

When 25 Cents is too much: An Experiment on Willingness-To-Sell and Willingness-To-Protect Personal Information

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ABSTRACT

We present an empirical study of willingness-to-pay for protecting information (we term it willingness-to-protect) and willingness-to-accept a proposal to sell information (willingness-to-accept). We conducted the study in two parts. In the first part we presented the study participants with two yes/no offers, asking them to protect themselves against information release for a fixed amount of money, or offering them a fixed amount of money to release their information. In the second part we asked subjects to specify their maximum willingness-to-protect for personal data and their minimum willingness-to-accept for the release of personal information.

Our results show a clear preference for money over data across the vast majority of participants in both the protection and the release scenarios, even when the monetary advantage of releasing or not protecting in the fixed amount choice situations is very small. In all hypothetical scenarios, we find that the average willingness-to-accept is dramatically higher than the average willingness-to-protect.

Keywords

Willingness-to-pay, Willingness-to-protect, Willingness-to-accept, Experimental economics, Human subjects experiments, Privacy, Information security

1. INTRODUCTION

Privacy is the claim of individuals, groups or institutions to determine for themselves when, how, and to what extent information about them is communicated to others. (Alan F. Westin, Privacy and Freedom, 1967)

The classical 1967 privacy definition by Alan Westin is still relevant today for researchers, businesses, and public policy stakeholders. However, it does not capture an important distinction in privacy decision making: *protecting information* is based on different marketplace activities and behavioral processes than *giving away information*.

Individuals protect their personal information when they use technologies such as firewalls, curtains, document shredders, caller-id or sunglasses to shield themselves from potential observers. People might also show reserve when communicating with others. To attain complete privacy they could even restrict their contact with others to a minimum.

To the contrary, individuals act as sellers of their personal information when they purchase goods with loyalty or credit cards, carry cell-phones, or purchase goods that contain RFID tags. Similarly, information is offered to others during communication online and offline, whether persistently stored or not. In extreme cases, individuals might aim for complete openness to the outside world - for example, when they are participating in game shows with constant visibility to a broad audience; a modern panopticon.

The object of our analysis is to understand how differently individuals value information when protecting themselves than when they are offered the opportunity to communicate information to others. Awareness of such different valuations may be incorporated in theoretical and empirical works on privacy, as well as inform privacy-relevant policy making.

To date, the evidence on this research question is incomplete, since security studies have either covered protecting or selling behavior, but not both at the same time. Several studies address individuals' monetary valuations when *selling* information. Huberman *et al.* [2005] determined individuals' bids for weight and age information experimentally and showed a correlation of price demanded with subjects' personal attributes. Cvrcek *et al.* [2006] and Danezis *et al.* [2005] studied hypothetical valuations for the release of location information. Hann *et al.* [2002] estimated the trade off of privacy for monetary rewards for their survey participants. However, the empirical evidence on consumers' valuations for *protecting* information is scarce and mostly indirect, as it focuses on consumers' marketplace choices in terms of information protection. Acquisti and Grossklags [2005] report that 63 percent of their survey respondents who suggested that privacy should be protected by each individual with the help of technology actually never used encryption; 44 percent did not use email filtering technologies; and 50 percent did not use shredders for documents to avoid leaking sensitive information. In a recent AOL/NCSA [2005] study that surveyed computer users' attitudes and experiences with computer security and scanned those users' computers for spyware, viruses, and protection software, the researchers found that 83 percent had some virus scanner installed (but only 44 percent had it updated within the last week). Sixty-two percent had an anti-spyware/anti-adware program installed. Eleven percent used firewall software and 71 percent had a hardware firewall protection (18 percent had both).

In this paper we study whether this hypothesized behavioral difference between protecting and selling information survives an experimental test. We relate our research to the growing literature on the valuation of privacy. In particular, we seek to determine monetary valuations for protecting and selling information in one single experiment.

A similar distinction to the one we described above has been made in the behavioral economics and psychology literature for the last 30 years. Researchers have observed that individuals' maximum willingness-to-pay (WTP) for a good is, under a wide range of experimental and hypothetical scenarios, different from their minimum willingness-to-accept (WTA) an offer for the same good. The classical experiment endows consumers with a mug and asks them whether they would be willing to exchange this good for an alternative item (such as a pen). The same experiment is conducted in the reverse direction with different participants from the same subject pool. The widely observed result is that most mug-holders prefer to hold on to the mug, and most pen-holders prefer to hold on to the pen. When asked for numerical valuations, subjects specify a higher demand for a mug they hold compared to their lower offer for a mug owned by another subject or the experimenter [Knetsch, 1989]. These results have often been interpreted to be evidence for the so-called endowment effect. The numerical difference between WTA and WTP is referred to as the WTA-WTP gap. We discuss different explanations for this gap in Section 2.

In the case of privacy, the actions available are similar: consumers can pay for protection (we call this willingness-to-protect) or they can demand compensation for their information (willingness-to-accept). To research this distinction we conducted a two-part study. In the first part we present the participants with two single closed-ended yes-no questions forcing individuals to make a decision on whether they are willing to protect themselves against information release for a fixed amount of information, or whether they are willing to release their information for a fixed amount of information. In the second part we ask subjects to specify their maximum willingness-to-protect personal data and their minimum willingness-to-accept a release of information.

Several research methods have been applied in the literature on WTA-WTP estimation: simple open-ended questions such as ‘What is the maximum you would be willing to pay to obtain X?’; incentive compatible open-ended questions using the Becker-deGroot-Marschak (BDM) mechanism, Vickrey auctions, single closed-ended yes-no questions such as ‘Would you sell this good for \$x? (Yes or no)’, as well as other procedures [Horowitz and McConnell, 2002]. For our experimental part we chose simple closed-ended questions, since we felt they resembled many typical consumer decision making problems closely. In particular, commercial situations that allow consumers to explicitly specify a price for their personal information or negotiate the cost of a protection method are rare. Rather, consumers are left to accept or reject fixed offers and demands in the marketplace. However, we complement our experimental part with simple hypothetical questions to be able to give a preliminary estimate on the magnitude of a difference between protection and selling behavior.

In our study, we first conducted a knowledge and logic quiz on participants and recorded their individual weights. We then offered participants the opportunity to protect this information against release to all other participants of the experimental group, or to sell this information to have it released to all other participants. Details about the experimental procedures can be found in Section 4. We find that individuals almost always chose to sell their information and almost never elect to protect their information even for values as little as \$0.25.

In the hypothetical valuation scenario, individuals had to specify their willingness-to-protect and willingness-to-accept for their quiz performance scores, weight, favorite holiday destination, and the number of past sex partners. We find a significant gap between WTA and WTP. In fact, the ratio between WTA and WTP is as large as 105; a dramatic gap even in comparison to the related literature in behavioral economics. (We include in tables at the end of the paper the complete data for all individuals who took part to the study, in order to demonstrate the significant dispersion of privacy valuations across subjects.)

Our results contribute to the growing literature on security and privacy economics [Camp, 2006] and add to the small number of experiments and economically motivated survey studies, by introducing a novel experimental framework for the analysis of privacy decision making and by simultaneously researching both willingness-to-pay for protecting information and willingness-to-accept a proposal to sell information.

The rest of the paper is structured as follows. In Section 2 we briefly review related work on willingness-to-pay and willingness-to-accept and popular explanations for the discrepancy between those valuations. We also discuss related work on security and privacy economics. In Section 3 we list our research questions. Section 4 contains the experimental setup. In Section 5 we conduct the analysis of the experimental results. We conclude in Section 6 and discuss important implications for consumer protection and public policy.

