The Subjective Value of Information:

An experimental comparison of willingness to purchase or sell information

By

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Abstract

Subjective valuations determine the demand for information. Users formulated value judgments regarding information are important for the design of information systems. This paper focuses on information as content. We begin with the "Endowment Effect" extension of "Prospect Theory". In a simple computer simulated business game, two groups of fourteen and seventeen participants simulated a management task in which they were provided opportunities to buy or sell information. The bidding mechanism was incentive compatible. Results show that, in agreement with Endowment Effect theory, people value information they own much more than information not owned by them. Our findings indicate a place for the subjective value of information on the WTA/WTP ratio continuum that emerges from pertinent literature. The ratio for information is similar to that of market goods. Participants had a strong inclination to purchase but not to sell information although the profit data suggests that the use of information had no objective benefit for profit-making. This preference is attributed to risk aversion rather than to loss aversion which is the most widely-accepted explanation of the Endowment Effect.

Introduction

Do we want information to be free? What is the value of information? How can the value of information be determined? How does this translate into the demand for information? Is the demand for information rational? The focus of the present paper is on information as content and the measurement of its subjective value. We present findings that support a proposed theoretical foundation for measuring the subjective value of information. Numerous voices in both the public and intellectual arena have expressed the sentiment best captured in the slogan "information wants to be free". This view has been related to different incarnations of information: operating systems, software, business information, news or academic knowledge (Rafaeli 1989; Harnad 1990; Rafaeli and LaRose 1993; Branscomb 1994; Stallman 1994; Kelly 1997; Schwartz 1997; Lessig 1999; Shapiro and Varian 1999; Raymond 2001). The implications of this position vary from political ideology through novel business models to an upheaval in the established order of academe. The term "Free" means different things in different contexts. "Free" indicates either "liberated, available and accessible", or "at no cost". Or does it imply both? The slogan "information wants to be free" includes arguments against copyright law, in favor of collaborative development of software or support for unmitigated proliferation of content, often using information as attention grabbing inducements ("information freebies"). The evolution of media that erase the distinction between author and audience accelerate these notions of free information. Of course, the popular "information wants to be free" slogan cannot be evaluated apart from the fact that producing, manipulating and searching information is often rather costly. The issue is not just philosophical: business and markets promise and perils fluctuate widely around divergent conception of the value of information.

The Value of Information

Information is costly to produce, but very cheap to reproduce. It is therefore difficult to assess its value (Shapiro and Varian 1999). Neither cost nor value of information are related to the quantity of information produced. Information provides indirect utility in support of decisions so direct utility measurement is inappropriate (Van Alstyne 1999). Theoretically, there are three ways to assess the value of information (Ahituv and Neumann 1986): Normative, realistic and subjective. While user utility should be the base for calculating the price of information, utility varies by person and circumstance. Information is an "experience good", the value of which is revealed only after use (Shapiro and Varian 1999). Normative and realistic methods are ex post and consequently inappropriate for evaluating information content (also referred to as the "inspection paradox") (Van Alstyne 1999). We are, therefore, focused on the subjective value of information.

Measuring subjective value is inherently problematic due to the potential mismatch between qualitative reports and quantitative or monetary scales. Another problem relating to methodology is how to translate attitudes to behavior. If we assess value using an attitude questionnaire, how will we predict people's actual information purchasing behaviour?

The tradition of studying decision-making under uncertainty has addressed patterns of information use and the value assigned to information. The heuristics experiments (Tversky and Kahneman 1982) as well as later studies (Kahneman and Lovallo 1993) demonstrated that people tend to ignore available information like prior probabilities, sample size and the like. Instead, decisions are based on other subjective methods such as representativeness, availability and

adjustment and anchoring (also known collectively as heuristics). Earlier experiments have also shown that people tend to be conservative and undervalue available information for the revision of a prior opinion (Branthwaite 1975). A recent study (Bastardi and Shafir 1998) tested the pursuit of information for daily decisions. Participants preferred to seek information and based their choices on (objectively) noninstrumental information. In other words, people assigned positive subjective value to objectively worthless information. Theory also suggests that people seek information because it seems like the right thing to do (Feldman and March 1981) implying over-demand for information and a high subjective value. People tend to accumulate information "just in case" they may need it in the future, again leading to excessive demand (Van Alstyne 1999). The theoretical tension is, therefore, between studies indicating that information is under-valued and other research that shows that information is over-valued.

