
The Price Is Right? Economic Value of Location Sharing

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Abstract

The popularity of location-based services such as Foursquare has made location sharing a common practice. Commercial companies can use the shared location for marketing purposes and often motivate users to share using discounts or special offers. We examine the reward users demand in such a scenario to try and estimate the value they ascribe to their own location information. Our user study is conducted using a mobile phone application that randomly offers users hypothetical money coupons in exchange for publishing their location. Responses by 25 participants to 481 such offers show that the willingness to share increases with coupon value, yet varies greatly with the location being shared. We use logistic regression to estimate the value above which most users will share their location and find it to be €8/€5.4 (\$10.4/\$7) for a user's home and work respectively. This work contributes to the growing body of knowledge about the economic aspects of location-based services.

Author Keywords

Location Sharing; Privacy Economics; Mobile Technology

ACM Classification Keywords

K.4.1 [Computers and Society]: Public Policy Issues --- Privacy.

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Ubicomp'13 adjunct, September 8–12, 2013, Zurich, Switzerland.

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<http://dx.doi.org/10.1145/2494091.2497343>

General Terms

Economics, Experimentation.

Introduction

In recent years, with the prevalence of GPS-fitted smartphones and other positioning technologies, people's location has become an accessible and exchangeable piece of information. The growing popularity of Online Social Networks (OSN) and social location-based services such as Foursquare¹ and Facebook check-ins² has made location sharing a common practice [10]. These services allow users to *check-in*, i.e. notify other users of their current location. Commonly, if a user checks-in to a commercial venue, the service also notifies the venue's owner of the user's arrival.

People's willingness to reveal their location has not gone unnoticed by commercial companies. With the emergence of OSN, traditional "word-of-mouth marketing" has been adapted to the digital age (and was rebranded as *viral marketing*). The basic idea remains unchanged: when users check-in to a restaurant they expose it (and implicitly recommend it) to their social network, thus contributing to the restaurant's promotional efforts. Moreover, attaining location of existing or potential costumers allows businesses to build detailed customer profiles, leading to effective marketing and more sales. A recent example is the startup company *Trendit* (<http://trendit.net/en/>) that infers the socioeconomic status of clusters of shoppers (using their home

¹ <http://www.foursquare.com>

² <http://www.facebook.com>

neighborhood obtained from anonymous cell phone data) and sells the statistical information to retailers.

It is apparent that businesses want users to share their location with them and "check-in" to them. But what would motivate users into doing so? Lindqvist et al. show, in a study about Foursquare [10], that the decision to share is affected by a complex incentive system. Users share for social benefits (e.g. interact with friends); for fun and gaming (Foursquare awards frequent users virtual "badges"); and sometimes to receive discounts or special offers from checked-in venues. These factors interact, as the places a user visits affect his public image. For example, the paper shows users who refrained from checking into a cheap fast-food restaurant (albeit the gaming incentive mentioned) so as to not lose face with their social network. The question remains whether a discount offered by that restaurant would have changed their decision and what discount value would have sufficed. An illustration of this effect can be seen by a \$10 McDonald's promotion, reportedly leading to a 33% increase in the number of check-ins to the chain [13].

This work explores the economic value users ascribe to their location information. It differs from previous work on this subject in several ways, as will be detailed in the next section.

Our two main contributions are:

- We present a novel scheme to assess the monetary value of location sharing in a realistic scenario, where each sharing request is considered individually. To the best of our knowledge, this is the first study of such a scenario.

- We estimate the proportion of users who will share their location for a given price, and show the effect of the location being shared on that proportion.

Related Work

Several studies have examined aspects of location-sharing services. Methods used include user surveys, interviews, observations and field studies with designated location-sharing applications. The paper by Lindqvist's et al. [10] surveys some of these works. Two factors that constantly show up as barriers to location sharing are privacy concerns and self-representation (public image) concerns. Kelley et al. show [9] that privacy concerns are even greater when location is shared for commercial purposes. The scenario we present to participants of our experiment emphasizes these two factors. As opposed to [9], we use a dynamic pricing scheme, that can change for each sharing request and captures not only the tendency to share location for commercial purposes but also the required compensation.

The effects of mobile coupons have been previously examined by Dickinger and Kleijnen [6]. They conducted a user survey and showed that different "user types" (e.g. *value seekers*) react differently to coupons and are affected differently by their value.

Finally, there is a growing body of work on the economics of private information (see the survey by Camp [3]). Several researchers (e.g. [7, 8, 12]) have tried estimating the monetary value people ascribe to their personal information, but only few works have tried valuating *location information*, which is the focus of our study.

