

An Online Survey Experiment on Ambiguity and Privacy (*)

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Abstract: We provide three related approaches to better understand the connections between the literatures on the value of privacy, and economic decision-making. In particular, we consider economic scenarios where individuals lack important information about facets of a privacy choice and where the relevant outcomes of a choice are non-deterministic. We begin by highlighting the reasons why a lack of information by at least one party of a transaction is central to many privacy situations. We further comment on the foundations of the terms uncertainty, risk, and ambiguity and their relationship to privacy research. Next, to provide a practical example, we dissect the terms of a real-world sweepstakes solicitation to highlight the layers of complexity inherent in this specific offer, and other scenarios that involve collection and use of personal data. Finally, we provide evidence from an online survey experiment showing how an individual's valuation of a marketer's offer that is imprecise about material privacy terms of the bargain can be manipulated through simple reframing as a discount. In these scenarios, we study the valuation for thirteen different categories of sensitive personal information such as health information. We observe significant treatment differences between the original and the reframed offer that are mainly driven by the gender of the participants.

Key words: privacy, ambiguity, valuation of personal information, survey experiment

The lack of information an individual has about a privacy choice is important for at least two reasons. The first reason is central to the very concept of privacy. An individual has some control on the level of primary access that other entities can gain on her personal information. Other people will thus rely on an incomplete representation of facts when interacting with this individual. This is the interpretation of privacy as

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concealment (of job-relevant skills, valuation for a product, creditworthiness, etc.) that POSNER (1978) and many subsequent formal economic models have recognized.

Secondly, a lack of information may adversely affect the individual herself. For example, VARIAN (1996) noted that an individual has little or no control over the secondary use of her personal information, and hence may be subject to externalities whenever other parties transact her personal data. Recent research has shown that consumers falsely believe that control over the release or publication of information also translates into control over the use of such information by marketers (BRANDIMARTE *et al.*, forthcoming). A current example of this scenario are the data sharing arrangements between social networks and third parties (e.g., in the form of data access by marketers via third-party applications to users' profiles, as discussed in WANG *et al.*, 2011).

This second sense in which the lack of information introduces decision making complexity to privacy is, therefore, not new in the economic or legal literature on privacy. Further, different researcher teams are continuously adding formal or empirical analyses on various aspects of privacy decision making (BRANDIMARTE & ACQUISTI, 2012).

In this paper, we complement this research from three different perspectives.

- We begin by discussing important concepts from the economics literature that discuss methodologies to account for the lack of information in decision-making situations with non-deterministic payoffs. In particular, we address the applicability of research on uncertainty, risk, and ambiguity to work on privacy.

- To provide a practical example, we dissect the terms of a real-world sweepstakes solicitation. The layers of complexity and partially-revealed marketing practices inherent in this specific offer are also relevant for many other scenarios involving collection and use of personal data.

- We provide evidence from an online survey experiment in which a marketer's offer that is imprecise about material terms of the bargain (and may cause privacy-related consequences) is reframed as a discount. We show how an individual's valuation of the offer is impacted by this manipulation.

The goal of this paper is to provide consumers and policy makers with relevant previous research and experimental data about a still

underappreciated factor at the heart of many privacy decision-making situations. That is, the complex nature of the 'privacy good' prevents consumer protection agencies and consumer-friendly businesses from fully describing the consequences of a privacy choice. Moreover, marketing professionals are likely designing their offers so that they already take advantage of related weaknesses in human decision making. A variety of measures have been proposed to address these problems. For example, we have witnessed diverse approaches to improve notice and consent practices by providing meaningful information, with better formatting, and more effective timing (CATE, 2006; GOOD *et al.*, 2007). However, the stubborn refusal of privacy consequences to be pinned down in an easy-to-grasp fashion leaves consumers with highly difficult choices. This article explores this problem from different angles and provides a complementary perspective to recent work on the value of private information (e.g., ACQUISTI *et al.*, 2009).

■ Risk, uncertainty and ambiguity

The valuation of privacy is a complex issue presenting researchers with theoretical challenges and contradictory empirical revelations (SOLOVE, 2008; SPIEKERMANN *et al.*, 2001). A number of review articles have summarized findings about the various factors that influence individuals' perceptions, preferences and behaviors regarding privacy (see, for example, BRANDIMARTE & ACQUISTI, 2012; HUI & PNG, 2006).

Capturing this complexity in an adequate decision-making model may appear as an insurmountable task. In this section, we use economic theory, and psychology and marketing research to partially illustrate the varying degrees of complexity of privacy choice situations.