Previous studies have tried to elicit the subjective value of information by using surveys or semi-structured interviews (Davies 1994; Vlahos and Ferratt 1995; Hepworth 1998). This paper will focus on experimental methods, seeking higher internal validity.

Value Measurement

Subjective value has been studied experimentally for many types of market goods (also called private goods) and nonmarket goods (also called public goods). One very interesting finding of experimental research on subjective value is the identification of a disparity between the highest amount one is willing to pay (WTP) for a good and the lowest amount one is willing to accept (WTA) as compensation to give up the same good. Traditional economic assumptions imply that the difference between WTP and WTA should be negligible when income effects are

eliminated (the difference should amount to the decreasing marginal utility). However, empirically, experiments with various types of goods have shown that the differences between WTA and WTP are often substantial. Most research in this field indicates that WTA is significantly larger than WTP. By definition, WTA and WTP values are neither normative nor realistic. Instead, they are subjective values since they represent the individual's personal perception of an object's worth for him or herself. We apply the WTA/WTP methodology used for various types of goods to investigate the subjective value of information in order to determine what characterizes content as a good.

The WTA/WTP Disparity

The consistent, unexpectedly large and uni-directional difference between WTA and WTP observed with relation to traditional goods and services has generated much research interest. Attempts were made to explore whether the discrepancy can be explained by economic theory or whether the ratio belongs to the realm of irrational choice and is rooted in psychological origins. We will briefly review some of the pertinent literature on the WTA/WTP disparity and the explanations offered by economists and psychologists. We will highlight the common denominators for these two approaches.

Commonly, bidding is employed as the general experimental approach for researching the values of WTA and WTP . Participants in experiments are offered the opportunity to bid for the purchase of an item, or to state a reserve price for the sale of an item. There are many bidding mechanisms and there is no specific experimental design common to all the experiments described below. A comprehensive methodology review detailing the types of bids used in

different papers can be found in (Horowitz and McConnell 2000). Using the various bidding mechanisms researchers have demonstrated a significant disparity between the values of WTA and WTP for common market goods such as chocolates, pens and mugs (Kahneman, Knetsch et al. 1990; Bateman, Munro et al. 1997), and a much larger disparity for nonmarket goods such as health (Thaler 1980; Shogren, Shin et al. 1994). Trading induced value tickets or tokens of known value has not shown a WTA/WTP disparity (Kahneman, Knetsch et al. 1990; van Dijk and van Knippenberg 1996; Irwin, McClelland et al. 1998). In this case, of "induced value" items, the expected number of trades took place. The expected number of trades is half of all possible trades. Herein lies one of the important implications of the disparity: The existence of a significant difference between WTA and WTP leads to a reluctance to trade and results in undertrading. This was further confirmed by trading induced-value tickets of unknown value (van Dijk and van Knippenberg 1996; Irwin, McClelland et al. 1998) as well as lottery tickets (Knetsch and Sinden 1984; Bar-Hillel and Neter 1996) which resulted in a WTA/WTP disparity or undertrading. Interestingly, uncertainty was not the cause for the disparity observed in the mugs experiment (Kahneman, Knetsch et al. 1990) since the bids were made on mugs marked with clearly visible price labels.

The studies mentioned here as well as dozens of other studies (Horowitz and McConnell 2000) reveal a continuum ranging from induced (known) value tickets where WTA is found to equal WTP, through market goods where the disparity exists and on to nonmarket goods where the disparity is largest. The WTA/WTP ratio approaches unity for induced value items, is usually about 3 for market goods, while for nonmarket goods the WTA/WTP ratio is very large, usually about 10.