The first work that examined the value of location information was by Danezis et al. [5]. Their experiment was facilitated using a *cover story*. This is a common technique in privacy studies needed in order not to bias participant's answers (this bias was recently explored and empirically measured by Braunstein et al. [1]). They pretended conducting a study that required subjects to have their location monitored (via their phone) 24 hours a day over a period of one month. For participating, subjects would receive a monetary compensation. 74 participants were recruited, all students at the University of Cambridge.

Participants were told that due to limited budget, an auction will be held where each of them will offer the compensation he requires for participating in the study. Median bid was GBP £10. Several days later, participants were told of "possibility of commercial interest" in the study. They were asked how their bids will change if the data collected can also be used by commercial entities. Median bid now rose to £20.

Cvrcek et al. [4] followed up and generalized this study by recruiting some 1200 participants of a more varied background from 5 European countries. They followed the same method used by Danezis et al. and reported similar results. Median bid for non-commercial use was EUR €43 (£28 at relevant exchange rates) and it roughly doubled for commercial use. Authors noted large differences between bidders from different countries. As in Danezis et al.'s study, after the bidding stage ended, participants were told of the study's actual purpose. Accordingly, no actual location information was collected and participants did not actually receive the amount they bid for.

Brush et al. [2] repeated this experiment in 2009 with 32 participants from the United States. Median bid for commercial use was USD\$ 100 (approx. €80), twice as high as the result from Cvrcek et al. A possible explanation is bias introduced by the researchers, as the bidding followed from a comprehensive interview regarding location privacy risks and preferences.

Our work differs in several ways from these previous works. Mainly, the experimental setting has more resemblance to real-life location sharing scenarios:

- Users are presented with specific location sharing requests, and not a continuous month-long tracking. This setting also allows us to analyze the effect of the specific location being shared.
- Location sharing in this study incurs multiple privacy concerns at once: personal privacy (e.g. concerns of burglars or stalkers), commercial usage of data and social network self-representation issues.
- Implications of sharing are better communicated to users: the meaning of a 'post' on a Facebook page is much clearer to users than an ambiguous "academic usage" or "commercial usage" offered in previous studies.

Method

We recruited participants by e-mailing invitations to students in the Faculty of Engineering, allowing them to forward the invitation to other people who may be interested. The invitations stated simply that we are looking for users of mobile phones with Android operating system willing to take part in a short study. No monetary compensation was offered to participants. The experiment itself was approved by our Institutional Review Board (IRB).

In order to avoid the bias toward privacy concerns, as explained earlier, we disguised the study's real purpose. Interested subjects were told the study is intended to check their attitudes toward marketing proposals. Also, concepts used in the study were of commercial association: coupons, business offers and location publishing. Out of 28 initial responders, 3 decided to opt-out after receiving more details of the study.

Of the 25 final participants, 14 were males and 11 females. Average age was 29 ($\sigma=6.5$ years). Participants were of various backgrounds, ranging from shop clerks to electrical engineers.

Smartphone Application

Participants were asked to install on their mobile phones a designated Android application we developed for location-based surveying. The application tracks users' location through the phone's positioning services (GPS, Wi-Fi and cellular antennas).

The application pops-up randomly 2-4 times a day, with survey questions regarding a location the user had visited lately. The location is presented on a detailed map, showing street names and specific landmarks. All participants were given detailed instructions regarding the application installation and survey questions. Participants used the application for a period of twelve days in June 2012.

"10 Coupon" Survey

We implemented a survey in the application that comprised two questions (see Figure 1. Map details intentionally removed). The survey name, "10 Coupon", was chosen to emphasize the commercial association, as it resembles the name of a popular restaurant index.

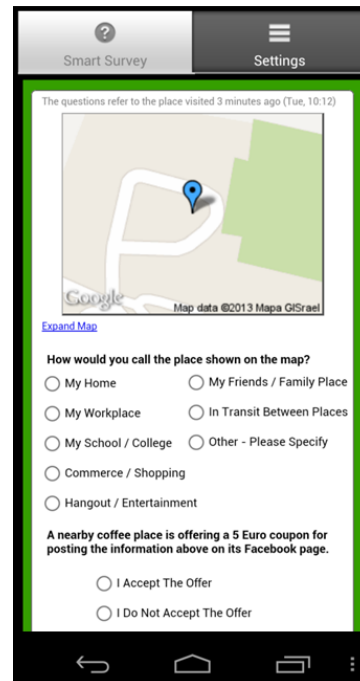


Figure 1. The location-based surveying application. Map details intentionally removed.

The first question requires the user to define the semantics of the location shown (e.g. my home, my work, a friend's home). The choice is from a closed list plus an "other" options that allows users to enter free text.

