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Informational regulation of consumer health risks: an empirical evaluation of hazard warnings

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On the basis of data from a survey of almost 400 consumers, this article assesses whether consumer behavior is responsive to information about product hazards that is provided in response to regulation. We find that the extent to which consumers take precautions is consistent with the level of risk indicated, the amount of risk information, the specific risk and precaution indicated, and the economic benefits of safety precautions. We also use the patterns of precautionary behavior to analyze the implicit value of the morbidity effects and to assess the consistency of consumer choices. Our findings support the use of product-hazard information as an alternative to more direct regulation of safety risks.

1. Introduction

■ A principal basis for most health and safety risk regulation is that the individuals are believed to have imperfect knowledge of the risks they face and consequently cannot make sound decisions regarding whether to engage in hazardous activities. To overcome this problem the government has initiated a number of efforts to control health and safety hazards by placing direct constraints on the use or availability of hazardous materials.

In recent years, however, there has been increased emphasis on health and safety regulation with an informational character. In addition to the Environmental Protection Agency's long-standing program to label pesticides,[1] the Toxic Substances Control Act now permits the use of labelling programs to control the hazards from the use of toxic chemicals. To address the hazards posed by thousands of previously unregulated workplace carcinogens, the Occupational Safety and Health Administration (1983, p. 53280) has promulgated a

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[1] The difficult policy issues involved in pesticide regulation are detailed in Dorfman (1982).

major hazard communication policy (primarily chemical labelling and training). A number of other agencies have also adopted labelling as a regulatory alternative.[2]

To the extent that lack of information leads to excessive risk-taking, hazard-warning regulation addresses the problem directly without disturbing other beneficial features of the market. Users of a product with different susceptabilities to a particular hazard, different preferences toward risk, and different product needs and usage rates can select the combination of risk, product efficacy, and usage rates that reflects their particular needs. The informational strategy is often viewed as a stopgap measure until the health implications of a hazard are better understood. Thus hazard-warning regulation is more flexible than direct regulation where knowledge of risks is evolving over time. For example, where risks are not great enough to warrant a ban on a product, but are sufficiently disturbing to make ignoring the hazard unattractive, policymakers often adopt labelling as an intermediate course.

For the provision of hazard information to be a successful policy, however, individuals must be able to think systematically about risks and to make sound decisions under uncertainty. These assumptions have begun to be challenged with increasing frequency by economists,[3] because decisions under uncertainty are notoriously difficult to make.

Little evidence exists on the effects of providing information to consumers. Many informational campaigns have been educational efforts that have provided little new knowledge and have yielded disappointing results.[4] One empirical study by Viscusi and O'Connor (1984) suggests that individuals' processing of risk information does lead to rational economic behavior. They found that chemical labelling in the workplace affected workers' risk perceptions in the predicted fashion and led to the expected demands for compensating wage differentials. Although not investigated directly, these results also suggest that workers would take additional safety precautions in response to the provision of information about workplace hazards.

The linkage of precautionary actions taken to safety regulations has also been the focus of studies of the effects of direct safety regulations. This line of research began with the analysis of the effect of mandatory seatbelts on driver behavior by Peltzman (1975), and it remains controversial.[5] Just as wearing seatbelts may reduce the incentive to drive safely by reducing the activity's riskiness, an informational program may affect precautionary behavior through changes in the perception of risk. Consequently, the research results reported here are pertinent both to the debate over the degree to which safety precautions are governed by economic factors and to the more general issue of whether individuals make rational decisions under uncertainty.

Since existing data are inadequate to resolve these issues, we undertook a field experiment in which we presented consumers with products with different hazard-warning information. We then related the precautions that consumers said they would undertake to the presence and amount of risk information, as well as to their personal characteristics. Ideally, one would like to ascertain their final behavioral responses. Past studies suggest, however, that in carefully designed surveys closely linked to actual decisions, the hypothetical responses

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[2] The Federal Trade Commission has promulgated labelling regulations for products such as home insulation, textile wearing apparel, and used automobiles. The U.S. Department of Agriculture has long required the grading and labelling of fruit and meat. The Food and Drug Administration and the Consumer Product Safety Commission also have labelling programs. See Hadden (1985) for a comprehensive review.

[3] See, for example, by Arrow (1982) as well as the compendium by Kahneman, Slovic, and Tversky (1982).

[4] For a pessimistic view of consumer information policies, see Adler and Pittle (1984). Related articles include those by Mazis, Staelin, Beales, and Salop (1981) and Staelin (1978).

[5] See, in particular, the recent traffic safety studies by Blomquist (forthcoming) and by Crandall and Graham (1984).

parallel actual behavior.[6] Moreover, the nature of the research issues, including analysis of labels of purged hazard warnings, necessitates the use of such an approach. We describe the experiment in Section 2 and discuss the findings in Section 3. In Section 4 we explore possible shortcomings in consumers' information processing. Section 5 summarizes the results.

2. Experiment description and the sample

■ **Experimental design.** We selected two products for analysis, a liquid bleach and a liquid drain opener. The hypothetical drain opener product we examined was actually a hybrid between a conventional liquid drain opener and a granular opener containing 100% lye, which has more serious health implications. Household bleach is technically classified as a pesticide because of its biocidal properties. As a result, the labels for bleach products are governed by the regulations of the EPA Pesticides Office. Drain opener labels are not subject to similar rules, but this product has similar types of attributes to toxic chemicals that might potentially be regulated by EPA under the Toxic Substances Control Act.

