture.

Relative to trust in information sources, in 2005 TUNIVER (trust in university research scientists), is significant in the estimation of BSE (mad cow disease), soil erosion, resistance to herbicides & pesticides and adverse effects of agriculture on biodiversity. Those who indicated that they trusted university research scientists showed a lower tendency to choose each of these four issues as "high risk" and a higher tendency to choose "almost no risk". Those who indicated that Canadian governments are a trusted information source were less likely to view pesticide residuals and adverse effects of agriculture on biodiversity as "high risk". However, having trust in information from friends and family, newspapers and magazines, radio and TV and doctors and nurses did not have a significant influence on risk perceptions.

Comparisons Between the Two Periods Based on Rankings and Marginal Effects of the Ordered Probit Model Estimations

As shown in Table 2, the issue of bacteria contamination was ranked as the second highest risk food (in terms of the percentage of respondents citing this as "high risk") in the eight cited food safety issues in 2003, but as the eighth highest food risk in 2005. The Ordered Probit estimations in 2003 and 2005 indicate a change overall in the importance of gender: based on the 2005 data, MALE tends to be significantly positive, in many more instances than was the case with the 2003 data. The marginal effects of MALE and INCOME show that men and those with higher incomes were less likely to rate bacteria contamination as "high risk" in 2005, compared to 2003. Pesticide residuals were rated by 29% of respondents to be "high risk" in 2005, but this rating was given by more respondents--40%--in 2003. MALE, AGE, UNIVER, INCOME and QC are statistically significant in 2005 but not in 2003; the models estimated on 2005 data indicated that males and those with higher incomes tended to choose pesticides as a less risky issue than did other groups in 2005 (although these variables were not significant in 2003), while older respondents, those with university degrees and people living in Quebec appeared to rate pesticides as a more risky issue in 2005 than in 2003. The significant 2005 results for income are consistent with some other literature. For example, Roe et al. (2004) found that U.S. respondents with lower incomes tended to give higher food safety concern ratings. Similarly, U.S. consumers with annual incomes less than US$40,000 were more likely to express concern about pesticides than were those with higher incomes (Govindasamy and Italia, 1998). It may be that people with higher incomes may view themselves as being able to offset food risks by buying higher quality or organic food.

In 2005 the use of hormones was ranked as the highest risk of all the eight food safety issues; the percentage of those rating this issue as "high risk" did not change much in the two years (high risk ratings were given by 33% of respondents in 2005 and by 30% in 2003). Males were less likely than females to view the use of hormones as risky in 2005 (but this was not a significant variable in 2003). Older respondents tended to rate the use of hormones as more risky in 2005 than was the case for younger respondents (again this variable was not significant in 2003).

Overall, 31% of respondents rated the use of antibiotics as "high risk" in 2005, while 34% gave this rating in 2003. Men and those with higher incomes were less inclined than others to consider the use of antibiotics as "high risk" for food safety in 2005 (these were not significant variables in 2003). Relative to the responses regarding BSE (mad cow disease) in the time period between the two surveys, it is of interest that three cases of BSE were found in Canada during this period—one in 2003 (confirmed as positive on May 20, 2003 by the Canadian Food Safety Inspection Agency) and two in 2005 (confirmed as positive on January 2 and 11 2005). In addition a Washington State cow, confirmed to have BSE in December 25, 2003 was found to have been born on a Canadian (Alberta) farm (CFIA, 2006). Thus it might be expected that Canadian's concern rankings might have increased for BSE as a food safety issue. However, the percentage of Canadians rating mad cow disease as a major food risk (ie as a "high risk") issue actually declined from 31% to 24% over this time period according to our results. Respondents with children were more likely than others to consider mad cow disease to be risky in 2005 (although this factor was not significant in 2003). Men and those with higher incomes were less likely than others to perceive mad cow disease as a high food risk issue in 2005. Our finding that Canadians' concern with mad cow disease as a high risk issue may have eased between 2003 and 2005 does not support an initial hypothesis that people may tend to view BSE as more risky as more instances of this animal disease are found. The relatively low number of animal incidents in which BSE was found and the potential perception that this risk issue is under control may underlie this tendency and tends to suggest successful risk communication has occurred relative to these incidents. Further research relative to this issue is recommended.