2. RELATED RESEARCH

2.1 The gap between willingness-to-accept and willingness-to-pay

A discrepancy between the price an individual is willing to accept for a good he owns, and the price he would be willing to pay to acquire the same good in case he did not own it is called WTA-WTP gap. Such dichotomy has been at the center of a sizable literature that Horowitz and McConnell [2002] have summarized in a statistical meta-study on 45 willingness-to-accept and willingness-to-pay surveys and experiments. Participants in the studies surveyed by Horowitz and McConnell had to assign values for goods as diverse as chocolates, pens, mugs, movie tickets, hunting licenses, visibility, nuclear waste repositories, nasty-tasting liquids, potentially pathogen-contaminated sandwiches and many more. The authors concluded that “with regard to experiment design, we find that ratios in real experiments are not significantly different from hypothetical experiments, and that incentive-compatible elicitation yields higher ratios, not lower. In other words, survey techniques that would be expected to yield a ‘truer’ picture of preferences lead either to no change or to higher observed ratios. We also found that students tended to have lower, not higher, ratios than the general public, so moving the experiments out of the classroom seems not to lead to lower ratios. The evidence on the effects of repetition is mixed, but there is not strong evidence that the ratio decreases through iteration. Therefore, high WTA-WTP ratios are not the result of experimental design features that would be considered suspect, even apart from their WTA-WTP results.”

Not all studies, however, consistently report evidence of a gap between compensation demanded and willingness-to-pay. See, for example, Plott and Zeiler [2005] and Singh [1991]. Plott and Zeiler [2005] argue based on their review of the prior experimental evidence, that “while many experimenters have observed a WTP-WTA gap, others have failed to observe it. This variation in experimental results seriously undermines the claim that the gap is a fundamental feature of human preferences.” They suggest that subject misconceptions lie at the heart of the observed gap. According to their thesis using anonymity, incentive-compatible elicitation, practice, and training together eliminates the endowment effect. Roth [2005], however, cautions that Plott and Zeiler “cannot explain how the endowment effect can be both present and absent when the same experimental methods are used. Therefore, this argument is inconsistent with 10 out of the 25 studies [reviewed in Roth, 2005], where results change from a significant WTA-WTP-gap to no gap by only changing the good in question and sticking to the method.”

What is a reasonable threshold to define a ‘fundamental feature of human preferences’ or behavior, and what are, specifically, the causes for the gap between WTP and WTA that so many researchers have identified? Many results observed in surveys, field, and laboratory experiments – such as time-inconsistent decision-making (for example, signing up for a year-long gym membership but actually never going), or the winner’s curse in auction studies – have been known to decrease in magnitude when individuals receive feedback about their and/or others’ performance during practice and training rounds. Are these observations therefore of less relevance? During privacy decision making it appears unlikely that individuals will receive coaching to understand the connection between actions, their likely consequences and payoffs. In fact, even experienced researchers have only a vague understanding of the negative expected value from releasing information to a particular marketer – less so consumers [Acquisti and Grossklags, 2005]. From anecdotal evidence we know that individuals who were subjected to a privacy or security compromise act often more cautiously in future interaction. This proves the importance of consumer education but does not help to understand ad-hoc decision-making for most consumers.

In the following paragraphs we survey popular explanations for the gap between willingness-to-pay and willingness-to-accept and show how they may apply to privacy scenarios.

2.1.1 *Loss aversion and endowment effect*

In 1979, Kahneman and Tversky introduced *prospect theory* as an alternative descriptive model for economic choice. They suggested that gains are treated by individuals differently from losses. Further, economic actors underweight outcomes that are merely probably compared to their interpretation of certain outcomes. On the basis of this research, Thaler [1980] theorized the *endowment effect*. He wrote that “a certain degree of inertia is introduced into the consumer choice process since goods that are included in the individual's endowment will be more highly valued than those not held in the endowment, *ceteris paribus*. This follows because removing a good from the endowment creates a loss while adding the same good (to an endowment without it) generates a gain. Henceforth, I will refer to the underweighting of opportunity costs as the endowment effect.”

Huck *et al.* [2005] research theoretically whether preferences that are consistent with the endowment effect can be explained by evolutionary processes. In their scenario, two groups that either own product x or y are randomly matched in bilateral Nash-type bartering. Higher utility is achieved with more balanced consumption patterns increasing the incentive to exchange. They observe that individuals with a strictly positive endowment effect will never die out in the long run.

An endowment effect can be observed when giving up information leads to a loss of privacy that is weighted more intensely than the gain from monetary compensation, and vice versa.

2.1.2 *Lack of substitutes*

Neoclassical economics would predict a difference between willingness-to-pay and willingness-to-accept if significant income or wealth effect or transaction costs exist [Knetsch and Sinden, 1984]. Several experiments have controlled for these factors experimentally and still found a substantial gap.

Hanemann [1991] has proposed lack of substitutability as another source of observed WTA-WTP disparities. In the context of public goods (holding income effects constant and in absence of transaction costs) he theoretically shows that a decrease in the substitution effect (for example, fewer substitutes are available to the individual) will result in an increase of the expected gap. If there are private substitutes available for a public good (such as the Alaskan shoreline or a public park) then the disparity between minimum compensation and maximum payment should disappear. Shogren *et al.* [1994] and Harless [1989] researched this hypothesis experimentally with mixed results.

Lack of substitutability appears particularly relevant for privacy. Only in few scenarios a simple replacement for personal information is readily available. For example, in case of a loss of a pseudonym that is otherwise not connected to critical information, individuals may just pick a new artificial identity [Feldman *et al.*, 2006].

2.1.3 Uncertainty about value

The gap between willingness-to-pay and willingness-to-accept may also be explained by information overload and bounded rationality. Hoehn and Randall [1987] argue that individuals take into consideration the time necessary to compute the correct valuation of a particular good. Therefore, the iterative process of completing the optimal choice between bundles might stop short of a final result and the formulated valuation (or willingness-to-pay) for a good under consideration might shift downward from the alternative valuation under optimal non-constrained conditions.

In a related hypothesis, Eisenberger and Weber [1995] research whether individuals' valuations differ if presented with risky or ambiguous lotteries. They find no impact on the gap between compensation demanded and willingness-to-pay. Roth [2005] proposes that uncertainty about the desire to trade a good could be a predictor for the discrepancy. He conducts experiments that validate this hypothesis.

In Acquisti and Grossklags [2005] we suggested and showed in a simple survey choice situation that ambiguity can have an impact on privacy valuations for marketers' proposals. However, we discussed how depending on the framing of the offer consumers may either value a proposal more conservatively or more favorably.

2.2 Valuation of privacy and personal information

Empirical studies of the value consumers assign to privacy have highlighted a dichotomy between professed attitudes and actual behavior, raising questions about individuals' awareness of privacy trade-offs and their true valuation of privacy. On the one hand, privacy seems to be so highly regarded by individuals that many claim to only reluctantly trade off convenience or other benefits for it. A 1998 Business Week/Harris Poll survey found that among the 77% of Internet users who had never purchased products on the Internet, 86% were holding back because of concerns about the use of their personal and financial information [Varney, 1998]. In 2000, a PriceWaterhouseCoopers study claimed that nearly two thirds of the consumers surveyed "would shop more online if they knew retail sites would not do anything with their personal information" [Allen, 2000]. A 2002 February Harris Interactive study found that the three biggest consumer concerns in the area of online personal information security were companies trading personal data without permission, the consequences of insecure transactions, and theft of personal data [Harris Interactive, 2002]. (See also Kumaraguru and Cranor [2005] for an extensive review of publicly available Westin privacy surveys.) Also in 2002, Jupiter Research calculated that \$24.5 billion in online sales would have been lost by 2006 because of privacy concerns [Jupiter Research, 2002]. In more recent years, these concerns have continued to hinder consumers from making online purchases: a 2005 survey conducted by Privacy & American Business (P&AB) found that concerns about the use of personal information led 64% of respondents to decide not to purchase something from a company, while 67% of respondents decided not to register at a website or shop online because they found the privacy policy to be too complicated or unclear [P&AB, 2005].