At the bottom of the complexity scale are situations in which all important aspects are known by all parties and all outcomes are deterministic. However, once consequences of a choice are probabilistic in nature, the cognitive burden to represent a privacy choice in an economic model quickly increases. On the one hand, individuals might face situations characterized by risk in which the different possible outcomes of an event have known associated probabilities (KNIGHT, 1921). For example, the expected utility theory of VON NEUMANN & MORGENSTERN (1944) was originally based on such objectively knowable probabilities. On the other hand, KNIGHT,

1921) suggested that precise mathematical probabilities are unknown to the decision maker when facing *uncertainty*¹. To overcome this impasse, SAVAGE (1954) postulated that decision makers respond to such uncertainty by assessing subjective probabilities based on personal beliefs about the possible states of nature.

Assuming full rationality, we can draw on different approaches to predict outcomes of scenarios with objectively known or subjectively assessed probabilities and outcomes. The different protagonists of an interaction can utilize a toolbox of economic analysis approaches to derive optimal strategies. For example, if all individuals are equally well informed about the characteristics of a situation and all possible probabilities and outcomes (i.e., complete information) then a simple elimination of dominated strategies or determination of Nash equilibrium strategies will yield a (unique or multiple) optimal outcome(s). If information is incomplete, more advanced concepts can be utilized such as the Bayesian Nash equilibrium.

In contrast, given the ample evidence provided by experimental economists and psychologists we know that even in such relatively simple scenarios a number of deviations from rationality can be observed (see, for example, GOEREE & HOLT, 2001; KAHNEMAN & TVERSKY, 1984; and ELLSBERG, 2001).

In the following, we want to return to the concept of lack of information, i.e., what information an individual has available about a privacy scenario and how she uses this information. In practice, each privacy choice situation will be subject to a mix of information categories. For example, even in very complex scenarios some pertinent information may be known. However, other aspects may be unknown. We also agree that some lack of information can be overcome (i.e., information is knowable or can be assessed subjectively; perhaps at a cost). But other facets of a privacy situation will remain unknowable before a choice is made, or even after a decision has been taken. For example, HOOFNAGLE (2007) discusses the informational complexity of identity theft cases. In those scenarios, individuals are frequently unaware of being a victim long after they have shared some information (with a merchant or bank) which eventually leaked to a malicious party. Further, the high degree of difficulty of identifying and appropriately evaluating consequences of a privacy choice remains unresolved

¹ Economists, psychologists, and marketers often use the terms risk, uncertainty and ambiguity (the latter term we will introduce further below) in different ways. Even within the same discipline disagreements exist.

irrespective of a calculation being done *ex-ante* or *ex-post* (ACQUISTI & GROSSKLAGS, 2005).

Typically, individuals will struggle with the identification and calculation of probabilities and outcomes for at least some parts of a privacy scenario. In addition, they may not be able to place a value on the manifestation of a particular outcome. For example, they may hold conflicting attitudes about whether privacy should be primarily considered as a human right, or an economic good that can be readily traded to an individual's advantage (ACQUISTI & GROSSKLAGS, 2005). The value of private information may also depend on whether a choice is framed in the context of protecting information, or selling information (GROSSKLAGS & ACQUISTI, 2007; ACQUISTI *et al.*, 2009).

ELLSBERG (1961) recognized the importance of conflicting judgments about value when he discussed the concept of ambiguity of information. He described it as a third dimension of a choice situation that should be considered in addition to the relative desirability of a particular outcome and its probability of occurrence. In choice situations with high ambiguity, individuals would suffer from considerable ignorance rooted in low confidence about the quality of information available to the decision maker. According to his definition, most privacy scenarios exhibit a high degree of ambiguity.

Ellsberg's work leaves open the question how individuals behave in highly ambiguous scenarios. Part of the evidence provided since then indicates that individuals may act in a predictable fashion when presented with ambiguous lotteries. Indeed, it appears sensible that individuals show a degree of ambiguity-aversion which has been shown in simple choice experiments (see CAMERER & WEBER, 1992). Given the choice between a certain outcome (e.g., \$10) and a lottery over outcomes (e.g., \$0 with 50% likelihood and \$X with 50% likelihood), individuals prefer the certain choice unless they are offered a premium in the lottery so that the expected value of the lottery is greater than the certain outcome (e.g., X strictly greater than \$20).