The percentage of those respondents who chose "high risk" for use of food additives was 25% in 2005, almost twice the percentage in 2003 (13%). The major difference between the model estimations of the marginal effects based on the 2003 and 2005 data relate to income. This variable is significant in the model tested on 2005 data, but not in the case of the 2003 data, and indicates that respondents with higher income were less likely than others to see this issue to be risky in 2005. Overall, 28% of respondents rated the use of GM/GE to increase food production as a "high risk" food issue in 2005 while only 20% of respondents saw GM/GE in agriculture as "high risk"

for food in 2003. Men were less inclined to view the use of GM/GE in food production as a high food risk issue. In 2005 GM/GE was still viewed as more risky by Quebec residents than those who resided in other provinces.

Some 30% of respondents rated fat and cholesterol in food as a "high risk" issue in 2005; only 24% respondents had chosen this as "high risk" in 2003. AGE was a significant variable in 2005 but not in 2003; the marginal effects of this are, however, small. Gender is also significant, with males less likely to see this as "high risk".

As shown in Tables 3 and 4, of the various environmental issues associated with modern agriculture, more respondents tended to be highly concerned about water pollution by agricultural chemicals (though the percentage of respondents rating this as high risk fell somewhat in 2005 relative to 2003). Specifically, water pollution by agricultural chemicals was rated as "high risk" by 47% of respondents in 2005 while 61% cited this as "high risk" in 2003. MALE, AGE, INCOME, and QC are significant in the estimations based on 2005 data, but Male and income were not significant in 2003. Those who are male and those with higher income levels were less likely to view water pollution by agricultural chemicals to be a high risk to the environment. The Marginal effects of AGE and QC have the same signs in the estimations on 2003 and 2005. Older respondents and those who lived in Quebec were more likely to see this as "high risk".

Resistance to herbicides and pesticides was rated to be high risk by 46% of respondents in 2005 while 49% gave this rating in 2003. Males tended to see this issue to be less risky than females in 2005, as was also the case in 2003. Those who lived in the Prairie Provinces tended to see this issue as less risky than others in 2005,   but the factor of living in the Prairie region was not a significant factor (i.e. did not affect risk ratings) in 2003. Similarly, older respondents and those who expressed trust in University scientists saw resistance to herbicides and pesticides to be more risky than others in 2005, but age and having trust in University scientists were found to be insignificant variables in the 2003 data analysis.

Agricultural waste disposal was rated by 26% of respondents as a "high risk" issue in 2005 and this was the case for 28% of respondents in 2003, a similar proportion of respondents giving this a "high risk" rating. Similarities are also found in the Ordered

Probit models for this issue based on the 2003 and 2005 data sets. Males were less likely to see agricultural waste disposal as risky, whereas older respondents, those lived in Quebec and those who expressed trust in friends and family were more likely than others to see this as a high risk issue in 2005.

Soil erosion was rated as high risk by 24% of respondents in 2005 and by 27% of respondents in 2003. The Ordered Probit model results are similar for the two periods. For instance, males and those with higher incomes saw this as a less risky issue but older respondents, those who lived in Quebec, and those who trusted university scientists were more inclined to view this issue as more risky in both years.

The effect of GM/GE on the environment was seen by 23% of respondents as a high risk issue in 2005, while 26% gave this rating in 2003. The marginal effects of MALE and INCOME in the model for this issue in 2005 had the same signs as in 2003, and indicate that males and those with higher incomes tended to rate the influence of GM/GE effects on environment as less risky than did other respondents. A major difference between the models results based on 2003 and 2005 data is that this coefficient is significant in 2005 but not in 2003, suggesting that respondents who lived in Quebec viewed the effects of GM/GE on the environment to be more risky in 2005 than in 2003.

The issue of adverse effects of agriculture on biodiversity was cited by 21% of respondents as high risk in 2005, but 40% of respondents gave this rating in 2003. The marginal effects of MALE are similar in each of the two years. Men tended to see adverse effects of agriculture on biodiversity as a high risk issue in both 2003 and in 2005. However, INCOME, UNIVER and QC were significant in the model tested on 2005 data, but insignificant in 2003, and indicate that those with high incomes, those with a university degree or who lived in Quebec were more likely than others to see adverse effect of agriculture on biodiversity risky in 2005.