Both bleach and drain opener pose substantial, short-term risks. The major risks associated with household bleach are twofold. First, individuals who drink bleach (typically children under the age of five) usually vomit and experience stomach aches for about a day. The pertinent precautionary action is to keep such products out of the reach of children, such as on a high shelf. The second risk is that of chloramine gas poisonings. If bleach is mixed with ammonia or ammonia-based products, chloramine gas forms and can lead to headaches, burning lungs and eyes, and possibly hospitalization for several days. Chloramine gas is the leading "involuntary" source of poisonings among adults.[7] This risk can be avoided by not mixing bleach with toilet bowl cleaners or other ammonia-based products.

The two main risks of drain opener also affect both children and the product users. Accidental ingestion, typically by children, leads to severe and painful burns to the mouth and throat, possibly including the loss of the esophagus. This health outcome was the most severe health effect analyzed in this study and is avoided by making the product inaccessible. Injuries from spilling the product on one's hand involve painful burns and red swollen blisters that heal in about a week. The recommended precaution is to wear rubber gloves.

For both products we placed professionally drafted labels on identical containers. The front label logo was identical for all bleach labels and for all drain opener labels. We called the product the "Vector" brand of cleaning agent. Because most consumers are familiar with the contents of bleach labels, we induced them to read the labels more carefully by designating the product as a new cleaning agent rather than a bleach. The drain opener was given the brand name "Unstop."

The product labels differed only in their hazard warning information. For each product all labels included the same information regarding the functions of the product and directions for use. In each case one label for the product included no hazard-warning information. For bleach we tested three other labels, while for drain opener we tested two other labels.

Those labels with warnings all apprised consumers of the pertinent hazards associated with the product. They differed in terms of the degree of informational content, however.

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[6] Magat, Payne, and Brucato (forthcoming) directly address this issue and summarize the literature. Lichtenstein and Slovic (1973) analyze the close similarities between hypothetical and actual decisions in gambling behavior. In a study of chemical labelling in the workplace, Viscusi and O'Connor (1984) found that the compensating differential results and quit intention behavior in a similarly designed study of worker behavior closely parallel the findings using existing sets of survey data.

[7] The more prominent poisoning causes among adults involve drug overdoses, suicides, and intentional poisonings.

As the summary in Table 1 indicates, the fraction of the label devoted to risk information varied considerably, reaching as high as 78% for a label modelled after the existing labels for Drano and Red Devil Lye (hereafter called the Drano label). Most of these differences pertained to the size of the type used and the degree of repetition of the warning throughout the label. A second critical aspect of informational content is the label format used.[8] The bleach labels patterned after Clorox brand bleach and the Kroger grocery chain's house brand Bright bleach were of standard format, but the Bright label placed the risk information more prominently. The Drano label likewise gave the risk information prominence.

Because of the potential importance of label formats, we asked three labelling experts to design ideal labels for the products and designated them the "Test" labels.[9] The Test labels organized all of the usage information systematically on the top and bottom of the labels. The risks were listed in the middle of the labels, as well as summarized by symbols on the top of the labels. Precautions were listed to the right of the risks and explicitly linked to the risks that they avoid. The new format was structured to improve the label's effectiveness regarding all product uses, not just those that were safety-related.

Each consumer in the sample examined only one of the product labels and was then interviewed regarding his perspective use pattern. We informed subjects that they were participating in a marketing study, rather than an examination of risk-related issues. A marketing research firm administered the questionnaire, and most of the questions in the survey were not related to risk, but to other product attributes. For example, only three of the seven bleach usage questions were risk-related. The majority dealt with issues such as whether the product would be used to remove mildew. In addition, consumers were not asked directly whether the product would be stored in a childproof location, but instead the interviewer ascertained the storage location and probed regarding the access children might have to the location. The questionnaire was specifically designed to diminish the potential response bias.

TABLE 1 Summary of Products and Label Characteristics

Label	Percentage of Risk Information (*WARNAREA*)	Label Format
Bleach		
No Warning	0	Standard
Clorox	31	Standard
Bright	41	Standard, but More Prominent Risk Information
Test	69	Formatted to Highlight Uses, Risks, and Precautions
Drain Opener		
No Warning	0	Standard
Drano	78	Standard
Test	63	Formatted to Highlight Uses, Risks, and Precautions

[8] The instrumental role of format effects is analyzed in Bettman and Kakkar (1977) and Magat, Payne, and Brucato (forthcoming).

[9] This effort is detailed in Bettman, Payne, and Staelin (1986) and Bettman, Payne, and Staelin (forthcoming). Their academic areas of expertise are in marketing and psychological risk analysis, particularly in the consumer information processing field.

TABLE 2 Sample Characteristics

Variable	Sample Mean (Std. Dev.)	U.S. Population Mean
Household Income ($/year)	30,828 (17,932)	28,557
Education (years)	13.3 (2.2)	12.5
Age (years)	33.1 (12.8)	30.0
Married (1 = yes, 0 = no)	.57 (.50)	.64
Male (1 = yes, 0 = no)	.32 (.43)	.47
Black (1 = yes, 0 = no)	.26 (.40)	.12
Five (number of children under 5)	.23 (.51)	.29
Sample Size	368	N/A

Source: Bureau of the Census, *Statistical Abstract of the United States*, U.S. Department of Commerce (1985) (1983 data, with family income adjusted to 1984 $).