However, as discussed above, privacy scenarios are typically much more complex than such simple choice experiments. In particular, privacy consequences are often bundled with other primary or secondary transactions. For example, when an individual purchases a book online, she will often reveal her credit card details to the online merchant, which may lead to an increased risk of identity theft.

Marketing research has demonstrated that offers which consist of items that are difficult to convert into any meaningful common unit of measurement can be designed to make promotions more effective. For example, NUNES & PARK (2003) show that when a promotion is presented in non-monetary terms (e.g., an umbrella rather than \$10), then individuals are typically less sensitive about the relative value of the bargain compared to other aspects of the offer. In the context of romance, WHITCHURCH *et al.* (2011) conducted an intriguing experiment about the influence of ambiguity on dating preferences. In their study, female study participants would prefer to go on a romantic date with a man who has not stated a preference about them, if the alternative is a dating opportunity with a man (who was rated by the women to be equally attractive) who previously rated the women's attractiveness highly. These findings challenge the common observation that individuals are predominantly ambiguity-averse. However, little is known about how individuals evaluate ambiguous offers, if they involve requests for various kinds of personal data.

■ A real-world example of ambiguous privacy trade-offs

To further motivate our forthcoming online survey experiment, we present the following sweepstakes advertisement that we collected at San Francisco's Pier 39 (see figures 1 & 2). The advertisement offers passers-by the opportunity to participate in a sweepstakes organized by an entity that is likely unknown to potential participants (Grand Pacific Resorts; Promotion Department). On the day this advertisement was collected a car was show-cased.

The offer's small-print gives an approximate winning probability for the 'grand prize' of 1 out of 700,000 for a value between \$15,000 and \$25,000. Each participant is asked to provide contact information (that needs to be accurate if one wants to be notified as a winner) and further data about the individual and the spouse such as age, job description, combined income, house ownership, basic credit card information and an email address (for which no further verification was required). The advertisement also gives the opportunity to opt in for further Pier 39 marketing offers.

The small-print further informs the reader that all data will be owned by a second entity (PNR Marketing Inc.). Additionally, participants of the offer may be contacted to participate in sales promotions of a third entity (i.e., Red

Wolf Lodge at Squaw Valley). No further information is provided about the entities that are acknowledged to use the information. In addition, further trade to other parties is not excluded.

Figure 1 - Sweepstakes offer (front)

Free Giveaway!

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Home Phone: _____

Work Phone: _____

Single Married

Age: _____ Occupation: _____

Spouses Age: _____ Occupation: _____

Combined Income:

Under \$30,000 Over \$30,000 Over \$50,000

DO YOU: RENT OR OWN YOUR HOME?

VISA MASTERCARD AMERICAN EXPRESS

Would you like info on special events & promotions at Pier 39?

Yes No

E-mail address: _____

It is difficult to exactly predict the expected benefits associated with this offer. Given the information provided, we estimate them to be at most 3.5 cents. A further non-monetary benefit could be the thrill to participate in sweepstakes, which would have to be weighted with the possible disappointment if the participant in the sweepstakes does not win. The negative consequences are likely telemarketing and other forms of sales contacts. Importantly, nothing is known about the further use of the collected data and the resulting consequences (including whether the data is stored securely). We do not want to make a strong normative judgment whether this offer should or should not be accepted by an individual.

We, however, are interested in testing how people value such an offer and react to framing changes in its presentation.

Figure 2 - Sweepstakes offer (back)

Details of Participation and Eligibility Requirements

- Only one Entry per Family.
- Winner allows the use of his or her name, photo, and statements for future promotional use without further compensation.
- Winner must be 18 or over. I.D. required. Winner must provide all necessary federal and state tax reporting information before receiving prizes.
- Drawing held February 23, 2003. Last date to enter drawing is February 16, 2003.
- Winner need not be present to win. Winner will be notified by phone.
- Drawing will be conducted by a Certified Public Accounting Firm at the corporate office of Grand Pacific Resorts, 5900 Pasteur Ct., #200, Carlsbad, CA 92008. To request winner information, correspondence may be forwarded to Grand Pacific Resorts, Promotions Dept. P.O. Box 4068, Carlsbad, CA 92018.
- All local, state, and federal taxes, fees and licenses are the winner's responsibility. Acceptance of the prizes constitutes a release of Facility Management, its agents and employees from all responsibility to the winner.
- Odds are based on number of entries received, approximately 1 in 700,000.
- No purchase or attendance is necessary to be entered into the drawing. Entrants may be invited to attend a sales presentation about the Red Wolf Lodge at Squaw Valley.
- Entries become the property of PNR Marketing Inc.
- The annual "Grand Prize" Giveaway consists of any vehicle with a retail value not to exceed \$25,000 or a three year lease (value to \$25,000) on a luxury car; or any prize (or similar) displayed in a Grand Pacific Resorts Promotion February 25, 2002 - February 23, 2003 (valued up to \$15,000), or the winner may choose cash in the amount of \$15,000.