Theoretical Foundation of the WTA/WTP Disparity

Explanations for the WTA/WTP disparity have come from two main schools of thought, psychology and economics. Broadly, the psychological view is that decisions under uncertainty are often irrational and are based on rules of thumb, heuristics. This other-than-rational behavior in also manifested in market settings. People who are endowed with a certain good will require a significantly larger sum of money to give it up than they would be willing to pay for its purchase. Since the assignment of higher value is attributed to the ownership of the object, this phenomenon was termed the "Endowment Effect" (EE) (Thaler 1980). A later study presented the EE as part of a broader theory called the "Mere Ownership Effect" (Beggan 1992). The broader claim is that assigning greater value to owned objects is not limited to trading situations. The focus of the present paper is on the EE in trading situations. The main explanation for the EE in trading offered by psychologists (Kahneman, Knetsch et al. 1990; Thaler 1991; Bateman, Munro et al. 1997) is loss aversion which is part of the broader Prospect Theory (Kahneman and Tversky 1979). The value function described by Prospect Theory is based on observed behavior rather than on economic theory (reflected in the utility function). The value function reveals that losses are weighted heavier than gains since the slope of the function is steeper for losses. Giving-up an owned object is viewed as a loss while the utility of obtaining the same object is viewed as a gain. Therefore, people expect a higher price for disowning an object than the price they are willing to pay to gain the object. Some studies (Chapman 1998; Hoorens, Remmers et al. 1999) have tried to distinguish between the object of trade and the transaction and have found that both play a role in loss aversion. Further extensions and explanations of loss aversion in the context of the WTA/WTP disparity are described by "preference reversal"

(Thaler and Tversky 1992), the "status quo bias" (Thaler, Kahneman et al. 1992), the "reference-dependent model" (Tversky and Kahneman 1991; Bateman, Munro et al. 1997) and the anticipation of regret (Knetsch and Sinden 1984; Bar-Hillel and Neter 1996).

We now turn to the economic explanations of the EE. Most experiments on the EE were conducted controlling for income effects, therefore, the large WTA/WTP disparity was attributed to psychological or behavioral reasons without an economic theory explaining these findings. Hanemann (Hanemann 1991), developed a theory based on the substitution effect. In his article he showed that the WTA/WTP disparity and substitution effect are inversely related. A market good with many optional substitutes will show equality (WTA=WTP) while a good with few substitutes will show a large disparity. According to Hanemann the disparity can range between zero (the ratio equalling one) and infinity. Shogren (Shogren, Shin et al. 1994) tested Hanemann's theory and provided empirical evidence for the substitution effect theory: Experimental markets for candy did not show an endowment effect while health-risk experimental markets showed a large WTA/WTP disparity.

However, the fact remains, contrary to the substitution effect theory, that many experiments cited above have identified a WTA/WTP divergence even for simple market goods such as pens, mugs and chocolate. Possibly different experimental methods are at the root of this difference since different bidding mechanisms were employed and also because the theory by Hanemann and the experiments by Shogren were developed for a single-sided bid whereas other experiments used double-sided auctions.

Recent economic research (Kolstad and Guzman 1999) claims that an economic model can be developed to explain the divergence between WTA and WTP based on the uncertainty

created by lack of information about the value of the goods traded. The authors suggest that this model's prediction for the WTA/WTP divergence is an alternative to behavioral explanations such as the endowment effect or other economic theories like the substitution effect. According to this model information use is inversely related to the WTA/WTP divergence with the price of information directly related. When the price of information is high relative to expected payoffs, little information is consumed and a large disparity in WTA/WTP is observed. When the price of information is low relative to the expected payoffs, the values of WTA and WTP approach the common value, better known as the market value. In Kolstad's model the choice seems to be rational. However, usually the price of information relative to its payoff is not known so decisions have to be made under uncertainty.

A study on environmental goods (Boyce, Brown et al. 1992) revealed that the disparity between WTA and WTP is increased by the existence of an intrinsic value for environmental goods. They show that WTA includes an intrinsic value, which in the case of environmental goods is some moral responsibility, that has no utility or consumer value.