On the other hand, consumers have also been found to be willing to provide personal information for small discounts and rewards. Tedeschi [2002] reported on a 2002 Jupiter Research study that found 82% of online shoppers willing to give personal data to new shopping sites in exchange for the chance to win \$100. Hansell [2002] reported that a study by comScore found little reaction by web users to Yahoo!'s change in its marketing policy the previous March: comScore projected that while 1.1 million users visited Yahoo!'s opt-out page within four weeks of the policy change, only 73,000 users considered ending their relationship with the website. Presenting the results of the 2003 Harris privacy poll, Taylor [2003] uses Alan Westin's privacy classifications and observes that most people are privacy pragmatists: while concerned about privacy, they would "sometimes trade it off for other benefits." In an experiment at Humboldt University Berlin, Spiekermann *et al.* [2001] simulated an online shopping environment in which an anthropomorphic 3-D shopping bot posed a variety of personal questions to shoppers. Many of these inquiries requested information unnecessary to the shopping task. In order to receive discounts on the purchase of certain goods, subjects answered a majority of the personal questions asked by the bot, even if they had previously claimed to have high privacy concerns and sensitivity. The authors also found that the content of the privacy statements associated with the bot had no effect on the amount of information disclosed by the subjects.

Following Spiekermann *et al.* [2001], other researchers have conducted context-rich experiments and surveys to understand privacy behaviors. For example, Earp and Baumer [2003] find that for a significant portion of Internet users, how well a web site is designed correlates with positive privacy attitudes about that site. Using conjoint analysis, Hann *et al.* [2002] found that while online privacy protection (in terms of protection against secondary use and unauthorized use of data provided to a website) is associated with positive consumer valuation, "financial gains and convenience can significantly increase the individuals' motivational score of a website." Huberman *et al.* [2005] used a second-price auction experimental setup to study the monetary value of private information to individuals. Choosing weight and age as information that the subjects may find sensitive (and therefore value), the authors found that "the more undesirable the trait with respect to the group, whether perceived or actual, [the greater the impact on] ... the price demanded to reveal private information." Rose [2005] used a

contingent valuation survey approach to estimate the economic value subjects place on a change in the data protection laws that would give the subjects enforceable property rights in their personal information. The author found that while most survey participants expressed high sensitivity to privacy, their willingness to pay for such strong property rights was low – only 47.5% of those surveyed would pay for it (an average of NZD 55.40 or USD 28.25). Hui *et al.* [forthcoming] used a field experiment in Singapore to study the values of various privacy assurance measures. They found that privacy statements and monetary incentives could both induce more information disclosures. In addition, providing personal information to an online merchant may decrease future search or transaction costs, with positive implications for both seller and buyer (see Brynjolfsson *et al.*, 2003). Still, Chellappa and Sin [2005], in a study of the trade-offs consumers face between personalization and privacy, noted that online companies need to gain consumers' trust if they want to implement personalization, in order to overcome the negative implications of their privacy concerns. More recently, Danezis *et al.* [2005] and Cvrcak *et al.* [2006] studied hypothetical valuations for location information. Wathieu and Friedman [2005] show in an empirical study that consumers might be more sensitive to the context of information collection and further indirect effects, rather than data collection itself. Good *et al.* [2007] studied how program installation behavior of consumers is influenced by terms disclosed in End User License Agreements. They report that users do not discriminate between programs if they are only provided the lengthy, complex and difficult to read license agreements. However, consumers act upon more precise short notices that address privacy, security and computer performance concerns. Tsai *et al.* [2007] study consumer choices based on search results when online consumers are presented with privacy icons and privacy summaries that indicate website privacy practices. Consumers tend to purchase from websites with better privacy terms and conditions.

The above surveys and empirical studies paint a nuanced picture: in overwhelming numbers, Internet users claim to highly value their privacy; still, they are willing to trade off personal information for small rewards, or are unwilling to change their behavior when privacy threats arise.

Several possible explanations for this apparent dichotomy have been discussed in the literature [Acquisti and Grossklags, 2003; Shostack, 2003; Syverson, 2003; Acquisti, 2004]: from incomplete information about privacy threats and defenses, to bounded ability to deal with their complex trade-offs; from low (and decreasing) privacy sensitivities, to behavioral phenomena, such as immediate gratification. It is likely that not one single factor can, alone, explain that dichotomy. Privacy is a complex and variegated concept, interpreted differently by different people and cultures [Murphy, 1964]; its psychological and sociological nuances have been highlighted over the years by researchers coming from different disciplines [Westin, 1967; Altman, 1975; Agre and Rotenberg, 1997; Bellotti, 1997; Scoglio, 1998].

Rather than painting a firm and conclusive picture of what determines privacy behavior, the above studies confirm that privacy decision-making is affected by a multitude of psychological factors and conscious deliberations. Our research on the relationships between willingness to pay (to protect) and willingness to accept (to sell) personal information are part of this growing body of research.

We want to complete the section with a pointer at other research on the value of information that is not concerned with privacy and security. Ford and Staples [2006] show in a quantitative study that perceived value of knowledge is positively related to intentions to share knowledge. However, uniqueness of knowledge is negatively related to the desire of an individual to share with others. For privacy similar relationships have been observed. Rafaeli and Raban [2003] and Raban [2004] conduct an experiment on information sharing in a competitive market. Subjects have to manage a lemonade sale where demand is affected by weather information, prices and best lemonade mixture (and effects between these variables). Participants could sell or share this information (or a secondary copy of this information) with other players. They find a willingness-to-accept to willingness-to-pay ratio of at least 3. Furthermore, secondary information is valued less highly.

3. Research questions

To the best of our knowledge, in this paper we present the first study that simultaneously researches both willingness-to-pay for protecting personal information (we term it willingness-to-protect) and willingness-to-accept a proposal to sell personal information. Our experimental design focused on two sub-studies: in a first study we presented the participants with two single closed-ended yes-no questions, forcing individuals to make a decision on whether to protect themselves against the release of various types of personal information for a fixed amount of money, or to release various types of personal information for a fixed amount of money. In a second study we asked subjects to specify their hypothetical maximum willingness-to-protect personal data and their minimum willingness-to-accept release of information.

We will describe the experimental setup, the subject pool, and the types of information we chose for the studies in Section 4. Below, we describe the research questions that motivate our interest.

Question 1: Can we specify a price-point for selling and protecting personal information?

With our study we add to the increasing literature on valuation of private information. In the first part of our experiment we observe decisions of individuals in simple yes-no choice situations that are similar to privacy choices consumers are likely to encounter in everyday decision making. We set very low prices for protecting and selling information and expect individuals to protect themselves against the release of their information. However, based on evidence from prior studies, we expect individuals also to sell their information for very low rewards.

Question 2: Is there a gap between willingness-to-protect and willingness-to-accept for personal information?

The literature reviewed in Section 2 suggests that for non-market goods a significant gap exists between willingness-to-pay and willingness-to-accept. We expect similar results for personal information, which shares both public and private good characteristics, and market and non-market characteristics.

Question 3: What is the size of the gap between willingness-to-protect and willingness-to-accept?

The second part of our study allows for a specification of the difference between average maximum willingness-to-protect and average minimum willingness-to-accept. We determine and compare the gap for four different personal data categories and we contrast this gap to those found in other studies.

Question 4: What is the magnitude of inconsistent behavior of experiment participants?

Due to our two-part design, we can estimate the number of individuals that react differently to experimental choice situations versus hypothetical contingent valuation tasks. We expect the number of individuals that act inconsistently to be small since all decisions are made in a compact time frame.

Question 5: Do we have individuals in our dataset that specify a higher willingness-to-protect compared to their willingness-to-accept?

The customary gap between willingness to pay and to accept arises as the subject values (and is willing to sell) a good for more than she is willing to pay for it. In the privacy case, however, one may not be surprised by such a reserve gap arising systematically at low evaluations – when, for instance, a subject rejects an offer of 50 cents to reveal her personal data, but is willing to spend 50 cents to protect it.

Question 6: Do individuals anchor their valuations of personal information on the experimental cues and priming provided in the instructions?

Researchers have observed that valuations for immaterial or difficult to evaluate goods might be susceptible to random signals provided to experimental subjects. This anchoring effect might also be prevalent in our data. In particular, we expect the hypothetical valuations to vary based on the choice experiment in part one.