□ **Sample description.** The sample consisted of 368 consumers interviewed in June, 1984, at a Greensboro, N.C., shopping center. We screened participants in the survey on the basis of whether they used household cleaning products to avoid including in the sample individuals who would never purchase such products. The subjects were drawn from a broad socioeconomic group and included a fairly representative sample of the Greensboro, N.C., population. The sample is summarized in Table 2. The sample means closely match the U.S. population means, and the differences are consistent with the likely differences between the U.S. population and the population of product users. To the extent that one wished to extrapolate the results of the experiment to other population groups, the personal characteristic variables can be used to control for these factors. Very few strong influences of a demographic nature were apparent, however.

The survey results we describe below were dominated by the influence of the experimental treatments. This result is not unexpected. We randomly assigned the labels for each product to different consumers, with 200 receiving bleach labels and 168 receiving the drain opener labels. Because of this randomization, we eliminated much of the need for detailed control variables that is present in most econometric studies since consumers do not choose their product labels. If there is a random mix of consumers in each labelling group, the differences in the fraction of consumers undertaking precautions for each label will provide the principal test of the impact of labels.

3. The effect of labels on precaution-taking

■ **Mean effects.** Since the principal economic hypotheses we investigate are fairly straightforward, we shall discuss the expected effects in conjunction with our review of the experimental results.[10] Table 3 summarizes the effects of the four bleach labels on the key pre-

[10] The seminal seatbelt model that gave rise to such analysis was developed by Peltzman (1975). Also see Crandall and Graham (1984) and Blomquist (forthcoming).

TABLE 3 Effects of Labels on Precautions for Bleach

Precautions	Fraction Taking Precaution Label Format				Maximum Incremental Effect of Labels
	No Warning	Clorox	Bright	Test	
(1) Do not mix with toilet bowl cleaner (if toilet is badly stained).	.17	.23	.32	.40	.23
(2) Do not add to ammonia-based cleaners (for particularly dirty jobs).	.69	.69	.67	.86	.17
(3) Store in childproof location.	.43	.64	.51	.76	.33

cautions. Note that the precautions necessary to avoid one of the risks, that of chloramine gassings from mixing bleach with ammonia-based products, are measured through two separate questions (numbers (1) and (2) in the table). In addition, the chloramine gas precautions were related to conditional behavior for unusual circumstances (badly stained toilets and particularly dirty jobs) so that these results are conditional on particular cleaning situations' arising. The extent of misuse in practice may be understated by the fraction of consumers who indicate potential misuse in the questionnaire if these contingencies do not always arise. The four label formats were those involving no hazard warnings, the Clorox label, the Bright label, and the Test label.

Despite our efforts to restrict the role of prior consumer knowledge by calling the product a cleaning agent rather than a bleach, it is clear that there was some influence on behavior of consumer familiarity with similar cleaning products. In particular, even in the presence of no hazard warning, 17% of all subjects would not mix the cleaning agent with toilet bowl cleaner, 69% would not mix it with ammonia-based cleaners, and 43% would store it in a childproof location. The toilet bowl cleaner mix and the ammonia-based cleaner mix responses may include, in part, consumers who do not envision the need for ever mixing the product in that fashion, rather than those reluctant to mix the products for safety-related reasons. In contrast, the storage in a childproof location response presumably would reflect this prior knowledge of the risk to a greater extent. Insofar as existing labels have contributed to this knowledge base, the results that we obtain understate the incremental effect of labels in situations in which consumers have never read similar labels.

For all the bleach precautions the Test label is associated with the greatest propensity to take precautions. The Clorox and Bright labels have modest effects on the chloramine gas risks from mixing bleach with toilet bowl cleaner, and the Test label more than doubles the fraction of subjects who would undertake this precaution.[11] Nevertheless, in this case more than half of the subjects say they would not undertake the precaution in spite of the warning on the Test label. This last result does not imply that with the Test label 60% of the consumers would actually misuse the product. The original question was conditional in that it dealt with use of the cleaning agents for "badly stained" toilets. If this contingency did not arise, the potential misuse might not occur either.

Consumers appear to be much less likely to mix the cleaning agent with ammonia-based cleaners other than toilet bowl cleaners. But the two labels now used to alert consumers to the chloramine gas dangers of undertaking such a mixture have no apparent beneficial effect compared with the no-warning situation. The only label that shows any impact whatsoever is the Test label, which increases the fraction of subjects who would not add the

[11] Only the Test and Bright fractions are statistically different from the no-warning fraction at a 95% confidence level.

product to ammonia-based cleaners by a statistically significant 17%. This brings to over four-fifths the fraction of subjects who would not undertake such a mixture.

All three labels with risk information increase the percentage of subjects who say they plan to store the bleach in a childproof location, although the Bright label was not significant at traditional confidence levels. The Test label was most effective, as it increased the childproof storage propensity by 33% over that with the label containing no warnings. The Test label created an awareness of the key risks among over one-tenth of the subjects who would not otherwise have been affected with existing labels. To the extent that consumer responses to the new information format on the Test label would be enhanced by longer-term familiarity with its new format, these results understate the label's eventual effectiveness.