Common Denominators Between Psychological and Economic Explanations

The main psychological explanation of the WTA/WTP disparity are loss aversion which is based on Prospect Theory, degree of similarity and degree of uncertainty in the cases of induced value tokens and lottery tickets. The main economic explanations are the substitution effect, the tradeoff between the price of information and expected payoff and intrinsic value. The Prospect Theory approach received experimental economic substantiation (Horowitz, McConnell et al. 1999). Similarity observed in psychological experiments (Chapman 1998) is equivalent to economists' explanations of the substitution effect. Psychologists also

acknowledged that lack of commensurability is necessary for the EE to manifest itself (Kahneman, Knetsch et al. 1990), again a hint for the substitution effect. The immunity of induced value tickets to the Endowment Effect also supports the substitution effect explanation as such tickets have perfect substitutes when their values are known. Degree of uncertainty or the amount of information provided has also been researched both by psychologists and by economists as the studies cited above exemplify. The results in all cases show similar trends. Psychological theory proposed in order to explain the WTA/WTP disparity is based on observations of human behavior. This is in line with economic models which in this area of research are inductive and based on experimental markets rather than on traditional economic assumptions. Overall it can be said that economic and psychological research are moving in the same direction thus lending support to each other. The main underlying causes of the EE seem to be loss aversion and the substitution effect with their respective outgrowths. Variables that influence the EE are the type of good traded (induced-value, market, nonmarket) and the existence and availability of substitutes which imply the availability of information on the market.

Implications for the Subjective Value of Information

A choice to pursue information is a result of the desire to reduce uncertainty that characterizes certain decisions. Information in this sense is not a regular consumer good, it is more like a raw material consumed in the production of other goods down the value chain. The decisions of what kind of information will aid in reducing the uncertainty, where to look for information, what is the information worth are in themselves made under uncertainty. One rarely knows what kind of information one will find, what will be the quality of that information and to

what extent it will actually reduce uncertainty. All this stems from the fact that information is an experience good, the value of which is revealed only after consumption and also from lack of access to meta-information. Research that would shed some light on the value of information prior to consumption or what influences value formation will be of importance to content providers, decision makers and information system designers. Likewise, models that help predict market making processes pertinent to the trading of information would be welcome.

The result of the WTA/WTP disparity or the EE is that it creates undertrading. Fewer trades take place than should have occurred under standard economic assumptions. As cited earlier, lack of information contributes to an increase in the WTA/WTP divergence and hence leads to undertrading. Conversely, abundance of information suggests an accelerated pace of trade. Information is an economic catalyst. Increasing the perceived value of and the demand for information should be the objective of any market-oriented organization in order to increase the number of trades.

Substitution effect theory should predict a large WTA/WTP disparity for information. This is because of its inherent nature as an experience good meaning each item of content is unique. On the other hand, the abundance of free information on the Internet and searchers' inclination to seek free content suggest a low subjective value for information producing parity between WTA and WTP. In light of this apparent contradiction we have chosen to begin our investigation with a fundamental question about WTA and WTP for information in order to form a basis for further research on factors influencing these values and other issues of importance. Our research question is : Where is information found on the WTA/WTP disparity continuum? Our hypothesis is that the WTA/WTP ratio for information is at least as high as holds for market

goods. In other words, the WTA/WTP ratio will be greater than unity. We predict that the value will approach three, which is the value observed for regular market goods. We expect the ratio to go no higher than the standard set for market goods.

Research Methods

Experimental Instrument

A Java-based computer simulation of a simple-to-understand business game called the Lemonade Stand was used as the experimental instrument. In this simulation the player owns a lemonade stand and must operate it to maximize his/her profits by selling to passers by. Participants are charged with making quality, pricing and inventory decisions. The player can modify product quality parameters for the lemonade (amounts of sugar, lemons and ice) and is also able to set the price charged per cup. Players also decide how much inventory (lemons, sugar, paper cups, ice) to purchase at each round (day). Inventory purchases are selected from three predefined options per raw material. The players' price, quality and inventory decisions should be influenced by information about weather conditions that is made available prior to each day of trading and also by the reactions of the clients which appear as textual bubbles above their heads during the trading day. After entering all quality and inventory decisions the player presses the "sell" button at his/her leisure to start the trading day. Selling is done automatically based on the parameters entered and cannot be interrupted by the player. During the trading, the player sees an animation of the stand, clients walking by, and the textual feedback with comments from clients. Typically, a "day" would take two minutes. After playing for several consecutive days which constitute a cummulative "game", the player is notified about the clients'

satisfaction and the combined net profit or loss. Players have been urged to maximize their profit and were rewarded monetarily according to the actual profit achieved. The entire simulation was conducted in Hebrew for the benefit of participants who were all native Hebrew speakers.