Question 7: What methodological lessons-learned arise from our study on privacy valuation?

The literature on privacy and security experiments is growing in size. However, it has not yet formed a consistent body of experimental practices and conventions. We compare our results to a similar study by Huberman *et al.* [2005] and attempt to point out how design choices in our experiment might have driven our different observations.

4. EXPERIMENTAL SETUP

In this section we present the experimental setup of our study. Our experiment involved 47 participants at Carnegie Mellon University.

4.1 Recruiting and subject-pool

Conforming to standard experimental practice, we tried to avoid problems of self-selection by not advertising to potential subjects the experiment to have privacy or information security implications. We described the study as “decision making and market transactions”. Recruiting was facilitated by an online system of the Center for Behavioral Decision Research at Carnegie Mellon University. Individuals can sign up online for future experiments that are announced to them by email. The pool of potential subjects mostly consists of students of the Pittsburgh universities that have chosen to participate in experiments.

4.2 Process and Experimental Materials

Individuals that agreed to participate in the study were assigned to four different group. All groups met – at separate time – in a medium sized conference room without privacy dividers, with the subjects seated facing each other along two rows (see Figure 1). They were asked to review and sign a consent form before being handed the experimental documents. Participants knew that they would receive \$10 show-up fee plus a variable payment that would in part depend on choices made later in the experiment. The variable payment consisted of game money for the experiments that participants were endowed with at the start of the study (e.g., to be able to spend for protecting information). The game money remaining at the end of the experiment was added to the participants’ total experimental earning. By selling information (willingness to sell, or to “accept” in the usual experimental parlance) individuals could earn additional game money. By protecting information (willingness to protect, the equivalent in our study to the willingness to “buy” analyzed in other experimental studies) individuals would decrease their game funds and therefore their compensation at the end of the study. The experimental incentives were as close as possible to real life incentives, as the game money translated into actual cash by the end of the study, and the privacy consequences of decisions taken during the experiment were actually borne by the subjects.

4.2.1 Quiz and Entry-Survey

The first part of the experiment served to collect private data about the participants, who were still unaware of the actual purpose of the study. All participants had 10 minutes time to complete a knowledge and logic quiz that included 13 questions. This quiz was used to compute a simple IQ-type score about each individual. Thereafter, participants had to complete a short survey covering demographics and increasing personal questions about individual attributes, preferences and past behaviors.

From the questions included in the test and the survey we used the following data for later parts of the experiment:

- Quiz performance: Simple IQ-type measure of correctly answered questions
- Individual’s weight
- Individual’s favorite vacation/holiday destination
- Number of sex partners the subject had had in his/her life

The quiz score and the individual’s weight information could be verified by experimenters. We anticipated that these two types of information would only raise medium privacy concerns: one referred to personal information already known or knowable by other subjects (a participant’s weight); the other referred to newly created piece of information that did not exist before the experiment itself (the performance in the quiz). We were not planning to prove the correctness of the responses to the remaining two categories. The individual’s holiday preferences were chosen as personal information likely to be of very little privacy concern to the subject. Sexual experience was included as an example for a data item that would cause individuals substantial discomfort and raise privacy concerns even if the subject provided incorrect information.



Figure 1 - The experiment room

4.2.2 Privacy choices: Selling or protecting personal information

The main part of our experiment consisted of two choice tasks for each participant. In these tasks individuals could choose a) to sell or not to sell information, and b) to protect or not to protect information. Each participant had to undertake one choice on selling information and one choice on protecting information. We conducted two treatments, varying the order of selling and protecting information. In two further treatments we varied the amount of game money individuals would earn or had to spend when selling or protecting information, respectively. Further, the first choice task always concerned the quiz performance, and the second choice task was about the individual's weight information. To summarize, our experiment featured a 2x2x2 research design with 2x2 between-subjects factors (ordering: protect/sell or sell/protect and money: low and high offer) and 2 within-subjects factors (data category: quiz performance or weight).¹ Table 1 offers an overview of the details of the 4 experimental sessions with 8 treatments.

We modeled the privacy consequence of our experiment after Huberman *et al.* [2005]. In their experiment participants had their weight and/or age information announced to the remaining study subjects if they demanded the lowest value in a sealed reverse second price auction. In our experiment we expected that individuals would be concerned about revealing information that is not readily observable but somewhat reflects on personal abilities (culture and intelligence) such as quiz performance, which would trigger privacy concerns. Similarly, despite others being able to observe an individual's weight to

¹ We will include further data categories in future experiments.

a certain degree of accuracy, we felt – based on Huberman *et al.* [2005]’s results - that clear proclamation of the exact data might cause hesitation and unease.

Table 1 Overview over experimental treatments

Treatment	Choice task 1	Choice task 2	Number of subjects
1	Sell or not sell quiz performance information for \$1		14
2		Protect or not protect weight information for \$1	
3	Protect or not protect quiz performance for \$1		14
4		Sell or not sell weight information for \$1	
5	Sell or not sell quiz performance information for \$0.25		7
6		Protect or not protect weight information for \$0.25	
7	Protect or not protect quiz performance for \$0.25		12
8		Sell or not sell weight information for \$0.25	

We used the following text to elicit individuals’ choices on the selling task:

This part of the experiment is about your personal consumer decision making. Our purpose is to study technical issues involved in decision-making. Various research foundations have provided funds for this research. The instructions are simple, and if you follow them carefully and make good decisions, you might earn money. What you earn will depend on the choice you make. You will perform buying tasks and selling tasks.

In today’s marketplace personal information is also a factor. This experiment is about your decision-making involving personal information.

In the first part of the experiment you participated in a <Quiz/Survey> (Part 1). Your answers in the <Quiz/Survey> have been recorded.

Currently, your answer to the <data item category> question is not known by the other people in this room. In this part of the experiment, the researchers wish to pay you \$<amount> to reveal your <data item category> to the rest of the group at the end of the study. Please make a choice between the two following options:

- Accept the additional \$<amount> and have your <data item category> announced to the other people in this room at the end of this study.
- Do not accept the additional \$<amount>, and never have your <data item category> announced to the other people in this room at the end of this study.

The protection task differed in the last part of the description:

In the first part of the experiment you participated in a <Quiz/Survey> (Part 1). Your answers in the <Quiz/Survey> have been recorded.

Your <data item category> will be revealed to the rest of the group at the end of the study. However, you can pay \$<amount> so that your <data item category> will remain unknown to the other people in this room. Please make a choice between the two following options:

- Have your <data item category> announced to the other people in this room at the end of this study.
- Pay \$<amount>, and never have your <data item category> announced to the other people in this room at the end of this study.

Our design follows closely the simple choice tasks between mugs and pens conducted in the experiment by Knetsch [1989].

4.2.3 Hypothetical choices

To complement the experimental choices we also asked participants to specify their hypothetical minimal acceptable exchanges for all four categories of private data. More specifically, we asked for their maximum willingness-to-pay for protecting and minimum willingness-to-accept for selling information.

The exact description to draw out willingness-to-accept for selling information had the following form:

We are also interested in your valuation of the other personal information following the same procedure. Imagine that you are still in the experiment following the procedures outlined above. However, you will not receive payments for the following decisions and you will not have to announce your information to the group.

At the start of the experiment we asked you a number of questions. Your answers have been recorded.

We have recorded your answers for <data category>. Please determine the minimum amount of US\$ that you would have to be paid in order to have your answer announced to the rest of the group in this room at the end of the study.

Please specify the minimum amount at which you would “sell” this information.

For willingness-to-pay to protect information the last part of this description was adapted:

We have recorded your answers for <data category>. Please determine the maximum amount of US\$ that you would be willing to pay in order to avoid your answer being announced to the rest of the group in this room at the end of the study:

We will use this data to comment on the existence of a discrepancy between willingness-to-pay and willingness-to-accept for privacy information.