■ Research questions, survey setup and demographics

In the online survey experiment, we are interested in the following two related questions.

- How do individuals value different categories of personal information if it is part of a marketer's offer with ambiguous consequences?

- How do the individuals' valuations for the different personal information categories change when the marketer's offer is reframed to involve a discount?

These questions are complementary to recent work undertaken on the value of private information. See, for example, GROSSKLAGS & ACQUISTI (2007), and ACQUISTI *et al.* (2009).

We contacted potential subjects who had shown interest in participating in economic studies at Carnegie Mellon University. We offered participants a lump sum payment of \$16 to fill out an online, anonymous survey about e-commerce preferences and gathered 119 valid responses. We used the term "e-commerce preferences" to mitigate self-selection bias from pre-existing privacy beliefs. The survey contained several questions organized around different categories: demographics, a set of behavioral economic characteristics (such as risk and discounting attitudes), past behavior with respect to protection or release of personal information, knowledge of privacy risks and protection against them, and attitudes toward privacy. In this article, we focus on the answers to two of the questions. Details about the analysis of other attitudinal and behavioral questions from this survey can be found in ACQUISTI & GROSSKLAGS (2005).

Participants ranged from 19 to 55 years old (with the mean age of 24). The sample included 55 male (46.2%), and 64 female (53.8%) subjects. Eighty-three percent were United States citizens. More than half of our subjects worked full or part time or were unemployed at the time of the survey, although students represented the largest group (41.3 percent). All participants had studied or were studying at an institution of higher education.

Most participants had personal and household incomes below \$60,000. Approximately 16.5 percent reported a household income above that level, including 6.6 percent with an income greater than \$120,000. Most respondents were also reasonably frequent computer users (62.0 percent utilized computers for at least 20 hours per week), internet users (69.4 percent spend more than 10 hours per week) and accessed computers both at home and at work (76.0 percent).

■ Valuation of thirteen personal information categories

This section is addressing the research question how individuals value different categories of personal information if the requested data is part of a marketer's offer with ambiguous consequences. More specifically, we attempt to explore the individual differences in monetary valuation when survey subjects are faced with a nonspecific 'information purchase' offer by a marketer similar to the offer in figures 1 and 2. We asked individuals the following 'question 1':

"Suppose a marketing company wants to buy your personal information. You do not know and you cannot control how the company will use that information. You know that the company will effectively own that information and that information can be linked to your identity. For how much money (in U.S. dollars) would you reveal the following data items to this company: (if you would never reveal that information, write 'never')?"

We asked individuals to reveal their valuation for 13 data categories: a) full name, b) Social Security Number (SSN), c) favorite online user name, d) physical home address, e) phone number, f) email address, g) job title and job description, h) interests outside work or study, i) previous and current health history, j) statistics about personal email received and sent (e.g., keywords, names, places), k) actual content of personal emails, l) rights to future health history (e.g., genetic predisposition to certain ailments), and m) description of sexual fantasies. People were asked to indicate a dollar amount, if they would accept the offer, or write down 'never' to categorically refuse such an offer.

In question 1, we avoided giving specific details about the purpose for which the data would be collected by the marketer, or the positive or negative consequences the survey participants would have to expect. We anticipated substantial differences for the willingness-to-accept the offer for the different data categories and between survey participants. Table 1 presents a classification of the response data into 3 categories: values requested below \$500, values above \$500, and the number of survey participants who responded with 'never'.

When considering the number of participants who rejected the marketer's offer, we can distinguish different degrees of sensitivity for the collection of the thirteen data categories. We subjected this data to a statistical test to evaluate whether the rejection frequencies differ significantly for the different

data categories. ² The resulting rank order (lowest rejection frequencies first) is as follows:

(outside work/study interests and job information [and favorite online name]) < ([favorite online name and] email address and full name) < (home address and phone number) < (previous health history, sexual fantasies, and email statistics) < (email contents) < (future health history) < (Social Security Number).