The necessary precautions for avoiding the risks of drain openers appear to be well known to consumers, even in the absence of a warning on the label. From Table 4 the majority of the subjects (64%) would wear gloves even in the absence of the warning and would also store the product in a childproof location (57%). The more frequent storage in a childproof location for drain opener than for bleach in the absence of a hazard-warning suggests that there is no simple uniform response to the childproofing warning on the part of consumers independent of the product. Rather, the prior knowledge of the greater severity of the health impact of child poisonings from drain opener rather than from bleach accounts for the difference. This result accords with our expectations, since the optimal safety effort increases with the size of the loss.

As for bleach, with drain openers there was evidence of differential performance of the labels that included risk information. The Drano label increased the propensity to undertake such precautions by 19% in the case of wearing rubber gloves and by 11% in the case of storage in a childproof location. In contrast, the Test label had roughly half this effectiveness, and differed from the label with no risk warning by statistically insignificant amounts.

There clearly is a consistent differential impact of labels on precautionary behavior. For both products examined labels including risk information generally led to an increase in safety precautions compared with labels purged of risk warnings. There were some differences among the labels, and we shall further explore these below. In addition, labels do not lead all consumers to take precautions, as one would also expect if there is heterogeneity in the benefits or costs of taking precautions.

□ **Variations in precautionary behavior.** The results in Tables 3 and 4 provide an unbiased measure of the incremental effects of the labels since the experiment was undertaken in a randomized manner. This randomization serves to distribute individuals with different attributes across the labelling treatments so that with perfect randomization and a sufficiently large sample it would not be necessary to perform a multivariate analysis to distinguish the effect of labels. Such an analysis is instructive, however, to identify whether variables other than labelling format influence the propensity to take precautions. Moreover, to the extent that the limited sample was not large enough to ensure sufficient randomization, this procedure will result in smaller mean error than the unadjusted analysis.

TABLE 4 Effects of Labels on Precautions for Drain Opener

Precautions	Fraction Taking Action by Label Format			Maximum Incremental Effect of Labels
	No Warning	Drano	Test	
(1) Wear rubber gloves.	.63	.82	.73	.19
(2) Store in childproof location.	.57	.68	.62	.11

Variables associated with a lower disutility of effort, greater losses from an accident, or higher relative risk of an accident should lead to more frequent precautionary behavior. We examined the relationship between precaution-taking and seven demographic variables—the respondent's age (*AGE*), sex (*MALE* = 1 if respondent is male), race (*BLACK* = 1 if the respondent is black), marital status (*MARRY* = 1 if the respondent is married), years of schooling (*EDUC*), family income (*INCOME*), and the number of children in the high-risk poisoning group—children under five years of age (*FIVE*).

On average, female users are probably more likely to take precautions, such as wearing gloves, because to the extent that they wear rubber gloves regularly, the inconvenience, or disutility costs of doing so for drain cleaner are less. The influence of household wealth is captured by several variables: *BLACK*, *AGE*, *INCOME*, and *EDUC*. Because of the positive income elasticity of demand for health, the magnitude of any health loss is greater for wealthier consumers. As a result, more affluent consumers are more likely to take precautions. The cost associated with precautions, however, may be greater for richer consumers, particularly if the precautions involve time allocations, which will impose a greater opportunity cost on this group. The net effect of wealth is thus unclear theoretically.

Perhaps the variables whose influences are most clear-cut are *MARRY* and *FIVE*. Households with children under the age of five and, possibly, households where the product user is married will be more likely to have children exposed to the hazardous products (i.e., the household's relative risk of an accident is higher) and consequently will have a greater incentive to take care.

The labelling impacts were captured with three label dummy variables (*CLOROX*, *BRIGHT*, and *TEST*), where the no-warning label variable is omitted. We also explored an interactive effect of the labels with *EDUC* to ascertain whether only better-educated consumers were influenced by the risk information, but these results are not reported since no significant influences were observed.

Because of the discrete nature of the dependent variable, which indicated whether the respondent would take a particular type of precaution, we used a logit procedure to estimate the probability of taking precautions. The maximum likelihood estimates appear in Table 5 for each of the risk-related actions for bleach.

The effects follow the same general pattern as the percentages in Table 3. The propensity to avoid mixing bleach with toilet bowl cleaner is increased most by the Test label, with the Bright label ranking next in effectiveness. The Clorox coefficient is not statistically significant at the usual levels, and is much smaller in magnitude. The only label with a substantial positive effect on the propensity to add bleach to ammonia-based cleaners is the Test label, but the asymptotic standard error on this coefficient is quite large. The labelling results are strongest for storage in a childproof location. The Test label boosts this precaution dramatically, and there is a substantial effect of the Clorox label as well. Overall, the close parallels between the multivariate results in Table 5 and the means in Table 3 suggest that the randomization procedure was effective.

We expected that the presence of the variable *FIVE* would increase the likelihood of storing the product in a childproof location, because households with children in this age group are a higher-risk group. As expected, this variable has a significant positive sign. Indeed, the presence of a child under the age of five has a greater incremental effect on precautions than does the Test warning label (see equation (3) in Table 5).