4.2.4 Exit survey

Following the hypotheses in Huberman *et al.* [2005] we included questions about the participants’ self-perception regarding the data we collected. We asked them how they felt about their own attributes in comparison to the other participants and the public at large. We also included question on general privacy preferences and allowed participants to comment on the study.

4.2.5 Information announcement and payments

After completing the exit survey all individuals who did choose to sell or not to protect their quiz performance data and/or weight information were identified by the experimenter, who announced the participants’ personal information clearly to the rest of the group. Finally, subjects received their total payments from the experimenter.

5. RESULTS

We first present an overview of the survey and quiz results (Section 5.1), before focusing on how those results were used to study the WTA-WTP dichotomy (Sections 5.2 and following).

5.1 Demographics and personal information

5.1.1 General demographics

We ran four different experimental sessions with a total of 47 subjects (see Table 1 for details). Nobody declined to participate in the study after reading the consent form and instructions. Sixty-two percent were male. The average age of the participants was 20.6 years (stdev. 5.9). All participants were either current bachelor degree students or had obtained a bachelor or higher degree. Thirty-four were of Asian decent, ten Caucasian, and three African-American. Our subjects reported to use the Internet on average 4.6 hours per day (stdev. 2.6). Average income was reported to be \$4977.8 (stdev. \$7366.9; missing or N/A data for 11 subjects).

5.1.2 Quiz performance

Participants could achieve up to ten points in the quiz. Average performance was seven points (stdev. 1.8). We observed a minimum score of three. Subjects performed better on parts testing logical understanding and worse on knowledge question (e.g., who is the current US attorney general).

5.1.3 Weight information

The average weight of the participants was 141.3 pounds (stdev. 22.1 pounds). Female participants' mean weight was 124.4 pounds (stdev. 22.5 pounds), male participants weighted on average 151.8 pounds (stdev. 14.1 pounds). For comparison, by 2002, the recorded average weight for citizens in the United States between 20 and 74 for men was almost 191 pounds; for women, average weight was 163 pounds [National Center for Health Statistics, 2004].

5.1.4 Favorite holiday/vacation information

Destinations in Europe were favored by 14.9 percent, locations in Asia by 25.5 percent, attractions in the United States by 38.3 percent. Other locations were chosen by 21.3 percent of the participants.

5.1.5 Sexual experience

Among our participants, 31.9 percent reported to have had no sexual intercourse in the past. A little more than 23 percent reported to have had one sexual partner, while 34 percent claimed experiences with 2-5 sexual partners. Few individuals accounted for more partners: 6.4 percent for 6-10, 2.1 percent for 11-20, and 2.1 percent for more than 20.

In a recent poll of a Knowledge Networks panel of 2,065 heterosexual, U.S. non-virgins with a median age in their late 40s researchers found that the average number of sexual partners reported by women was 8.6 and by men 31.9. The researchers commented on the highly elevated numbers reported by men and uncovered several inconsistencies regarding their reporting behavior [Physorg, 2006].

5.2 Choice behavior

Each participant in our experiment was asked to make two choices that would influence her payments at the end of the experiment (see Table 1). The first decision concerned selling or protecting information about quiz performance, and the second choice option considered weight information. In Table 2 and Table 3, see the column "Type of Choice," that identifies whether individuals in the session were asked to protect or sell information; and the column "Choice," for the actual decisions made. Note that the participants had been endowed with game money to be used for the game transactions. The endowment was altered across conditions in order to achieve revenue equivalence. (For instance, one condition asked subjects to sell data at \$1; participants received \$5 in endowment, so if they had sold their information they would remain with \$6, but if they decided not to sell, they would be left with \$5. Similarly, individuals in the condition in which they were asked to protect data by spending \$1 received \$6 in endowment. If they did not protect their information, they would keep \$6; if they decided to protect, they would have a new budget of \$5.)

We find that only 2 out of 14 subjects refused to sell their quiz information for \$1. *None* of the 7 subjects declined to *sell* the quiz result to the rest of the group for \$0.25. In the remaining two treatments on quiz performance, individuals could choose to *protect* their information for \$1 or \$0.25, respectively. We observe that *all* subjects waived the option to shield their information.

The weight information was not sold by 1 out of 14 participants and 1 out of 7 participants for \$1 and \$0.25, respectively. Only two out of 19 subjects choose to protect their information for \$1, while no individual safeguarded their information for \$0.25.

The data shows a clear preference of the subjects for money in exchange for their data on quiz performance and weight even if the potential monetary advantage of selling or not protecting is very small (also compared to the show-up fee). Aggregating across both weight and quiz performance, only 6 out of 47 subjects chose to protect or refused to sell. This stands in sharp contrast to the results by Huberman *et al.* [2005] who reported an average demand price of \$74.06 for weight

information when subjects specified demands in a sealed reverse second-price auction.² Therefore, (almost) all of their subjects (if acting consistently) would have rejected the \$1 and \$0.25 choices in our experiment.

We attribute this difference in behavior to two aspects: differences in the subject pool and, perhaps more importantly, methodological dissimilarities. First, the average age of subjects in Huberman *et al.* was 40 years.³ Privacy preference may vary with age and it is likely that their participants showed a more substantial variation in weight and appearance than our fairly homogeneous subject pool. Second, while paid decisions in a choice experiment and paid decisions in an auction experiment allow observations that are both largely incentive compatible there might be still differences. For example, evidence from experiments indicates that a second price auction usually produces efficient aggregate outcomes, but that individual bidders do not always bid sincerely [Kagel, 1995]. Similarly, participants in our choice experiments might be influenced by the immediate temptation to receive an additional payment in exchange for a not well-specified or easily predictable future privacy impact [Acquisti and Grossklags, 2005]. More significantly, our subjects may not have anchored their valuations to a large amount the same way participants in Huberman *et al.*'s study did, who may have been primed by the announcement of a \$100 ceiling to their bids.

5.3 Consistency of choice with hypothetical willingness-to-accept and willingness-to-protect

After the choice experiments, subjects were specifying their hypothetical values for willingness-to-accept the experimenter's offer and willingness-to-protect from having to reveal the information to the group. This allows us to conduct a simple consistency test: for example, is the maximum willingness-to-accept lower than \$1/0.25 or not if people accepted the choice offer in the experimental part?; is the maximum willingness-to-accept higher than \$1/0.25 or not if people declined to reveal their information?; etc. We assume that many individuals were tempted by immediate gratification to accept the choice offer for sale and were refraining from the immediate loss of paying money to the experimenter for protecting information. The last column in Table 2 and Table 3 shows the results.

While the majority of our respondents gave consistent responses, we find that 15 out of 47 subjects specified a minimum willingness-to-accept or maximum willingness-to-protect that was not consistent with their earlier choices for quiz performance (13 out of 47 for weight). More subjects contradicted their earlier sales decision compared to their protection decision (10 vs. 5 for quiz performance; 12 vs. 1 for weight information).

While we cannot confirm this hypothesis affirmatively, we believe that individuals felt more uncomfortable specifying a low willingness to accept for their information compared to the simple binary choice situation. We plan to explore these methodological differences in future studies.

5.4 Gap between willingness-to-accept and willingness-to-protect

Most participants who were given the choice did sell their information and declined to protect the information. The experimental literature that we reviewed earlier in this paper may have suggested that it is likely that participants hold on to their information when presented with the \$1/0.25 offer and decline to expend the \$1/0.25 when presented with the option to protect/buy back information. However, it may also have suggested that, in presence of a large gap between WTP and WTA, our straight-shot offers may drive subjects to strictly prefer money in contrast to information under both (sale or protection) scenarios. In other words, while we cannot confirm or refute the existence of a behavioral discrepancy between sales and protection behavior for the choice experiment, our results are compatible with the existence of such a gap. However, for the personal information chosen and payments offered, the results suggest that it was strictly dominant for most subjects to sell and not to protect.

It has been suggested anecdotally that individuals are often willing to give away private information for very small rewards. While our experiment seems to initially confirm this hypothesis, we want to caution that our setup might have been (against our expectations) too mild of a privacy intrusion or more generally did not implement the appropriate proportion between privacy consequences and monetary payments.