Summary and Conclusions

In this study we examined Canadian consumers' perceptions of selected food and environmental safety issues based on data collected in January 2003 and October/November 2005. The effects of socio-demographic and attitudinal factors on each concern issue are assessed using Ordered Probit models. An earlier report gave the

results of detailed analyses of the full 2003 data set (Veeman and Li, 2006). Analyses of the full sets of the 2003 and 2005 food and environmental risk data are not directly comparable due to a slightly different set of explanatory variables in the two years (this is mainly due to different and less detailed trust data in the 2005 survey and the absence of data on organic food purchases, which was a significant predictor of food safety concerns in the 2003 data set). Nonetheless there are similarities in the influence of socio-demographic influences in explaining risk perceptions. Respondents' risk perceptions did change appreciably for some of the food safety issues in 2005 compared with 2003 in terms of the percentage of respondents' choices of "high risk" issues; there were less changes for environmental safety issues. Pesticide residuals were rated as less of a "high risk" food issue in 2005 than in 2003, while the use of food additives was chosen as "high risk" by more respondents in 2005 than in 2003. Statistical analysis suggests that women, older respondents and residents of Quebec were still the population segments tending to give high-risk ratings in 2005.

Detailed analysis was made in comparing reduced data sets based on the identical questions that were asked in each of the two periods. These suggest that a structural break exists in all the risk issues rankings between the two periods, indicating some differences in risk attitudes in 2005 compared to 2003. For example, men or those with a university degree tended to view pesticide residuals to be less risky than others in 2005, which was not the case in 2003 , while those with higher incomes or those living in Quebec were less likely than others to rate pesticide residuals to be risky in 2005. This was not the case in 2003. The use of GM/GE as a high food safety risk was chosen by more respondents in 2005 than in 2003—attitudes to this technology may be hardening. However, BSE was rated as a less high risk food safety issue in 2005 than in 2003 suggesting that more information and/or effective risk communication may have accompanied the three BSE incidents that occurred during this time period. A further conclusion from this study is that those with trust in different information sources have different perceptions of risk. Our earlier report that gave details of the analysis of risk ranking data from the 2003 survey indicated that relatively few respondents trust information from Canadian government and from farmer associations (Veeman and Li, 2006). Nonetheless "trust in government" tends to be a significant predictor of several risk class probabilities.

With new food technologies emerging, new food risk events becoming evident, changing information and with changes in demographic and socio-economic influences, Canadian consumers' risk perceptions appear also to be changing somewhat. Further research may be needed to learn more about consumers' attitudes and risk perceptions as these change over time. Experimental studies may add to the existing body of research. Refinements of existing econometric techniques, such as the development of multivariate Ordered Probit models may also be useful.

Study Highlights

Major features of the results of this study are:

- Overall, hormones, antibiotic and pesticide use in agriculture are seen as appreciable food risk concerns by Canadians.
- The use of GM/GE in agriculture is seen as somewhat more of an environmental risk than a food risk. Nonetheless, concerns about GM/GE as a food risk increased over the period from 2003 to 2005;
- Chemical runoffs from agriculture are viewed as the riskiest cited environmental issue associated with agriculture.
- Women express more concern than men for food risk issues and for environmental risk issues that may be associated with modern agriculture.
- Quebec residents are much more likely than other Canadians to rate food and agricultural risks to be high. The study also shows that education, income and age can also be significant risk perception predictors but their effects tend to be relatively small

Significance of Research

Concerns about issues of food safety and environmental quality associated with agriculture are considered to be major influences on consumers' demand for food. However, there is little information on how consumers' concerns relating to these issues are formed and whether or how these concerns may change over time. Knowledge of the nature of selected concerns about food safety and environmental consequences of

agriculture, whether these concerns are increasing or otherwise, and whether these are associated with socio-demographic or other influences are of interest in providing insights into consumers' demand for food safety and in informing policy and marketing decisions relating to agriculture and food. Industry and policy makers need to be aware of Canadians' risk perceptions and food risk concerns. Understanding risk perception and concerns can aid policy makers in developing acceptable food and environmental policies. Thus the risk ratings assessed in the study should provide useful information to Canadian policy makers and other decision makers.