The other personal characteristic variables were not particularly influential and, to the extent that there were significant effects, they only arose in isolated cases. For example, the only significant impact of household income is one negative coefficient, which is consistent with the role of higher costs of precautions for more affluent consumers outweighing the influence of the positive income elasticity of demand for health. Higher-income consumers are more likely to add bleach to ammonia-bleach cleaners, possibly because they are more

TABLE 5 Maximum Likelihood Estimates of Precaution Probability Equations for Bleach

Independent Variables	Coefficients (Asymptotic Standard Errors) (1) Do not mix with toilet bowl cleaner.	(2) Do not add to ammonia-based cleaners.	(3) Store in childproof location.
INTERCEPT	−2.468	−.901	−.709
	(1.271)	(1.240)	(1.155)
AGE	−.005	.012	.012
	(.015)	(.015)	(.013)
MALE	−.410	−.104	.554
	(.418)	(.391)	(.337)
BLACK	−1.252	−.521	.087
	(.545)	(.426)	(.422)
MARRY	−.248	.560	−.328
	(.369)	(.362)	(.352)
EDUC	.112	.141	−.042
	(.086)	(.087)	(.079)
INCOME	-6.2×10^{-6}	-2.2×10^{-5}	4.8×10^{-6}
	(13.6×10^{-6})	(1.2×10^{-5})	(11.8×10^{-6})
FIVE	—	—	1.707
	—	—	(.480)
CLOROX	.686	.020	.975
	(.530)	(.431)	(.417)
BRIGHT	1.151	−.104	.452
	(.543)	(.482)	(.463)
TEST	1.446	.809	1.556
	(.530)	(.529)	(.477)
−2 Log Likelihood	211.8	219.5	237.2

likely to own a variety of cleaning products. Black consumers were more likely to mix bleach with toilet bowl cleaners, but no other coefficients were significant (at the 5% level).

The multivariate logit equations for the precautions with drain opener, which appear in Table 6, reveal similar patterns of influences. Once again, the labelling format effects are the dominant influence, with the Drano label's being more effective than the Test label. The greatest relative difference between these two formats is for the precaution to wear gloves; location precaution differences are much narrower, as they differ by under one-half of the estimated standard errors of the coefficients.

As in the case of the bleach results, most of the demographic variables were not significant. No income effects were observed, and the only demographic influences other than *FIVE* that were statistically significant were that males and blacks were less likely to wear gloves. This may be a result of the preponderance of marketing efforts for rubber gloves directed at white females.

The demographic variable of greatest interest is *FIVE*. Once again, respondents with children under the age of five are more likely to store the product in a childproof location. Since this group is the high-risk population for poisonings, the higher responsiveness of this group to the product risk accords with expected economic behavior.

The degree to which the labels with hazard warnings succeed in generating a precautionary response among such consumers is reflected in Table 7. Without any hazard warning on the label, over two-thirds of all parents with children below five years old would take

TABLE 6 **Maximum Likelihood Estimates of Precaution Probability Equations for Drain Opener**

Independent Variables	Coefficients (Asymptotic Standard Errors) (1) Wear rubber gloves.	(2) Store in childproof location.
INTERCEPT	−.137	−1.467
	(1.285)	(1.211)
AGE	.014	.014
	(.016)	(.014)
MALE	−.882	—
	(.428)	—
BLACK	−.995	−.220
	(.434)	(.409)
MARRY	.222	.502
	(.402)	(.390)
EDUC	−.012	.045
	(.086)	(.080)
INCOME	1.6E-5	1.7E-6
	(1.5E-5)	12.2E-6)
FIVE	—	1.060
	—	(.473)
DRANO	1.558	.837
	(.470)	(.417)
TEST	.948	.659
	(.453)	(.435)
−2 Log Likelihood	176.4	199.9

precautions when using both products, as compared with under half for those without children in this age bracket. After being given the hazard warning, on average about 91% of parents said they would take this precaution.

This substantial effectiveness of the hazard warning on the targeted population accords with the predicted behavior, but the failure of the drain opener warning to produce greater precautionary behavior than the bleach warning does not. Drain opener poses more severe losses due to child poisoning than does bleach. Thus, if the disutility of precautions is similar, the degree of precaution-taking should be greater for the drain opener than for the bleach. Also, if the disutility of the two precautions is similar, but the drain opener causes greater losses, the incremental effect of the hazard label for any given initial level of precautions should be greater for drain opener.

TABLE 7 **Family Composition and Childproof Precautions**

Label Format	Percentage Taking Precautions to Childproof: Have Children Under 5	Do Not Have Children Under 5
Bleach		
No Warning	67	37
Bright	100	40
Clorox	91	57
Test	92	70
Drain Opener		
No Warning	70	48
Drano	90	63
Test	83	61

There are two possible explanations for the greater effectiveness of the bleach labels than of the drain opener labels. The first centers on the information content of the two sets of labels with respect to the childproofing precaution. The risk to children was featured prominently on the bleach label, including a section on the front of the label, whereas the drain opener label listed child poisoning as one of many hazards from this more severe poison. The amount of hazard warning information specifically related to child poisonings was greater and featured more prominently on the bleach labels. For both products it is likely that consumers underestimated the risks before reading the labels. Thus, the greater informational content pertaining to child poisonings of the bleach label could have outweighed the loss effect and led to a somewhat larger effect than the drain cleaner label, where the implied risk (i.e., loss from the accident) was greater, but the informational content was less.