This ranking reveals that certain types of identifying information are perceived similarly. Participants' email address and full name, on the one hand, and their home address and phone number, on the other hand, form bundles of similar sensitivity. The Social Security Number tops the list of data types that individuals would prefer to keep to themselves.

Table 1 - Question 1, response frequencies for the different data categories

<i>Data Type</i>	<i>Valuation ≤ 500</i>		<i>Valuation > 500</i>		<i>Reject Sharing</i>	
Full Name	78	65.5%	20	16.8%	21	17.6%
Social Security Number	4	3.4%	16	13.7%	97	82.9%
Favorite Online User Name	74	62.7%	18	15.3%	26	22.0%
Home Address	60	50.8%	24	20.3%	34	28.8%
Phone Number	56	47.5%	28	23.7%	34	28.8%
Email Address	78	66.1%	24	20.3%	16	13.6%
Job Title and Description	92	78.0%	15	12.7%	11	9.3%
Interests Outside Work/Study	98	83.1%	11	9.3%	9	7.6%
Previous Health History	38	32.2%	32	27.1%	48	40.7%
Email Statistics	34	29.1%	31	26.5%	52	44.4%
Email Contents	22	18.6%	29	24.6%	67	56.8%
Future Health Information	7	5.9%	33	28.0%	78	66.1%
Sexual Fantasies	37	31.4%	32	27.1%	49	41.5%

Another observation from table 1 is that the variation in the number of participants who demanded high dollar amounts (> \$500) for a data item is relatively limited. I.e., there are between 11 (for outside work/study interests)

² We utilized the non-parametric McNemar's test for matched-pairs (A: 'reject offer', B: 'accept offer'), and determined whether the proportion of A- and B-labels is equal for the various data categories. This resulting test data enabled us to rank the information categories on the basis of their rejection frequency ('never') and to form groups of data that are treated similarly by our participants (usage of brackets denotes membership to a group). The only data type that is not unequivocally sortable is 'favorite online name'.

and 33 (for future health information) of those individuals for the different categories. In contrast, the number of participants who completely reject the marketer's offer varies more drastically between 9 (for outside work/study interests) and 97 (for Social Security Number). Rather than seeking money as compensation for divulging personal information those participants reject data collection categorically in the setting outlined by question 1.

Next, we study the degree of monetary variation between individuals. Figure 3 displays the requested amounts in U.S. dollars for the different data categories. For readability purposes, we plotted the requested amounts in increasing order, thereby reordering the participants' IDs. We also avoided a log-scale representation, and instead printed values larger than 500 and 'never' as a constant (500 + small epsilon).

For all categories the minimum amount requested is between \$0 (for full name, phone number, email address, interests and job description) and \$10 (for SSN). The maximum numerical amount ranges from \$100,000 (for home address, email address, outside work/study interests and job description) to \$1021 (for complete contents of email archive).

Individual differences in valuation can result from various factors such as idiosyncratic beliefs about an expected financial loss, fairness considerations, previous experiences with data collection etc. The dispersion in valuation is further increased because for many of the data types we study no unified resale value is known (or publicly available). If such information is available, then it may conflict with privately held beliefs. For example, evidence from spam and cybercrime studies as well as from the pricing for marketing campaigns suggests that email addresses can be bought in bulk for relatively small amounts of money. In contrast, an individual may consider such a low pricing inadequate and an unfair compensation for the expected resulting nuisance.

In addition to differences across data categories and individual differences, we also observed that gender had a significant impact on the number of rejected offers. Female participants rejected the offer on average in 40.0% of the cases, while male subjects declined to sell their data in 30.5% of the requests ($p < 0.01$ for t-test across averages of all data categories). We observed the largest differences for health information. More specifically, the sale of previous and current health history was rejected by women in 57.8% of the cases (men declined 21.8% of the offers). Future health information collection was rejected by women in 73.4%, and by men in 58.2% of the requests. Other information categories

that yielded substantial differences were job description (a difference of 13.8%), home address (10.7%), and statistics about email (10%). No information category had a noticeably larger rejection frequency by men (i.e., only requests for email address were rejected by 0.5% more men than women).

■ Framing the information sale as a discount

This section is addressing the research question of how individuals' valuations for the different personal information categories change when the marketer's offer is reframed to involve a discount.

The modified version of question 1 asked participants to specify a discount for which they would be willing to accept the marketer's offer. The discount was on the purchase of a product with a fixed value (\$500).

"Would you provide this information for a discount on an item you want to purchase or service you want to use? The item's value is \$500. If yes, what discount (in US dollars) would you expect? If you would not provide this information please enter 'no'."