Participants

Thirty one honors program undergraduate students in two groups of fourteen and seventeen participated in the experiment as part of a class requirement. One group was presented with the selling scenario first and the other group started with the buying scenario. The players were seated in a computer lab with an individual computer for each player. They were not allowed to interact with each other but were allowed to ask the experimenter for clarifications.

Procedure

The experiment was preceeded by a detailed in-class presentation of the simulation along with handouts that included the instructions and sample screenshots. A sizeable monetary prize equalling the accumulated profit from all games was offerd to the player who would achieve highest profits. Participants were told that profits could be made in two ways: 1. By trying to optimize the inventory, lemonade quality and price per cup depending on the weather data (if available). 2. By trading information (selling generates direct income while buying information can generate indirect payoffs if played wisely).

The experiment began with two warm-up training games of five days each, one without weather information and one with weather information. The trial-training games were followed by six real games of three days each. The players were told that the training games will not

count toward the final profit calculations and were designed only for the purpose of getting acquainted with the game. Each of the following six real games began by presenting the players with either an opportunity to purchase the weather information, or a chance to sell weather information he/she would otherwise have and keep. For each game, participants were, therefore, shown online questions about their WTA or WTP. One bidding opportunity was presented per game with the order of appearance changing between groups. Market prices for the information trades were built into the simulation but were not known or revealed to the players. The players were only told that market prices were to be determined randomly and that trades will be executed at market prices if the bids they offered are acceptable. This was done to ensure incentive compatibility according to the Becker-Degroot-Marschak principle (Becker, DeGroot et al. 1964). Thus, the experiment yielded three WTA values and three WTP values of the weather information for each participant. The entire experiment lasted an hour and a half which included the presentation, the warm-up games and the six games with bidding.

Measures

Various measures were collected from the Lemonade computerized simulation: Stated value for the willingness to pay for weather information (in US Dollars) was entered by the participants in an empty dialog box in response to an online question: "Please state the price you are willing to pay in order to purchase weather data for the entire game period. The trade will take place only if your bid complies with the current market price." Participants were asked to reconfirm (with an option to change) their bid prior to proceeding with the game. Willingness to accept payment for weather information (in US Dollars) was entered by the participants in an empty dialog box following the question: "Please state the price for which you

will agree to sell weather data for the entire game period. After selling the information you will play without weather data. The trade will take place only if your bid complies with the current market price." Participants were asked to reconfirm (with an option to change) their bid prior to proceeding with the game.

Data recorded automatically included: Game profits, all quality and inventory parameters entered, use of the online help option, reputation (number of clients who came following a recommendation by satisfied clients) and popularity (derived from the number of clients who bought lemonade out of the total number of clients).

Analysis

Paired samples t-tests were performed to compare the means of WTA and WTP within groups for each of three replications of the games. The effect of conditions order was tested by an independent samples t-test of WTA and WTP values and of the ratios between groups. T-tests were perfomed to place the WTA/WTP ratio on the ratio continuum described in the introduction comparing the ratio to a value of 1 (WTA=WTP) and to a ratio of 3, the ratio for market goods. A General Linear Model for repeated measures was employed to test for differences among the three ratios. Paired samples t-tests were performed to compare the mean profits for the warm-up games with and without information.

Results

The present results reveal that the WTA/WTP ratio for weather information in the Lemonade simulation is about 3 and that there was a strong preference to play with information. Results shown here represent groups of thirteen and sixteen participants rather than the original

groups of fourteen and seventeen because one extreme outlier was removed from each group. The extreme outliers were larger than the other data by an order of magnitude. Table 1 lists pairs of bids given in six games during the experiment. The t value exceeds unity in all cases although not always statistically significant at the 0.05 level or better.

Table 1: Paired samples statistics to test differences between WTA and WTP within groups.