The second question is a close-ended accept/reject question offering the user to publish their name and location, along with the map and the location's semantics on the Facebook page of a nearby coffee place. Users were told that the Facebook page is publicly visible and is locatable via Internet search

engines. The supposed business rationale of the coffee place (as explained to users) was collecting information of potential customers nearby and exposing itself to their social networks. If the user accepts the offer, they would receive a money-valued coupon valid in that coffee place. Each time the survey shows, the offered coupon's value is randomly selected. Possible values were in Israeli local currency equivalent to 1, 2, 4, 6, 10, or 20 Euro. All offers given in this study were hypothetical: user's location information was not really published and no actual coupons were given. Obviously, this is a limitation and we will address it in the discussion section. The hypothetical nature of the experiment was clearly communicated to the participants before it began. Still, it did not expose the fact that the experiment's true focus was privacy and not marketing.

We chose accept/reject offers with a given price, instead of auction-based techniques, following the observation by Acquisti and Grossklags [7]:

"Closed-ended questions... resemble typical consumer privacy decisions closely. In particular, we are not aware of situations that allow consumers to specify a price for their information or negotiate the cost... rather, consumers are left to accept or reject offers in the marketplace".

Coffee shop coupons (and not cash) were chosen for several reasons. First, in accordance with our cover story, coupons make sense as marketing promotions (similar campaigns are frequently launched on Facebook and on location sharing services). Specifically, coffee shop coupons are valuable for a wide range of users, as opposed to coupons for pubs,

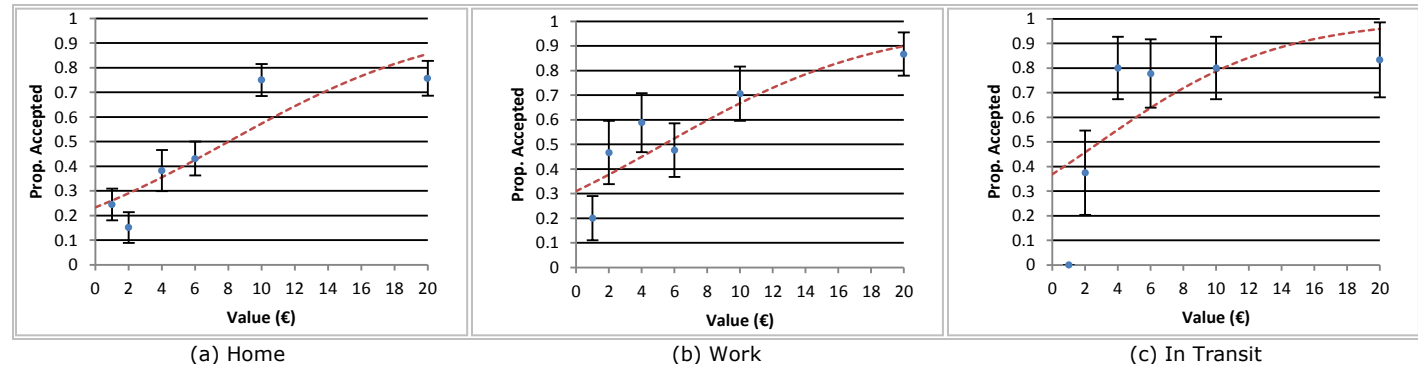


Figure 2. Proportion of offers accepted for each coupon value and location. Error bars show 1σ , dashed line is logistic regression curve.

for example, which would be more relevant to younger participants. To validate the latter, we asked the participants in their personal details questionnaire about coffee shops habits and found that all users visit coffee shops at least once every two weeks.

Results

481 distinct observations (survey responses) were received, most of them in the semantic locations *home* (244) and *work* (105). Next frequent location was *in transit between places* (49). Table 1 shows the proportion of accepted sharing offers in these top 3 locations. Other locations were observed less frequently: *friends/family* (30), *school* (21), *hangout* (13), *shop* (8) and *other* (11). Summing over all locations, roughly 50% (242/481) of offers were accepted and the rest rejected.

We began by verifying that higher coupon value does generally affect the tendency to share. Over all locations, average value for which users accepted a sharing offer was €9.5 (\$12.4). The average value for which users rejected such offer was roughly half, amounting to €4.9 (\$6.4).

	Home	Work	Transit	All Other Locations
Accepted	112/244 (46%)	56/105 (53%)	31/49 (63%)	43/83 (52%)

Table 1. Accepted sharing offers for each location

Wilcoxon rank sum test shows that the difference between means is significant ($p < 0.001$).

We further quantified the effect of coupon value on the sharing decision. Figure 2 shows the proportion of offers accepted for each coupon value, for each of the top 3 locations. It can be observed that the proportion rises with the initial increase in coupon value and then saturates.

We define the *median price* as the coupon value above which the proportion of sharing offers accepted is 50%. To assess that price we fitted a regression curve to the collected data. While not fully describing the data, best fit was obtained with a logistic curve, also plotted on Figure 2. We should emphasize that the logistic curve is used to show the response to different coupon values and locations - and not intended to be a complete user model.