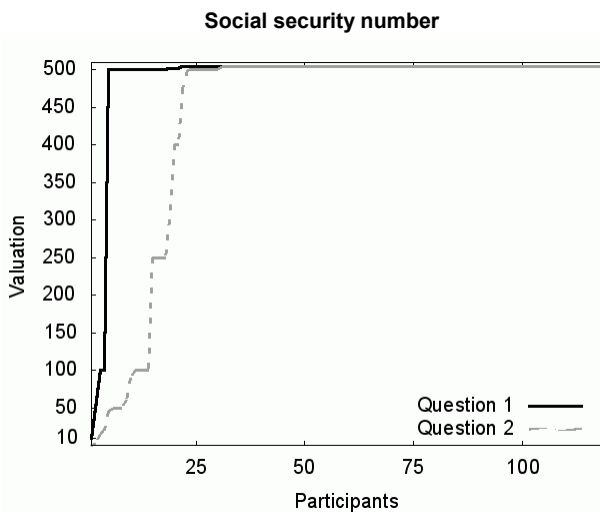
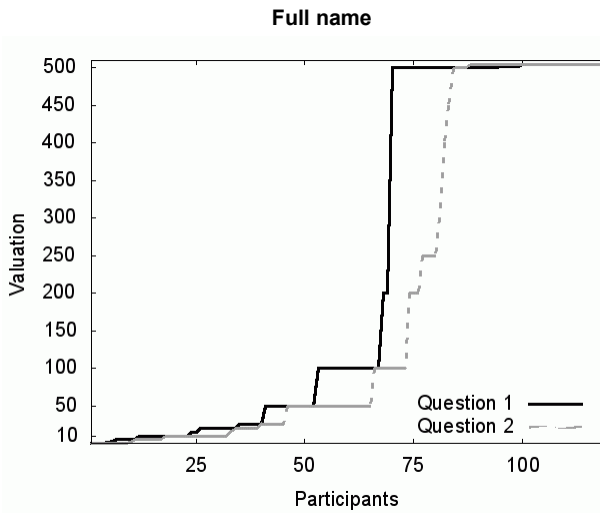
In question 2, we presented survey participants with requests for the same thirteen information categories. We expected questions 1 and 2 to be otherwise relatively comparable. In particular, we believed that the close proximity of the questions in the survey supported consistency of the participants' responses.

In figure 3, we display the data for question 2 in a similar fashion as for question 1. We represent 'no' with a value marginally above 500 (500 plus small epsilon). In the following section, we test whether more individuals accept the marketer's offer in question 2 compared to those who were presented with the offer in question 1.

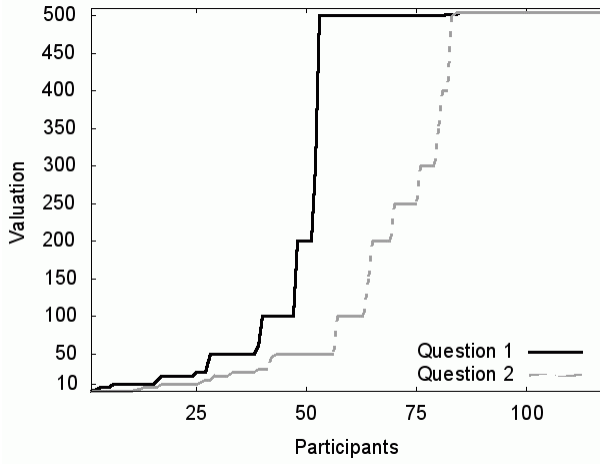
We observe that more individuals explicitly rejected the marketer's offer phrased as a discount. More specifically, for all data categories (except the Social Security Number) more individuals now declined the data sale in the scenario for question 2 ($p < 0.01$ for t-test across averages of all data categories). However, taking into consideration the fact that a number of individuals stated very high monetary demands for the data (i.e., larger than \$500) in the scenario for question 1, we can report a somewhat different result. A sizeable number of individuals now reported to be willing to demand

a value below \$500. The net result is that a much larger number of individuals accepted the offer and stated a value under \$500 in comparison to the scenario in question 1 ($p < 0.001$ for t-test across averages of all data categories).