² Note that the exact distribution of bids is not documented in the paper by Huberman *et al.* [2005] making direct comparison difficult. Furthermore, subjects were not able to specify bids above \$100. Of 127 participants in the weight and age auctions 5.5 percent and 3.5 percent, respectively, demanded more than \$100. For further data analysis bids at \$100 were assumed to be randomly distributed between \$100 and \$2000.

³ Only recorded for 88 out of 127 subjects.

The second explanation is supported by our analysis of the hypothetical data.⁴ For all four experimental sessions and all data categories we find that the average of the willingness-to-accept is substantially higher compared to average willingness-to-protect. Individual level data can be found in Table 2 - Table 4.

The average willingness-to-accept reported by our subjects was \$7.06 (stdev. \$16.1) for quiz performance and \$31.8 (stdev. 148.0) for weight information.⁵ Subjects reported an average willingness-to-protect of \$0.8 (stdev. \$2.3) for the test scores and \$0.8 (stdev. \$3.1) for weight data. If participants would have strictly acted upon these averages then they would not have sold their data nor protected it in the \$1 choice situation. For the remaining two data categories the average willingness-to-accept is \$6.0 (stdev. \$16.7) for favorite holiday destination and \$2291.3 (stdev. \$14897.6) for number of sexual partners in the past. The average willingness-to-protect is \$0.0 (stdev. \$0.0) for the preferred vacation spot and \$12.1 (stdev. \$26.7) for the sex partners question.

There is a sometimes surprisingly large variation between the data of different participants. We believe that the data follows the independent private value model [Vickrey, 1961] where the personal value of a data item is dependent on (multiple) private signals. Such signals could be a) individual evidence on an expected financial loss, b) fairness considerations, c) previous experiences with data trades etc. The dispersion arises also because no unified resale value is known [Acquisti and Grossklags, 2005]. Also the small number of independent observations would make any assumption on the underlying distributions problematic. We, therefore, subjected the data to nonparametric tests. The Wilcoxon matched-pairs signed-ranks test subjects the data to an equality test of matched pairs of observations. The signtest performs a one-sample test of the median. The former test uses the sizes of the differences and can differ from the signtest which uses the number of + and - signs of the differences. Below we report the data for the Wilcoxon matched-pairs signed-ranks test. The signtest resulted in a similar outcome.

The results show clearly that there is a significant difference between willingness-to-accept and willingness-to-protect for quiz performance ($P < 0.00001$, $n = 47$ participants), weight information ($P < 0.00001$, $n = 47$ participants), vacation destination ($P < 0.00001$, $n = 47$ participants) and number of sex partners ($P < 0.00001$, $n = 45$ participants). We grouped the survey results for the \$1 and \$0.25 treatment groups for the analysis since there was no significant difference between them (Two-sample Wilcoxon rank-sum (Mann-Whitney) test with at least $p > 0.23$ for the 8 hypothetical questions). A difference could have been caused by anchoring on the initial experimental stimulus [Ariely *et al.*, 2003].

We also investigate the size of the gap. A measure widely used in the literature is the ratio of willingness-to-accept and willingness-to-pay (in our paper: willingness-to-protect). Since we observed many zero-valuations for protection in our data set a large part of the values is undefined. For the remaining observations we find a surprisingly large mean gap. For quiz information we find that individuals show a hypothetical willingness-to-accept that is 21.4 times as large as the willingness-to-protect (stdev. 53.1, $n = 14$). Similarly large gaps we can determine for weight (14.5, stdev. 22.0, $n = 8$), vacation data (25.5, stdev. 34.7, $n = 2$), and number of sexual partners (105.7, stdev. 331.3, $n = 28$).

Alternatively, we calculate how large willingness-to-protect is compared to willingness-to-accept.⁶ For quiz we determine that willingness-to-accept is on average five times as large as willingness-to-protect (20.25%, stdev. = 43.1, $n = 40$). For weight and vacation information the gap is even larger (weight: 8.8%, stdev. 24.9, $n = 41$; vacation: 2.8%, stdev. 16.7, $n = 36$). The sale of number of sex partners information was valued four times higher than the corresponding protection action (25.1, stdev. 40.0, $n = 41$).

For the sake of completeness we also report the average absolute size of the gap (median, mean, stdev. mean): quiz (\$2, \$6.1, stdev. \$16.1), vacation (\$2, \$30, stdev. \$146.2), vacation (\$1, \$5.9, stdev. \$16.5), and number of sex partners (\$6, \$2279.4, stdev. \$14884.2).

Compared to most experiments and hypothetical decision making tasks on common goods such as mugs, pens and chocolate bars the gaps in our study are fairly large. Ratios reported are often in the area of 1-4. However, for less common goods higher ratios have been documented. For example, Brookshire and Coursey [1987] found by using a contingent valuation

⁴ Again we want to emphasize that in hypothetical survey situations (as surveys of this research indicate [Plott and Zeiler, 2005]) a gap between willingness-to-accept and willingness-to-pay is more readily observable. We, therefore, plan to conduct further experiments to shed light on this critical question.

⁵ We removed the one obvious outlier from this data analysis to make these values easier to interpret.

⁶ This value we calculate as: willingness-to-protect/willingness-to-accept*100%. Again some values are undefined because of zero-values for willingness-to-accept.

methodology that households demanded significantly higher compensation (up to 20 times higher) for decreasing tree density compared to their willingness to contribute to a higher plant concentration in a park.⁷

The customary gap between willingness to pay and to accept arises as the subject values (and is willing to sell) a good for more than she is willing to pay for it. Reversals (in which the willingness to pay dominates the willingness to sell) have been documented in the literature [see Knez *et al.*, 1985], although they may be attributed to errors or the subject's difficulty in understanding the experimental procedure. In the privacy case, however, one may not be surprised by such a reserve gap arising systematically at low evaluations – when, for instance, a subject rejects an offer of 50 cents to reveal her personal data, but is willing to spend 50 cents to protect it. Privacy is about control and emotions: too low an offer for one subject's data may trigger an irritated counter-reaction (rejection); while, by converse, a subject may be willing to sacrifice that same low amount in order to protect her data. In Table 2 - Table 4 we specify the individuals for which we observe such a reversal of the typically observed preference.

5.5 Privacy attitudes and willingness-to-accept and willingness-to-protect

We separated our population into two groups (Group 1: very concerned, marginally concerned; Group 2: unconcerned) with respect to their stated concern about privacy. We used the question: 'How concerned are you about threats to your personal privacy today?'

Based on this group categorization we conducted a two-sample no-matched-pairs permutation test. The permutation test determines the statistical significance of the experimental outcome based on randomizing the two groups many times and is a useful test for non-parametric data with small sample sizes [Good, 1995].

We find that privacy preferences help to predict both willingness-to-accept and willingness-to-protect for quiz performance (willingness-to-accept: $P < 0.02$, $n = 46$ participants; willingness-to-protect: $P < 0.08$, $n = 46$ participants), and number of sex partners (willingness-to-accept: $P < 0.03$, $n = 45$ participants; willingness-to-protect: $P < 0.0009$, $n = 44$ participants). Participants showed, however, no behavioral differences for vacation information (willingness-to-accept: $P < 0.35$, $n = 46$ participants; willingness-to-protect: $P < 0.85$, $n = 46$ participants). Privacy concerned individuals differed from unconcerned in their sales behavior but not in their protection behavior (willingness-to-accept: $P < 0.02$, $n = 46$ participants; willingness-to-protect: $P < 0.28$, $n = 46$ participants).⁸

The inability of the test to show differences for weight and vacation protection values should not surprise, since almost none of our subjects specified a non-zero value for these types of information (see Table 3 and Table 4). The hypothetical data, as a whole, seems to indicate that individuals with stronger privacy concerns are indeed requesting higher payments for their information and are also willing to expend more money to be protected. The experiment by Spiekermann *et al.* [2001] showed a similar correlation for privacy preferences and information revealing behavior. However, as in their experiment we observed a generally very low threshold for exposing information.