The second explanation is based on the different amount of learning about the dangers of child poisoning that the two sets of labels induced. If consumers initially had a higher assessment of the hazards to children from drain opener than bleach, then the bleach labels would have caused a larger revision in their priors that would have led to a greater increase in precautionary effort if this learning effect dominated the loss effect.

□ **Role of informational content.** The importance of the amount of informational content of the label is further supported by an econometric analysis that replaces the label dummy variables with a variable that captures the amount of risk information provided. The *WARNAREA* variable (see Table 1), which is the fraction of the label devoted to hazard warnings, reflects this difference in informational content. Since *WARNAREA* is a weighted average of the labelling format dummy variables, it is not feasible to include both in the same equation.

The general character of the results in Table 8 parallels that for the label dummy variables. The probability that the consumer takes precautions increases in all cases as the value of *WARNAREA* rises. If consumers of the two products generally underestimate the associated risks, more risk information induces them to take more precautionary effort. Only for the precaution to avoid mixing bleach with ammonia-based cleaners is the effect not statistically significant (at the 5% level).

Although it is likely that all of the hazard warning information provided will influence consumers' risk perceptions at least to some extent, one would expect information specifically targeted to a particular precaution to be most influential. To analyze this possibility, we

TABLE 8 ***WARNAREA* Effects on Precautions-Taking***

Precautions	*WARNAREA* Coefficients (Asymptotic Standard Errors)	*SPECWARN* Coefficients (Asymptotic Standard Errors)
Bleach		
Do not mix with toilet bowl cleaner.	.021	.695
	(.007)	(.254)
Do not add to ammonia-based cleaners.	.010	.053
	(.007)	(.031)
Store in childproof location.	.020	.056
	(.006)	(.020)
Drain Opener		
Wear rubber gloves.	.018	.017
	(.005)	(.015)
Store in childproof location.	.011	.034
	(.005)	(.016)

* Other variables included in the equation were the same as in Table 4a and 4b except that the labelling dummy variables were excluded. The *WARNAREA* and *SPECWARN* estimates were obtained by using separate equations.

developed a variable *SPECWARN*, which is the fraction of the labelling area devoted to each of the specific precautions. The *SPECWARN* variable is statistically significant in four of five cases, and in all instances either *WARNAREA* or *SPECWARN* has a statistically significant effect on precautions.

The magnitude of the effects also accords with the theoretical predictions. Providing additional specific precautionary information should have greater informational content with respect to that precaution than an equivalent amount of label area for general hazard warnings. The magnitudes of the *SPECWARN* coefficients consequently should be greater than the magnitudes of the *WARNAREA* coefficients.[12] This relative impact is reflected in four of the five coefficients in Table 8 that are greater than the *WARNAREA* coefficients. The relative discrepancy in the impacts is greatest for the bleach precautions relating to mixing the product with toilet bowl cleaner or ammonia-based cleaners. Unlike precautions, such as the need to store the product outside the reach of children, the precautions relating to the risk of chloramine gas poisoning are particularly difficult to infer from any general hazard warnings. The substantial differential impact consequently accords with expectations.

It is also instructive to compare the precaution that was common to both labels (i.e., storing in a childproof location). The *WARNAREA* and *SPECWARN* coefficients for childproofing in the bleach equations are almost double those for drain opener. These results are consistent with the earlier findings. Although the child-poisoning risk from drain opener is more severe and should create a larger impact, this influence is mitigated by differences in format. The prominence of the child-poisoning warning is not so great on the drain opener label, which treats child poisonings as one of many hazards. In contrast, the bleach label emphasizes this particular warning. Overall, the results presented here and earlier are consistent with the hypothesis that precautionary behavior will be influenced by the provision of risk information, the amount of hazard information given, and the format used to convey the information.

4. Value of precautionary actions

■ Rational consumers undertake safety precautions only if the expected value of the safety gains exceeds the associated disutility of the precautionary actions. Our survey included questions pertaining to this disutility so that, in conjunction with assumptions about the associated risk, we can calculate the critical value of the health outcome that is required to lead consumers to undertake each particular precaution.

Faced with a binary choice of whether to take precautions, consumers choose to exercise care if the associated disutility V is below the value of the risk reduction, which is the product of the change in the risk Δp associated with precautions and the value of the health loss L. For all consumers for whom L exceeds $-V/\Delta p$, precautions are desirable. We cannot make a calculation of this type on an individual basis, but we can derive suggestive results for individuals who face the average risk in the population.

Our survey included questions regarding consumers' willingness to pay per bottle for a variety of product characteristics ranging from a fresh lemon scent to attributes that relate to the disutility of taking precautions, such as the need to wear gloves when using the product. Special care was taken to avoid biasing the subjects' responses about their disutility of taking precautions with consideration of the risk reductions achieved by those precautions.

Column (2) in Table 9 reports the sample mean willingness to pay per bottle to avoid the need for taking each of the precautionary actions, where the amounts are the increases in current price ($.79 for bleach and $1.79 for drain opener) consumers would pay to be free of the need to take these actions. The product price increases ranged from $.15 to $.19

[12] The differences in all three bleach precautions coefficients are significant at the 5% level, with the drain-opener childproofing coefficients significantly different at the 10% level.