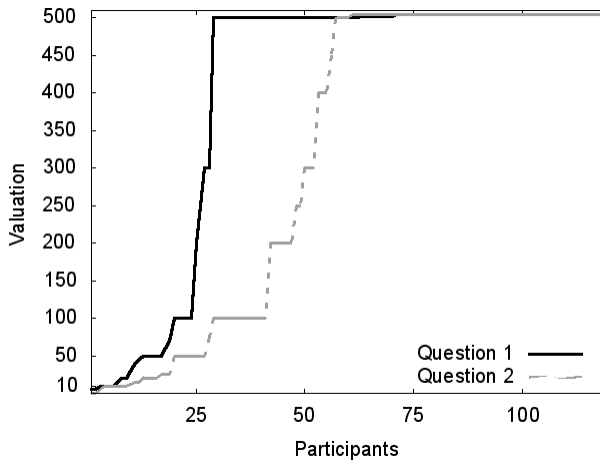
Figure 3 - Valuation for selected data items for questions 1 and 2 (valuations are depicted in increasing order for both questions; participant IDs are not matched pairs; valuations higher than 500 are shown as 501; valuations of "no/never" are shown as 505)



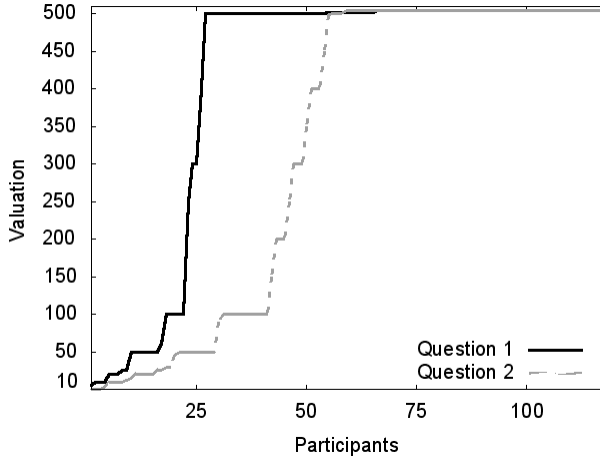
Home address



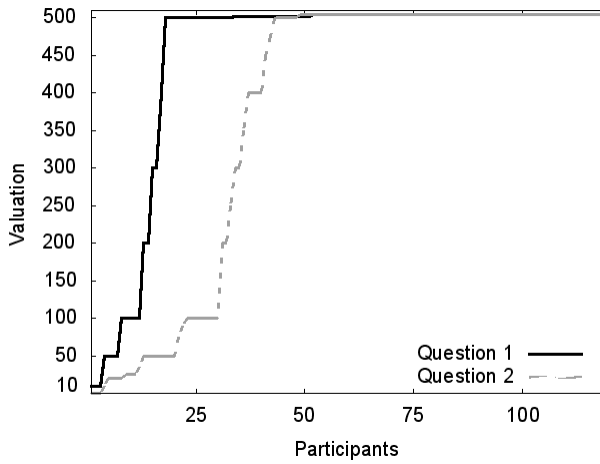
Previous health history

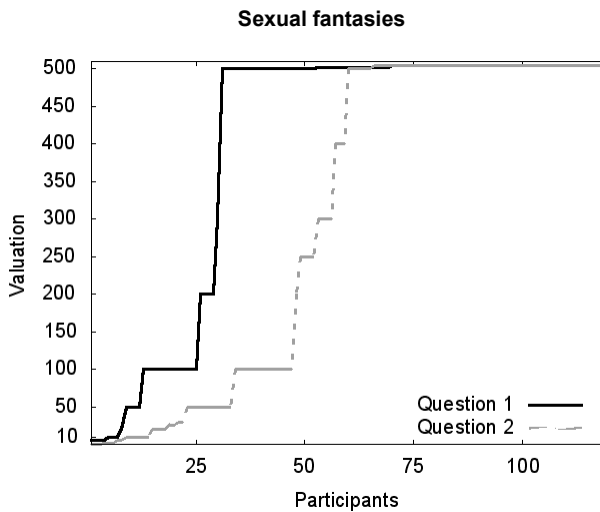
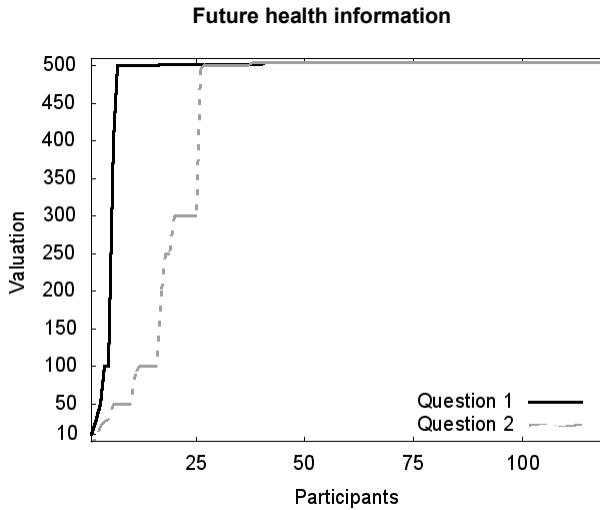


Email statistics



Email contents





Conducting a more thorough data analysis, it turns out that these seemingly contradictory results can be explained by considering gender differences.