APPENDIX 1: Ordered Probit Model Results based on the 2005 Survey Data

Table A1-1 Estimated Coefficients, Food Risks, Ordered Probit Models, 2005 data

	Bacteria Contamination		Pesticide Residuals		Use of Hormones	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
CONSTANT	0.945	5.869	0.565	3.503	0.442	2.673
MALE	0.259***	4.548	0.402***	6.974	0.306***	5.229
AGE	-0.005**	-2.364	-0.006***	-3.119	-0.004	-1.867
CHILD	-0.039	-1.651	-0.030	-1.246	-0.040	-1.614
UNIVER	-0.007	-0.105	-0.178***	-2.650	-0.132	-1.939
EMPLOY	-0.047	-0.785	-0.093	-1.528	-0.120	-1.943
INCOME	0.028**	2.474	0.042***	3.774	0.028**	2.423
BC	-0.008	-0.063	0.040	0.306	-0.067	-0.494
PRAIRIE	0.145	1.181	0.050	0.403	0.139	1.088
ON	-0.156	-1.377	-0.092	-0.803	-0.016	-0.134
QC	-0.123	-1.037	-0.251**	-2.102	-0.204	-1.657
TFRIEND	-0.028	-0.259	-0.084	-0.766	-0.036	-0.321
TNEWS	0.059	0.831	0.066	0.917	0.071	0.966
TRADIO	-0.036	-0.425	-0.022	-0.253	0.047	0.540
TINTER	-0.012	-0.208	0.083	1.480	-0.002	-0.038
TDOCTOR	-0.074	-1.004	-0.009	-0.119	-0.043	-0.572
TUNIVER	0.016	0.278	-0.060	-1.029	-0.053	-0.894
TGOV	0.075	1.088	0.141**	2.024	0.075	1.068
Mu(1)	1.048	32.548	0.994	30.849	0.961	29.896
Mu(2)	2.319	48.696	2.184	41.245	1.926	38.507
chi square	50.480		97.130		61.000	
Obs.	1538		1545		1502	
df	17		17		17	

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table A1-1 Estimated Coefficients, Food Risks, Ordered Probit Models, Continued

	Use of Antibiotics		Mad cow disease (BSE)		Use of food additives	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
CONSTANT	0.628	3.728	0.691	4.291	0.552	3.417
MALE	0.269***	4.566	0.225***	3.940	0.404***	7.017
AGE	-0.007***	-3.122	-0.005**	-2.180	-0.006***	-2.945
CHILD	-0.032	-1.314	-0.064***	-2.689	-0.046	-1.928
UNIVER	-0.139**	-2.035	-0.081	-1.226	-0.032	-0.486
EMPLOY	-0.057	-0.919	0.027	0.443	-0.063	-1.035
INCOME	0.025**	2.176	0.046***	4.083	0.033***	2.954
BC	-0.053	-0.384	0.035	0.267	-0.033	-0.249
PRAIRIE	0.082	0.636	0.192	1.555	0.158	1.274
ON	-0.085	-0.709	-0.190	-1.664	0.100	0.867
QC	-0.291**	-2.323	-0.403***	-3.380	-0.025	-0.209
TFRIEND	-0.130	-1.157	0.061	0.562	0.139	1.291
TNEWS	0.085	1.156	0.128	1.798	0.083	1.146
TRADIO	0.058	0.667	-0.125	-1.461	-0.138	-1.602
TINTER	0.088	1.526	-0.060	-1.068	0.014	0.256
TDOCTOR	0.071	0.940	-0.037	-0.504	-0.024	-0.330
TUNIVER	-0.128	-2.144	0.083	1.419	0.003	0.057
TGOV	0.065	0.916	0.094	1.366	0.069	0.994
Mu(1)	0.897	28.786	0.765	27.317	0.935	30.176
Mu(2)	1.848	39.211	1.631	42.800	2.112	44.027
Chi squared	66.290		108.4629		81.54769	
Degrees of freedom	17		17		17	
Obs.	1475		1539		1531	

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table A1-1 Estimated Coefficients, Food Risks, Ordered Probit Models, Continued

	Use of GM/GE		Fat and cholesterol in food	
	Coeff.	t-ratio	Coeff.	t-ratio
CONSTANT	0.462	2.813	0.713	4.364
MALE	0.277***	4.785	0.204***	3.551
AGE	-0.003	-1.555	-0.009***	-4.454
CHILD	-0.052**	-2.123	-0.004	-0.174
UNIVER	0.024	0.356	0.017	0.261
EMPLOY	-0.085	-1.381	0.056	0.921
INCOME	0.024**	2.130	-0.006	-0.558
BC	0.042	0.313	0.119	0.893
PRAIRIE	0.115	0.906	0.218	1.739
ON	0.093	0.794	0.108	0.930
QC	-0.301**	-2.468	-0.038	-0.309
TFRIEND	-0.107	-0.962	0.020	0.180
TNEWS	0.077	1.060	0.053	0.735
TRADIO	-0.074	-0.844	-0.109	-1.254
TINTER	0.055	0.979	0.040	0.714
TDOCTOR	-0.132	-1.745	-0.107	-1.439
TUNIVER	0.059	1.002	0.013	0.215
TGOV	0.079	1.127	0.007	0.101
Mu(1)	0.780	27.207	1.000	31.359
Mu(2)	1.673	40.682	2.049	40.933
restrictedll	-2025.680		-1934.534	
chi	81.050		44.53992	
df	17		17	
obs	1504		1544	