		Mean	N	Std. Deviation	t	p
Pair 1	wta rep 1 Group1	22.08	13	18.95	3.01	.011
	wtp rep 1 Group1	7.85	13	7.36		
Pair 2	wta rep 2 Group1	17.92	13	25.67	1.92	.078
	wtp rep 2 Group1	4.61	13	2.66		
Pair 3	wta rep 3 Group1	19.92	13	26.79	1.71	.113
	wtp rep 3 Group1	7.45	13	8.14		
Pair 4	wta rep 1 Group2	14.91	16	12.13	3.43	.004
	wtp rep 1 Group2	5.10	16	2.48		
Pair 5	wta rep 2 Group2	15.13	16	13.09	2.89	.011
	wtp rep 2 Group2	6.22	16	3.81		
Pair 6	wta rep 3 Group2	10.44	16	6.85	1.99	.065
	wtp rep 3 Group2	6.72	16	5.35		

A between-groups independent samples t-test was performed for WTA values and also for WTP values. In all cases statistical significance was not obtained meaning there is no statistical difference between the bids of the two groups. The ratios were also compared between groups and no significant difference was found in any case. Accordingly, the data from both groups have been united into one set of data.

Table 2 shows the mean values of the WTA/WTA ratios (mean of ratios), the t-value and its significance for a one-sample test once with the test value being one and once with the test value equalling three. The results indicate that the mean ratio is significantly different than one but not significantly different from three.

Table 2: One sample statistics to test differences between the mean WTA/WTP ratio (denoted "ratio" in the table) and values of 1 (meaning WTA=WTP) or 3.

	N	Mean	Std. Deviation	t (test value=1)	p	t (test value=3)	p
Ratio 1	29	3.31	2.49	5.00	.000	0.668	0.509
Ratio 2	29	3.49	3.91	3.43	.002	0.676	0.505
Ratio 3	29	2.70	3.46	2.64	.013	-0.468	0.643

The General Linear Model for repeated measures that was used to test for differences among the three ratios produced by each participant revealed that there was no statistical difference among the three ratios ($F=1.034$, $p< 0.369$).

Table 3 summarizes the means and medians of the ratios obtained by dividing each participant's bids for WTA and WTP. Most of the experimental papers to date have reported the mean WTA value divided by the mean WTP value (Horowitz and McConnell 2000). Table 3 includes these data as well to preserve comparability with data previously reported.

Table 3: A comparison of means and medians of ratios with the ratios of mean and median WTA and WTP values.

	Ratio 1	Ratio 2	Ratio 3
N	29	29	29
Mean of Ratios	3.31	3.49	2.70
Std. Deviation	2.49	3.91	3.46
Ratio of Means	2.86	2.98	2.09
Median of Ratios	2.05	2.00	1.43
Ratio of Medians	2.40	2.40	1.80

In order to examine whether the use of information produced an objective benefit for the participants we examined the two warm-up games profit data. These data with the results of a paired samples t-test are summarized in Table 4. The warm-up profit data were combined after an independent samples t-test of the profits between groups revealed no significant difference for profits with or without information.

Table 4: Mean profits in the warm-up games with and without weather information.

Mean game profits (US dollars)			
With information	Without information	t	p
7.58	7.40	0.096	.924

Table 5 summarizes the tendency to trade information in the buying and selling bids in all six games. A total of 68.3% (127 out of 186) of the games were played with information. Overall, 84 trades took place out of 186 trading opportunities (45.2% trading).

Table 5: Percent of trades executed in each type of bid for all games.

	WTA	WTP
Percent of trades executed	26.9%	63.4%

Discussion

As predicted by the Endowment Effect theory, WTA for information was consistently larger than WTP for information although statistical significance of the difference was not always achieved (Table 1). We attribute the lack of statistical significance in some of the results to several factors: Small number of participants and high variance due to lack of bidding limits and the fact that we removed just two outliers. Despite these drawbacks a consistent and significant trend is identified where information displays a disparity between WTA and WTP values as was found previously for many market and non-market goods reviewed in the introduction. Further support for the existence of a substantial disparity is found by two analyses. One is the t-tests between groups comparing separately the WTA and WTP values and the individual ratios in which no significant difference was found, meaning the reproducibility of results is good. The second analysis is that of the mean ratios (Table 2) which were found to

significantly diverge from unity but not different from the repeated research-reported level of three. This means the numerator (WTA) is three times larger than the denominator (WTP).