TABLE 9 Summary of Precautions-Related Decision Components

(1) Precautions	(2) Mean Disutility of Precaution in Dollars per Bottle (Std. Dev.)	(3) Mean Number of Containers Used Annually	(4) Nature of Risk	(5) Annual Household Risk without Precautions	(6) Critical Benefits Value ($)
Bleach					
Do not mix bleach with ammonia-based products or toilet bowl cleaner.	.19 (.46)	12.2	Chloramine Gas Poisoning	.000058	37,900
Store bleach to prevent access to children.	.16 (.46)	12.2	Nausea and Stomach Cramps for One Day	.000061	32,000
Drain Opener					
Wear gloves to prevent drain opener hand burns.	.17 (.34)	1.78	Temporary Hand Burns	.000061	5,200
Store drain opener to prevent access by children.	.15 (.33)	1.78	Very Severe Internal Burns, Possibly Irreversible	.000041	6,500

per bottle.[13] To complete the calculation of the precaution's associated annual disutility, one multiplies the disutility per bottle by the number of bottles used per year—a figure that was also obtained in the survey.

The next two columns list the nature of the injury associated with each precaution and the average household risk that will prevail if the consumer does not take precautions. We calculated this risk figure by using information on total poisonings (from the National Clearinghouse for Poison Control Centers and Consumer Product Safety Commission), coupled with information about the fraction of consumers who took precautions with current labels. We assumed that taking precautions would reduce the risk to zero. The incremental risk reduction achieved in each case is rather small, as all of these annual household risks are below 1/10,000.

The final column in Table 9 reports the critical valuation of the health outcome that would be needed for consumers to find it economically desirable to take precautions. Assuming the average figures for risk and disutility characterize all consumers, individuals who take precautions have valuations above the critical amount, and those who do not take precautions have health loss valuations below the critical amount. For the bleach risks precautions are desirable if the value of avoiding a chloramine gas poisoning is at least $37,900 and the child poisoning valuation is more than $32,000. These values are sufficiently high in view of the generally temporary nature of the ailments that one could easily envision consumers who would rationally choose not to take these precautions.

The critical valuations for the drain-opener health outcomes are lower, largely because fewer bottles of this product are used annually. If consumers value avoiding hand burns by at least $5,200 and child poisonings by at least $6,500, precautions are desirable. The hand-burn valuations of consumers may be in excess or below this amount, so some mix of responses is to be expected in this case.

[13] This fairly narrow range in valuations may falsely suggest that consumers did not attempt to distinguish their underlying preferences, but instead gave uniform responses of $.10 or $.20 to all questions. The valuations any consumer expressed for different product characteristics were not strongly correlated, and there was considerably more variation when the other product attributes included in the survey (such as using the cap as a measure) are considered. As a result, there is no evidence that consumers gave uniform responses to all product attribute questions.

What is most striking is that for the drain opener poisoning risk to children, which is by far the most severe outcome, the critical value of the loss that is needed before precautions are desirable is almost the lowest in the table. One would expect consumers to undertake the associated precaution most often in this case. No such dramatic difference was observed, and in many cases other precautionary warnings were more effective. Indeed, after reading labels with the hazard warning, more households with children under five would store bleach in a childproof location than they would drain opener (Table 7).

This result reinforces the earlier findings regarding the childproof warnings on the drain opener labels. By failing to communicate the need for precautions in a prominent fashion, the drain opener labels led consumers to take actions that clearly are not plausible in view of the desirability of the precaution and the relative merits of exercising care when compared with the other precautionary actions. Although the overall nature of the behavioral responses is consistent with rational behavior, fully optimal results clearly were not achieved. This difficulty seems largely attributable to the character of informational transfer, but shortcomings in individual decisionmaking capabilities cannot be ruled out as a contributing factor.

□ **Other effects of label information.** If labels are unduly alarmist, they might affect consumers' incentives to undertake other forms of precautionary behavior. To test for this possibility, we included in the questionnaire other questions about the proper use of the product. For bleach these questions were not risk-related, but for drain opener they were. Here we shall summarize the principal results, which are reported in greater detail elsewhere (Viscusi and Magat, forthcoming).

Two fundamental uses of bleach are to remove mildew and to use in a wash for problem stains. These uses were printed on all four bleach product labels, and there was no difference in the effect of the labels on these actions.

The label with no warning and the Clorox label specifically indicated that the cleaning product could be used to clean dirty sinks and to clean floors, whereas the Bright and Test labels did not include this usage message. Consumers were significantly less likely to undertake such uses of the product in the case of the Bright and Test labels, which suggests that the usage information was processed reliably and was not distorted by the hazard warnings.

All of the drain opener labels, including that with no warning, advised against pouring the product through standing water, and there was no differential effectiveness of the labels observed. Similar results were found with respect to whether the consumer believed that the product could be used with a septic tank. This also was an unexpected result, since there is no reason to avoid such usage. Finally, the Drano and Test label advised against the use of a plunger with the drain opener, but the additional precautions were not statistically significant. This precaution was of subsidiary importance both in terms of the label and consumer practices since few consumers envisioned the use of a plunger and thus limited the potential labelling effect.