Male participants significantly more often rejected the discount offer than the more straightforward data sale in question 1 ($p < 0.00001$ for t-test across averages of all data categories). On average, 5% of the male participants who had low monetary demands for question 1 (i.e., equal or smaller than \$500) rejected the offer. An additional 34.7% of those male participants who

previously demanded more than \$500 now rejected the discount offer. This also means that 65.3% (with previous valuations of larger than \$500) now lowered their demands to be able to accept the discount.

In contrast, the total number of female participants who rejected the sales offer did not change significantly with the introduction of the discount in question 2. This net result is driven by two effects. On the one hand, 21.1% of those female participants who previously demanded a large monetary amount now rejected the offer. The latter effect is a statistically significant difference between male and female participants, i.e., relatively speaking more women are willing to lower their demands to take the discount ($p=0.02$ for t-test across averages of all data categories). On the other hand, 5% of the female participants who previously rejected the offer were now willing to give away their data for a discount. This is exactly the opposite effect in comparison to the behavior of male subjects (the difference in behavior is statistically significant at $p<0.0001$ for t-test across averages of all data categories).

■ Discussion and concluding remarks

In this paper, we discussed the impact of a lack of information about material privacy consequences of marketing offers on individuals' behaviors. We presented previous research on risk, uncertainty, and ambiguity from the fields of economics, psychology and marketing to give the reader an overview of the topic area. We further analyzed data from an online survey experiment about the valuation of personal information in the context of an ambiguous marketer's offer.

Our data shows significant differences in the participants' willingness-to-sell personal information for the different data categories. Participants were particularly reluctant to divulge their Social Security Number, which is likely a result from extensive media coverage of the frequency and consequences of identity theft and financial fraud. Second, health information and the content and statistical information about personal email were considered precious and less tradable by our participants.

The experimental condition in which we reframed the sales offer as a discount provided nuanced results. The percentage of individuals who outrightly rejected the data sale increased from 35.6% to 41.7% once the request was framed as a discount. However, at the same time a substantial

number of individuals lowered their monetary demands for highly personal information to meet the cut-off value for the discount on a product (i.e., 14% of all subjects, which corresponds to 69.3% of individuals who initially demanded more than \$500 for a particular type of personal information).

We also observed significant gender differences in our sample. Most of the rejections of the discount business model originated from the male subject population. Women were more likely to reduce their monetary demands to be able to make use of the discount, and several female individuals who previously rejected the sales offer were now willing to take the discount. The gender effects reported in this paper deserve further empirical validation and follow-up studies. The susceptibility of a particular demographic group to specific marketing mechanisms is of interest to various stakeholders in the privacy community. Previous research in other sales contexts has shown that discrimination based on demographic data can be pervasive and may necessitate consumer education and other marketplace measures to compensate for its effects (AYRES, 1991).

Similar to the findings by GROSSKLAGS & ACQUISTI (2007) and ACQUISTI *et al.* (2009), our results highlight the difficulties to learn about individuals' genuine valuations for personal data due to their dependency on subtle context changes. However, policy actions and decisions may frequently depend on estimates of potential losses from privacy intrusions. Our study contributes to a better understanding of the factors that drive these changes in valuations, and will contribute to a more complete overall theory of the economic value of privacy.

In our future work, we intend to study different ways of better communicating risks to consumers when the privacy terms of a bargain and the associated consequences are ambiguous. Research in other contexts including health has already attempted to identify best practices for communication. However, representing uncertainty and ambiguity in effective information visualizations is challenging (see, for example, reviews by LIPKUS, 2007) and POLITI *et al.*, 2007). SPIEGELHALTER *et al.*, 2011) suggested that visualizations for situations with a lack of information and ambiguous context would have to be attractive and informative, but also effectively point out its own contingencies and limitations. Successful research in this direction may eventually help consumers to represent their privacy preferences more consistently even if presented with manipulative offers.

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