A widely used and heard slogan is that information is (or is becoming) a commodity. Nevertheless, information still has its peculiarities. It is easier to duplicate, easy to share, and ownership of it proves more difficult to enforce. A weighted overall mean ratio of 3.17 obtained here for WTA / WTP is typical of regular market goods (Horowitz and McConnell 2000). Does this imply that information is a regular market good? The relatively low WTA/WTP ratio for market goods is usually attributed in the literature to the existence of fairly good substitutes. But does information, which is an experience good, have substitutes? We believe further interpretation of the results as well as further research is called for before making conclusions about the nature of information as a good.

Each player provided three WTA bids and three WTP bids, hence three ratios per player were calculated. Our aim was to see whether the ratio can be established as a stable indicator of subjective value. If no significant differences were found among the three ratios, then the ratio could be suggested as a good predictor of subjective value. GLM for repeated measures was performed to test for significant differences among the three ratios. No significant difference was observed among ratios implying that a ratio is a stable predictor of subjective value despite the large variance of the values that comprise this ratio. The stability of the disparity has been researched specifically and reported to remain constant or even increase slightly over repeated trials for market goods (Morrison 2000). The stability of the WTA/WTP disparity has been attributed to the existence of an intrinsic value which distinguishes induced-value goods from

market and non-market goods (Boyce, Brown et al. 1992). The determination of the intrinsic value of information is a question for further research.

In Table 3 we report several descriptive data. We report the mean of ratios because we believe it is the best reflection of the individual bids which in turn reflect the individual subjective values assigned to the weather information in the Lemonade game. Reporting a ratio has several advantages over reporting individual values that comprise the ratio. First, a group of ratios is likely to have less variance than its components. Secondly, a ratio is unit-free and enables comparison of experiments run in different countries. Thirdly, a ratio neutralizes the object of the experiment and becomes an index in its own right. Here the ratio is an indicator of the type of good at hand. Finally, in the present case, a ratio is the traditional way to report results of experiments testing for the EE. We also report the ratio of the mean values of WTA and WTP since this is the value most often found in the literature. The problem with this type of calculation is that it does not reflect the individual ratios and that it is not usable for statistical analysis since it is a single point calculation rather than a statistical descriptor. A ratio of means may be the value of choice when participants in an experiment bid only on one value, either WTA or WTP because then an individual ratio cannot be established.

Interestingly, mean profit values with and without the use of weather information in the warm-up games were virtually identical (Table 4). No significant difference was found for the profits of players playing with information versus without information. It is quite srtiking that high subjective values were assigned to information despite the lack of objective value for the information presented. The players were shown their profit data at the end of each game so they were free to decide not to purchase information if it did not prove instrumental. However, our

data showed that even in the face of objective uselessness of the information, participants valued information and wanted to buy it. They exhibited a bias in favor of buying more than selling, although buying and not selling had an effect on subsequent profits (buying meant paying from one's budget while selling meant earning and enlarging one's budget). This is in agreement with the observations of (Bastardi and Shafir 1998) and with (Grant, Kajii et al. 1998) who found that preference for information does not imply expected utility. It could be argued that participants may act as "information dealers" wanting to maximize profits by buying and selling information in every opportunity given. To exhibit such behavior means to execute all three WTA deals and all three WTP deals. The bias in favor of buying information is further highlighted by the exceptionally low inclination to use free information available by clicking on the Help button. The Help button was selected twenty one times by all participants combined (out of a possible 1,240 times) although the availability of Help was stressed during the presentation and in the handout. Does this mean that for-fee information is valued higher and is more desirable than free information? This question awaits further research.

The strong preference to purchase information is also reflected in the percent of trades which actually took place as seen in Table 5. We assume a 50% expected percentage for trades. For WTA we see major undertrading while for WTP we observe considerable overtrading. Participants were reluctant to sell and eager to buy information for the game as also manifested in the number of games played with information (68.3% of the games played with information). The overall average of the trades that took place was 45.2% which shows only a small trend for undertrading. These results suggest that information may be a more marketable good than many other market goods because the desire to buy information is very high.

The distinct preference to own information is also reflected in the relatively high values assigned both to WTA and WTP which resulted in a relatively low ratio. The high value of WTA implies not only the reluctance to sell but also the value assigned to non-use of information for the purpose of playing the game.