Overall, the evidence suggests that the diverse information contained on the label was processed reliably. Moreover, there is no clear-cut evidence of any distorting influence of labels on other usage decisions.

5. Conclusions

■ Although information provision policies have considerable appeal on conceptual grounds, their efficacy has long been questioned. Regulatory policies based on information have typically been undertaken in situations in which individual decisions are not believed to be fully rational because of failure to understand fully the risks associated with different actions. Although imperfect knowledge can potentially be addressed through informational policies, if consumers do not process risk information reliably, these policies will not be effective. Moreover, if decisions involving low-probability events do not display individual rationality, informational policies also may not remedy these difficulties.

The experimental results presented here provide a more optimistic view of the potential efficacy of informational approaches. Consumers responded in a manner that was broadly consistent with the main predictions of an economic model of rational behavior. Households facing particularly large risks were more likely to undertake protective actions, and differences in the information provided produced the expected effects.

The overall efficacy of informational approaches will be governed not only by the level of the risk conveyed, but also by the informational content of that message. Many educational campaigns may have exhibited disappointing results because their informational content was low. In this study some widely used chemical labels likewise had negligible effects because they did not provide risk information in an effective manner, in marked contrast to the responsiveness of consumers to better designed labels.

Labels will not lead all consumers to take precautions because for some the disutility of taking the precautions outweighs the value of the benefits of reduced risk. In the case of drain opener storage to prevent access by children, it was clear that precautions either fell short of an optimal amount or else that consumers overreacted to the less severe risks on other labels.

The most that we can conclude at this point is that information can produce precautionary behavior consistent with the most salient predictions of rational economic actions. No convenient test of full rationality with imperfect information is available, however. Although perhaps not ideal, informational alternatives do appear to be sufficiently promising to warrant further scrutiny as an alternative to more direct regulatory approaches.

References

ADLER, R. AND PITTLE, D. "Cajolery or Command: Are Education Campaigns an Adequate Substitute for Regulation?" *Yale Journal on Regulation,* Vol. 1 (1984), pp. 159–194.

ARROW, K.J. "Risk Perception in Psychology and Economics." *Economic Inquiry,* Vol. 20 (1982), pp. 1–9.

BETTMAN, J. AND KAKKAR, P. "Effects of Information Presentation Format on Consumer Information Acquisition Strategies." *Journal of Consumer Research,* Vol. 3 (1977), pp. 233–240.

———, PAYNE, J.W., AND STAELIN, R. "Cognitive Considerations in Designing Effective Labels for Presenting Risk Information." *Journal of Public Policy and Marketing.* Vol. 5 (1986), pp. 1–28.

———, ———, AND ———. "Cognitive Considerations in Presenting Risk Information" in W.K. Viscusi and W.A. Magat, eds., *Learning about Risk: Consumer and Worker Responses to Hazard Information,* Cambridge: Harvard University Press, forthcoming.

BLOMQUIST, G. *Traffic Safety Regulation by NHTSA.* Washington, D.C.: American Enterprise Institute, forthcoming.

CRANDALL, R. AND GRAHAM, J. "Automobile Safety Regulation and Offsetting Behavior: Some New Empirical Estimates." *American Economic Review,* Vol. 74 (1984), pp. 328–331.

DORFMAN, R. "The Lessons of Pesticide Regulation" in W.A. Magat, ed., *Reform of Environmental Regulation,* Cambridge: Ballinger Publishing Co., 1982.

HADDEN, S. *Read the Label: Reducing Risk by Providing Information.* St. Paul, Mn.: Westview Publishing Co., 1985.

KAHNEMAN, D., SLOVIC, P., AND TVERSKY, A., EDS. *Judgement under Uncertainty: Heuristics and Biases.* Cambridge: Cambridge University Press, 1982.

LICHTENSTEIN, S. AND SLOVIC, P. "Response-Induced Reversals of Preferences in Gambling: An Extended Replication in Las Vegas." *Journal of Experimental Psychology,* Vol. 101 (1973), pp. 16–20.

MAGAT, W.A., PAYNE, J.W., AND BRUCATO, P., JR. "How Important Is Information Format? An Experimental Study of Home Energy Audit Programs." *Journal of Policy Analysis and Management* (forthcoming).

MAZIS, M., STAELIN, R., BEALES, H., AND SALOP, S. "A Framework for Evaluating Consumer Information Regulation." *Journal of Marketing,* Vol. 45 (1981), pp. 11–21.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION. "OSHA Final Standard 'Hazard Communication'." *Federal Register,* Vol. 48, Issue 228, November 25, 1983, p. 53280.

PELTZMAN, S. "The Effects of Automobile Safety Regulation." *Journal of Political Economy,* Vol. 83 (1975), pp. 677–725.

STAELIN, R. "The Effects of Consumer Education on Consumer Product Safety Behavior." *Journal of Consumer Research,* Vol. 5 (1978).

VISCUSI, W.K. AND O'CONNOR, C. "Adaptive Responses to Chemical Labelling: Are Workers Bayesian Decision Makers?" *American Economic Review,* Vol. 74 (1984), pp. 942–956.

——— AND MAGAT, W.A. *Learning about Risk: Consumer and Worker Responses to Hazard Information.* Cambridge: Harvard University Press, forthcoming.