6. DISCUSSION

Our goal in this study was to come to a better understanding of individuals' valuation of personal information by separating the decision processes that involve *revealing* and *protecting* personal information. In particular, our experiment was designed to investigate individuals' willingness to sell and protect personal information in a simple choice situation, followed by an exploration of minimum willingness-to-accept an offer and maximum willingness-to-protect information in a hypothetical setup.

Our work extends the growing literature on privacy valuation and the work presented in Huberman *et al.* [2005] on willingness-to-accept for private information. To the best of our knowledge, however, this is the first report of a study that directly contrasts sale and protection of personal data.

Based on anecdotal evidence and previous results, we speculated that participants would be willing to sell personal information for even small (i.e., \$1), yet not the smallest (i.e., 25 cents) rewards; and that they would not be willing to protect the same information for those same amounts. We also hypothesized that a significant dichotomy between WTP and WTA would arise in the hypothetical setup, and that valuations would be on average anchored to priming cues (such as the offer made to participants before they were presented with the hypothetical setup).

⁷ For example, to elicit willingness-to-accept they asked households within a one-mile radius of a park "what maximum dollar amount would your household be willing to contribute to a fund to increase the base plan from 200 to 225 trees under this one-time payment". Researchers showed household members different visualizations depicting the differences in tree density.

⁸ Again we removed the one substantial outlier from the data.

Our results show quite clearly a preference of the subjects for money in exchange for their data on quiz performance and weight even if the potential monetary advantage of selling or not protecting is very small (also compared to the show-up fee). We found that most subjects happily accepted to sell their personal information even for just 25 cents, and virtually all subjects waived the option to shield their information. Our experimental results are compatible with the hypothesis that a gap between willingness to pay to protect private data and willingness to accept to give away the same data exist (although we can only conclude that 25 cents is a price that lies within the set of values at which people are willing to sell, but does not lie within the set of values that people are willing to spend to protect). Our survey results, however, clearly support the WTA-WTP hypothesis with a surprisingly strong and almost unprecedented magnitude.

The dichotomy we point at in this paper is of significance to theoretical, empirical, and applied policy works in the realm of privacy and personal information value. Theoretically, we observe that our results show the benefits of clearly separating privacy decision making into decisions to protect and decisions to reveal data (the literature on the economics of privacy and security implicitly assumed that market behavior of individuals for both actions is identical, but related literature in psychology and the analysis of our hypothetical data suggests otherwise). Empirically, our data points out some of the confounding factors that may riddle any privacy valuation exercise that does not specifically address the framing (revealing or protecting) of the evaluation question. As for policy-making, our results strongly suggest that privacy legislation and privacy self-regulation are not interchangeable means to balancing the informational needs and goals of different entities. Depending on the system of rights created through legislation or self-regulation (for instance, the data subject's right to have his personal information protected versus the potential data holder's rights on somebody's else data), individuals are placed in radically different mental frames: deciding whether to give away or not protect personal information, versus deciding whether to invest or not to protect otherwise vulnerable personal information. Such different frames can lead, as shown above, to dramatically differing evaluations for personal data.

As pointed out by Kahneman *et al.* [1990], the endowment effect questions the validity of the Coase Theorem and the belief that privacy regulation is neutral towards the final allocation of personal information goods. Coase Theorem states that the allocation of property rights does not influence the way external effects are internalized by the market. However, if the endowment effect influences the valuations, property rights do matter, and the WTA-WTP dichotomy ends up measuring the consequence of assigning a property right one way or the other and the different individuals' valuations that such assignments will elicit.

In other words, the observation that individuals do not (or only rarely) pay for privacy cannot necessarily be used to conclude that individuals actually place little value on their personal information (although in many instances the latter may also be true). The framework of experimental analysis that we have introduced in this paper could be used, in fact, to further investigate how those valuations change with other conditions.

7. ACKNOWLEDGMENTS

We like to thank Carnegie Mellon University's IRB Board for their patient assistance in the development of this study. We particularly thank George Loewenstein for his advice on research design and Sasha Romanosky for his help conducting the experimental sessions. We are also grateful to Janice Tsai, Anuj Kumar, Matej Drev, Leslie Johns, and members of Carnegie Mellon University's CBDR Lab for help and suggestions.

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Table 2 Data for Quiz Performance

Session-Subject	Type of choice	Choice	Willingness-to-accept	Willingness-to-protect	Gap	Consistent with choice
1-01	Sell	Sold	\$10.00	\$0.00	Yes	No
1-02	Sell	Sold	\$0.05	\$0.00	Yes	Yes
1-03	Sell	Sold	\$100.00	\$0.00	Yes	No
1-04	Sell	Sold	\$10.00	\$10.00	No	No
1-05	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-06	Sell	Sold	\$0.01	\$0.00	Yes	Yes
1-07	Sell	Not sold	\$10.00	\$0.00	Yes	Yes
1-08	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-09	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-10	Sell	Sold	\$5.00	\$0.00	Yes	No
1-11	Sell	Sold	\$10.00	\$0.00	Yes	No
1-12	Sell	Not sold	\$5.00	\$3.00	Yes	Yes
1-13	Sell	Sold	\$1.00	\$0.50	Yes	Yes
1-14	Sell	Sold	\$10.00	\$1.00	Yes	No
2-01	Protect	Not protected	\$1,000,000,000.0	\$1,000,000,000.0	Reverse	No
2-02	Protect	Not protected	\$0.00	\$0.00	No	Yes
2-03	Protect	Not protected	\$5.00	\$10.00	Reverse	No
2-04	Protect	Not protected	\$3.00	\$0.00	Yes	Yes
2-05	Protect	Not protected	\$0.00	\$0.00	No	Yes
2-06	Protect	Not protected	\$2.00	\$0.00	Yes	Yes
2-07	Protect	Not protected	\$10.00	\$0.00	Yes	Yes
2-08	Protect	Not protected	\$1.00	\$0.00	Yes	Yes
2-09	Protect	Not protected	\$5.00	\$5.00	No	No
2-10	Protect	Not protected	\$2.00	\$0.00	Yes	Yes
2-11	Protect	Not protected	\$5.00	\$0.10	Yes	Yes
2-12	Protect	Not protected	\$0.00	\$0.00	No	Yes
2-13	Protect	Not protected	\$0.00	\$0.00	No	Yes
2-14	Protect	Not protected	\$5.00	\$1.00	Yes	No
3-01	Sell	Sold	\$0.00	\$0.00	No	Yes
3-02	Sell	Sold	\$0.00	\$0.00	No	Yes
3-03	Sell	Sold	\$3.00	\$1.00	Yes	No
3-04	Sell	Sold	\$0.00	\$0.00	No	Yes
3-05	Sell	Sold	\$3.00	\$0.00	Yes	No
3-06	Sell	Sold	\$15.00	\$0.00	Yes	No
3-07	Sell	Sold	\$1.00	\$0.05	Yes	No
4-01	Protect	Not protected	\$5.00	\$0.00	Yes	Yes
4-02	Protect	Not protected	\$50.00	\$0.00	Yes	Yes
4-03	Protect	Not protected	\$0.50	\$0.00	Yes	Yes
4-04	Protect	Not protected	\$5.00	\$0.00	Yes	Yes
4-05	Protect	Not protected	\$5.00	\$0.00	Yes	Yes
4-06	Protect	Not protected	\$1.00	\$0.00	Yes	Yes
4-07	Protect	Not protected	\$15.00	\$5.00	Yes	No
4-08	Protect	Not protected	\$10.00	\$0.05	Yes	Yes
4-09	Protect	Not protected	\$0.10	\$0.10	No	Yes
4-10	Protect	Not protected	\$5.00	\$0.00	Yes	Yes
4-11	Protect	Not protected	\$0.25	\$0.00	Yes	Yes
4-12	Protect	Not protected	\$4.00	\$0.00	Yes	Yes