The present experiment was a one-sided open-ended bid for the purchase of information which had potential instrumental value for the Lemonade game. One-sided, open-ended bidding in auctions is known to produce higher prices than auctions where the decision is to accept or reject a given price (Kagel 1995). This is yet another demonstration of a violation of procedure invariance which is the underlying explanation of the preference reversal phenomenon mentioned in the introduction. However, in the Lemonade game, bidders were told explicitly that they are not competing with each other for the information so they had no incentive to raise their bids above their private values. Each bidding question was followed by a statement reminding participants of the BDM rule that the trade will take place only if it is compatible with current market prices, again encouraging bidders to submit their true values.

It can be argued that the relatively high bids are a result of the BDM procedure which is incentive-compatible only for the market value. In the Lemonade game a player can enter a high bid but is assured of actually paying only the market price so the player bids high strategically out of risk aversion and his/her will to verify that the bid will achieve its goal (buying or not selling). Possibly the high bids both for WTA and for WTP for information and the moderate ratio of these values can be better explained by risk aversion rather than loss aversion which is the most widely-accepted explanation for the EE. Bidders wanted to ensure access to information and did not want to risk playing without it. The relationship between

information and risk aversion has been addressed by a theoretical model (Grant, Kajii et al. 1998) establishing that intrinsically information-loving people are also risk-averse. Risk aversion has also been linked empirically to lack of information (Kahneman and Lovallo 1993). The concern about strategic bidding with the purpose of making the deal rather than learning about the market value instead of bidding the true subjective value should be addressed by further experiments controlling for this issue. Possibly a closed-end BDM-based game can better predict the true subjective values.

Another explanation for the high bids is that bidders had no information about the market price and received only indirect feedback whether they succeeded in purchasing or selling information from the new game settings presented to them after the bid. Lack of information tends to produce higher bids (Kagel 1995). This corresponds well to the theory put forth by (Kolstad and Guzman 1999) who showed there is an inverse relationship between the amount of available information and value of goods traded.

Bidders in our game demonstrated their desire to play using weather data by entering relatively high bids for WTP (willingness to buy information) and for WTA (willingness to keep information). The result was a significantly larger number of trades executed for WTP than for WTA and a significantly larger number of games played with weather data than without. A by-product of the high value in both bids is that the ratio between the bids is relatively small and resembles that of market goods. We propose that eliciting the subjective value of a good requires an investigation into the number of trades in each type of bid. The ratio of the number of trades that took place for each type of bid is also an important dimension of the subjective value of information.

The present research gives rise to many questions. Information as content is an experience good. We neither have prior information on information nor do we have substitutes. How, then, can we explain the information economy in light of these findings? Can the EE phenomenon be related to the decrease in the relative demand for information while production is increasing (Lyman and Varian 2000)? One explanation can be the problem of information overload. We cannot handle and absorb the very large amounts of information at our disposal. Why do we complain of information overload while the WTA/WTP disparity and our market behavior suggest we suffer from lack of information? Perhaps, as suggested earlier (Bastardi and Shafir 1998), we misuse information. We pay attention to the wrong information for the wrong reasons. How can we reduce uncertainty regarding information and be better consumers of information? If we value our time so dearly as suggested by experiments (Ortona and Scacciati 1992; Hoorens, Remmers et al. 1999), why do we spend so much of it looking for useless information? These and many other questions await research.

In the experiment presented here a certain type of information was used in a specific setting. In order to generalize or differentiate various types of information and find their places on the WTA/WTP ratio continuum further experiments are needed using different types of information in different settings. For example, it can be hypothesized that information regarding a person's health will yield a high WTA/WTP ratio, possibly similar to that of public goods. Variations of the present or other simulations may be developed for training purposes to highlight the value of information and suggest ways for more efficient utilization of it.

Our aim to elicit the subjective value of information was achieved in that we have developed an experimental procedure based on widely researched theory. The main contribution

of the present research is that it shows the subjective value of information to be consistently high by a number of parameters. Our experiment has also shown that the consumption of information is based on irrational decisions possibly caused by risk aversion. Several experimental variations and refinements are called for in order to establish a coherent theory about the subjective value of information.

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