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table A1-2 Estimated Coefficients, Environmental Risks, Ordered Probit Models, 2005 data

	Water Pollution by Ag.		Resistance to herbicides & pesticides		Agricultural waste disposal	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
CONSTANT	0.386	2.297	0.232	1.371	1.058	6.574
MALE	0.190***	3.164	0.319***	5.323	0.249***	4.348
AGE	-0.006**	-2.563	-0.009***	-4.005	-0.011***	-5.562
CHILD	-0.017	-0.685	0.004	0.148	-0.004	-0.175
UNIVER	-0.127	-1.813	-0.036	-0.520	-0.033	-0.495
EMPLOY	0.006	0.096	-0.094	-1.483	0.000	0.006
INCOME	0.024**	2.091	0.016	1.338	0.014	1.242
BC	-0.055	-0.407	0.232	1.686	0.029	0.220
PRAIRIE	0.019	0.149	0.307**	2.368	0.012	0.100
ON	-0.169	-1.434	0.147	1.216	-0.211	-1.842
QC	-0.595***	-4.755	-0.238	-1.874	-0.258**	-2.162
TFRIEND	-0.153	-1.310	-0.060	-0.527	-0.275**	-2.479
TNEWS	0.072	0.961	-0.015	-0.202	0.017	0.236
TRADIO	-0.041	-0.456	0.016	0.181	0.040	0.470
TINTER	-0.028	-0.486	0.108	1.841	0.097	1.740
TDOCTOR	-0.032	-0.418	0.069	0.899	-0.037	-0.498
TUNIVER	-0.117	-1.914	-0.195***	-3.196	-0.052	-0.893
TGOV	0.073	1.016	-0.019	-0.266	0.068	0.987
Mu(1)	1.069	28.530	1.024	28.275	0.927	30.892
Mu(2)	2.164	29.142	2.103	30.373	1.819	43.790
restrictedll	-1673.410		-1711.690		-2041.130	
chi	85.320		97.430		72.430	
df	17.000		17.000		17.000	
obs	1555.000		1554.000		1536.000	

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table A1-2 Estimated Coefficients, Environmental Risks Ordered Probit Models, Continued

	Soil erosion		GM/GE (to increase production) effect on environment		Adverse effects of agriculture on biodiversity	
	Coeff.	Coeff.	Coeff.	t-ratio	Coeff.	t-ratio
CONSTANT	1.012	0.569	0.535	3.241	0.569	3.368
MALE	0.152***	0.140**	0.292***	5.069	0.140**	2.338
AGE	-0.006***	0.001	-0.003	-1.224	0.001	0.466
CHILD	0.039	0.028	-0.029	-1.218	0.028	1.146
UNIVER	-0.087	-0.228***	-0.034	-0.510	-0.228***	-3.303
EMPLOY	-0.058	-0.020	-0.057	-0.924	-0.020	-0.311
INCOME	0.025**	0.041***	0.030***	2.634	0.041***	3.491
BC	-0.180	-0.139	0.064	0.480	-0.139	-0.995
PRAIRIE	-0.048	-0.020	0.205	1.621	-0.020	-0.153
ON	-0.137	-0.137	0.159	1.355	-0.137	-1.123
QC	-0.414***	-0.328***	-0.360***	-2.943	-0.328***	-2.587
TFRIEND	-0.095	-0.013	-0.187	-1.675	-0.013	-0.113
TNEWS	-0.060	-0.012	0.038	0.526	-0.012	-0.166
TRADIO	0.122	0.128	-0.008	-0.095	0.128	1.454
TINTER	0.069	0.062	0.064	1.141	0.062	1.055
TDOCTOR	-0.087	0.055	-0.135	-1.803	0.055	0.703
TUNIVER	-0.131**	-0.132**	0.033	0.565	-0.132**	-2.157
TGOV	0.077	0.144	0.095	1.372	0.144	2.010
Mu(1)	1.015	0.986	0.996	31.830	0.986	29.919
Mu(2)	2.111	2.183	1.947	44.964	2.183	43.085
restrictedll	-1956.730	-1786.050	-1982.500		-1786.050	
chi	62.250	60.070	112.410		60.070	
df	17.000	17.000	17.000		17.000	
obs	1527.000	1404.000	1499.000		1404.000	

Note: *** denotes significant at 0.01 level; **significant at 0.05 level.