Table 3 Data for Weight Information

Session-Subject	Type of choice	Choice	Willingness-to-accept	Willingness-to-protect	Gap	Consistent with
1-01	Sell	Sold	\$50.00	\$0.00	Yes	No
1-02	Sell	Sold	\$0.05	\$0.00	Yes	Yes
1-03	Sell	Sold	\$1,000.00	\$0.00	Yes	No
1-04	Sell	Not sold	\$10.00	\$3.00	Yes	No
1-05	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-06	Sell	Sold	\$0.01	\$0.00	Yes	Yes
1-07	Sell	Sold	\$5.00	\$0.00	Yes	No
1-08	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-09	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-10	Sell	Sold	\$5.00	\$0.00	Yes	No
1-11	Sell	Sold	\$3.00	\$0.00	Yes	No
1-12	Sell	Sold	\$3.00	\$2.00	Yes	No
1-13	Sell	Sold	\$1.00	\$0.00	Yes	Yes
1-14	Sell	Sold	\$5.00	\$0.00	Yes	No
2-01	Protect	Not	\$1,000,000,000.0	\$1,000,000,000.0	Reverse	No
2-02	Protect	Not	\$0.00	\$0.00	No	Yes
2-03	Protect	Not	\$50.00	\$0.00	Yes	Yes
2-04	Protect	Not	\$3.00	\$0.00	Yes	Yes
2-05	Protect	Not	\$0.00	\$0.00	No	Yes
2-06	Protect	Not	\$1.00	\$0.00	Yes	Yes
2-07	Protect	Not	\$10.00	\$0.00	Yes	Yes
2-08	Protect	Not	\$1.00	\$0.00	Yes	Yes
2-09	Protect	Not	\$1.00	\$0.00	Yes	Yes
2-10	Protect	Protected	\$5.00	\$5.00	No	Yes
2-11	Protect	Not	\$5.00	\$0.10	Yes	Yes
2-12	Protect	Not	\$0.00	\$0.00	No	Yes
2-13	Protect	Not	\$1.00	\$0.00	Yes	Yes
2-14	Protect	Protected	\$50.00	\$1.00	Yes	Yes
3-01	Sell	Sold	\$0.00	\$0.00	No	Yes
3-02	Sell	Sold	\$0.00	\$0.00	No	Yes
3-03	Sell	Sold	\$10.00	\$5.00	Yes	No
3-04	Sell	Not sold	\$150.00	\$20.00	Yes	Yes
3-05	Sell	Sold	\$1.00	\$0.00	Yes	No
3-06	Sell	Sold	\$15.00	\$0.00	Yes	No
3-07	Sell	Sold	\$0.50	\$0.00	Yes	No
4-01	Protect	Not	\$2.00	\$0.00	Yes	Yes
4-02	Protect	Not	\$30.00	\$0.00	Yes	Yes
4-03	Protect	Not	\$0.50	\$0.00	Yes	Yes
4-04	Protect	Not	\$5.00	\$0.00	Yes	Yes
4-05	Protect	Not	\$5.00	\$0.00	Yes	Yes
4-06	Protect	Not	\$2.00	\$0.00	Yes	Yes
4-07	Protect	Not	\$2.00	\$0.00	Yes	Yes
4-08	Protect	Not	\$20.00	\$0.00	Yes	Yes
4-09	Protect	Not	\$0.00	\$0.00	No	Yes
4-10	Protect	Not	\$5.00	\$0.00	Yes	Yes
4-11	Protect	Not	\$0.25	\$0.00	Yes	Yes
4-12	Protect	Not	\$2.00	\$0.00	Yes	Yes

Table 4 Data for favorite vacation/holiday destination and number of sexual partners

Session-Subject	Favorite Holiday/Vacation Destination			Number of Sexual Partners		
	Willingness-to-accept	Willingness-to-protect	Gap	Willingness-to-accept	Willingness-to-protect	Gap
1-01	\$30.00	\$0.00	Yes	\$500.00	\$20.00	Yes
1-02	\$0.05	\$0.00	Yes	\$0.05	\$0.00	Yes
1-03	\$100.00	\$0.00	Yes	Infinite	Infinite	N/A
1-04	\$8.00	\$0.00	Yes	\$30.00	\$3.00	Yes
1-05	\$0.00	\$0.00	No	\$1.00	\$0.00	Yes
1-06	\$0.01	\$0.00	Yes	\$0.01	\$0.00	Yes
1-07	\$50.00	\$0.00	Yes	\$200.00	\$50.00	Yes
1-08	\$1.00	\$0.00	Yes	\$1.00	N/A	N/A
1-09	\$5.00	\$0.00	Yes	\$30.00	\$0.00	Yes
1-10	\$1.00	\$0.00	Yes	\$50.00	\$5.00	Yes
1-11	\$3.00	\$0.00	Yes	\$3.00	\$0.00	Yes
1-12	\$1.00	\$0.00	Yes	\$20.00	\$20.00	No
1-13	\$0.50	\$0.00	Yes	\$2.00	\$1.00	Yes
1-14	\$1.00	\$0.00	Yes	\$100.00	\$100.00	No
2-01	\$1,000,000,000.0	\$1,000,000,000.1	Reverse	\$1,000,000,000.0	\$1,000,000,000.1	Reverse
2-02	\$0.00	\$0.00	No	\$0.00	\$0.00	No
2-03	\$0.00	\$0.00	No	\$50.00	\$5.00	Yes
2-04	\$3.00	\$0.00	Yes	\$15.00	\$5.00	Yes
2-06	\$0.00	\$0.00	No	\$100,000.00	\$100.00	Yes
2-08	\$1.00	\$0.00	Yes	\$20.00	\$5.00	Yes
2-09	\$10.00	\$0.00	Yes	\$15.00	\$0.01	Yes
2-10	\$1.00	\$0.00	Yes	\$1.00	\$0.00	Yes
2-12	\$1.00	\$0.00	Yes	\$5.00	\$5.00	No
2-13	\$1.00	\$0.00	Yes	\$10.00	\$0.00	Yes
2-15	\$5.00	\$0.10	Yes	\$5.00	\$0.10	Yes
2-16	\$0.00	\$0.00	No	\$0.00	\$0.00	No
2-18	\$0.00	\$0.00	No	\$0.00	\$0.00	No
2-19	\$1.00	\$0.00	Yes	\$75.00	\$1.00	Yes
3-01	\$0.00	\$0.00	No	\$5.00	\$0.00	Yes
3-02	\$0.00	\$0.00	No	\$0.00	\$0.00	No
3-03	\$0.00	\$0.00	No	\$2.00	\$3.00	Reverse
3-04	\$0.00	\$0.00	No	\$500.00	\$5.00	Yes
3-05	\$2.00	\$0.00	Yes	\$200.00	\$50.00	Yes
3-06	\$5.00	\$0.00	Yes	\$50.00	\$10.00	Yes
3-07	\$1.00	\$0.00	Yes	\$3.00	\$0.05	Yes
4-01	\$2.00	\$0.00	Yes	\$10.00	\$0.00	Yes
4-02	\$20.00	\$0.00	Yes	\$1,000.00	\$30.00	Yes
4-03	\$1.00	\$0.00	Yes	\$100.00	\$100.00	No
4-04	\$1.00	\$0.00	Yes	\$10.00	\$0.00	Yes
4-05	\$1.00	\$0.00	Yes	\$5.00	\$0.00	Yes
4-06	\$2.00	\$0.00	Yes	\$18.00	\$4.00	Yes
4-07	\$1.00	\$0.00	Yes	\$7.00	\$1.00	Yes
4-08	\$8.00	\$0.00	Yes	\$50.00	\$10.00	Yes
4-09	\$0.00	\$0.00	No	\$0.30	\$0.30	No
4-10	\$5.00	\$0.00	Yes	\$10.00	\$0.25	Yes
4-11	\$0.25	\$0.00	Yes	\$0.25	\$0.00	Yes
4-12	\$3.00	\$0.00	Yes	\$6.00	\$0.00	Yes