Table A1-3 Marginal Effects of Bacterial Contamination, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.069	-0.033	0.064	0.038
AGE	0.001	0.001	-0.001	-0.001
INCOME	-0.007	-0.004	0.007	0.004

Table A1-4 Marginal Effects of Pesticide Residuals, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.137	-0.009	0.102	0.043
AGE	0.002	0.000	-0.002	-0.001
UNIVER	0.062	0.001	-0.046	-0.017
INCOME	-0.015	-0.001	0.011	0.005
QC	0.089	-0.001	-0.064	-0.024
TGOV	-0.047	-0.005	0.036	0.016

Table A1-5 Marginal Effects of Use of Hormones in Food Production, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.112	0.008	0.066	0.038
INCOME	-0.010	0.001	0.006	0.003

Table A1-6 Marginal Effects of Use of Antibiotics in Food Production, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.097	0.000	0.057	0.040
AGE	0.002	0.000	-0.001	-0.001
UNIVER	0.051	-0.002	-0.029	-0.020
INCOME	-0.009	0.000	0.005	0.004
QC	0.108	-0.007	-0.062	-0.039

Table A1-7 Marginal Effects of BSE (mad cow disease),   2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.069	-0.020	0.030	0.059
AGE	0.001	0.000	-0.001	-0.001
CHILD	0.020	0.006	-0.09	-0.018
INCOME	-0.014	-0.004	0.006	0.012
QC	0.133	0.026	-0.062	-0.096
TUNIVER	-0.026	-0.007	0.011	0.022

Table A1-8 Marginal Effects of use of Food additives, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.128	-0.027	0.097	0.058
AGE	0.002	0.000	-0.002	-0.001
INCOME	-0.010	-0.002	0.008	0.005

Table A1-9 Marginal Effects of Use of GM/GE to Increase Food Production, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.095	-0.012	0.049	0.059
CHILD	0.018	0.002	-0.009	-0.011
INCOME	-0.008	-0.001	0.004	0.005
QC	0.107	0.007	-0.056	-0.058

Table A1-10 Marginal Effects of Fat and Cholesterol in food, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.072	0.000	0.047	0.025
AGE	0.003	0.000	-0.002	-0.001

Table A1-11 Marginal Effects of Water pollution by Agricultural chemicals, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.076	0.031	0.037	0.008
AGE	0.002	-0.001	-0.001	0.000
INCOME	-0.010	0.004	0.005	0.001
QC	0.233	-0.112	-0.101	-0.019

Table A1-12 Marginal Effects of Resistance to Herbicides & pesticides, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.127	0.046	0.065	0.016
AGE	0.004	-0.001	-0.002	0.000
PRAIRIE	-0.120	0.036	0.066	0.019
TUNIVER	0.078	-0.028	-0.040	-0.010

Table A1-13 Marginal Effects of Agricultural waste disposal, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.082	-0.013	0.046	0.049
AGE	0.004	0.001	-0.002	-0.002
QC	0.088	0.008	-0.049	-0.047
TFRIEND	0.096	0.004	-0.054	-0.046

Table A1-14 Marginal Effects of Soil erosion, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
*MALE	-0.048	-0.010	0.035	0.022
AGE	0.002	0.000	-0.002	-0.001
INCOME	-0.008	-0.002	0.006	0.004
QC	0.138	0.012	-0.098	-0.053
TUNIVER	0.041	0.009	-0.030	-0.019

Table A1-15 Marginal Effects of GM/GE (to increase production) Effect on environment, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.089	-0.023	0.057	0.055
INCOME	-0.009	-0.002	0.006	0.006
QC	0.117	0.017	-0.073	-0.061

Table A1-16 Marginal Effects of Adverse effects of Agriculture on Biodiversity, 2005 Survey Data

	High risk	Moderate risk	Slight risk	Almost no risk
MALE	-0.043	-0.011	0.035	0.019
UNIVER	0.073	0.013	-0.057	-0.029
INCOME	-0.013	-0.003	0.010	0.006
QC	0.106	0.016	-0.083	-0.040
TFRIEND	0.004	0.001	-0.003	-0.002

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