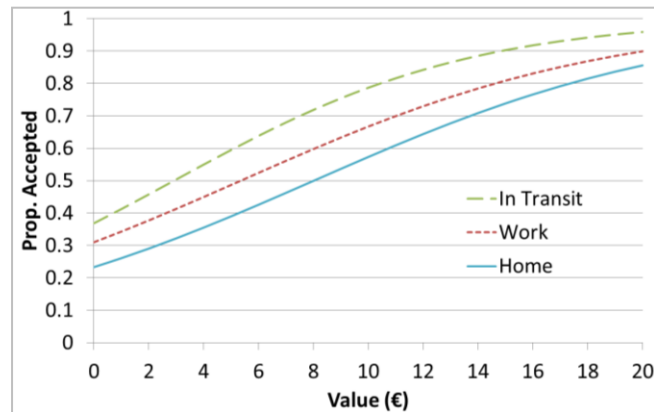


Figure 3. The 3 regression curves from figure 2 plotted on the same chart. Difference in sharing preferences is clearly visible.

Figure 3 shows the 3 fitted curves on one chart for clarity. Median prices predicted are €8 (\$10.4) for home, €5.4 (\$7) for work and €2.9 (\$3.8) for in transit. Summing over all locations, median price for a single location share is €6.8 (\$8.85).

Discussion

The scenario presented in this study reflects on some of users' most concerning privacy issues at once: users' privacy is threatened with their location publicly shared; users' location is used by a commercial entity; and by accepting the offer, users publicly admit their privacy can be "bought", rising more self-representation issues.

The results show that the location being shared affects the user's willingness to share, a phenomenon observed in earlier works. For example, Toch et al. [11] showed that *public* places, visited by many users (where no single user is noticeably frequent) are more easily shared than *personal* places, which are visited

only by a single user or few dominant users. In our study, users required a higher reward to share their private home location in comparison to the more public work location. A transient, diverse location such as the road a user is using when driving between places (in transit) is even more easily shared. Accordingly, we expect residence of family members or friends to be considered very sensitive by users, though we did not have enough observations of such locations to validate this statistically.

As expected, the willingness to share rises with the reward offered, while the saturation suggests some users may not give up their location privacy at any cost. Even at the highest coupon value offered, more than 20% of offers to share the home location are refused. This is a result never observed in previous location sharing studies.

These results have implications for designers of location-sharing systems and for commercial companies using these systems as a marketing platform. A proper value must be given to the information users share and users can be profiled by their sharing preferences and valuation of "public" locations vs. "personal" location. Another factor to consider are the diminishing returns (in terms of the user's tendency to share) on the compensation offered.

This study had several limitations. Mainly, the hypothetical nature of the offers allows users to act differently than they would have in a situation with real-life implications. Also, some behavioral effects could not have been controlled for. It follows that users' consecutive responses to offers are not truly independent: if a user shared his workplace once, he might feel easier to do this in the future, as this

information has already become "public domain". On the other hand, if a user had just agreed to share her location for €20, she might consider a consecutive offer of €2 to be "cheap" and refuse, even if she would have agreed to an independent €2 offer.

Uncovering and quantifying such behavioral effects is an interesting subject of research by its own, but it is not the focus of this paper. We performed some preliminary exam, yet did not reach any conclusive results regarding the existence and direction of such effects. Figure 4 shows the number of offers to share "Home" location that were accepted over 8 consecutive days. These accepted offers are separated into "low value" offers (coupon values of EUR 1,2,4) and "high value" offers (values of EUR 6,8,10). As expected (and shown earlier), "high" offers were accepted more frequently, and no significant behavioral effect or temporal pattern are observed.

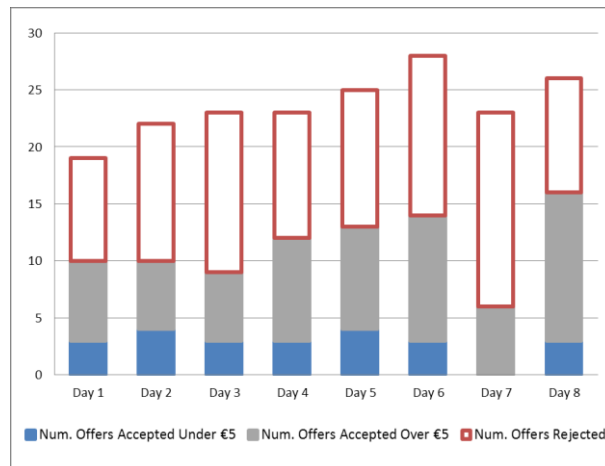


Figure 4. Number of sharing offers for "Home" that were accepted / rejected each day by coupon value.

Whether behavioral effects exist or not, to overcome both limitations mentioned, an actual payment mechanism will be required, as well as a larger sample, so that each user could be given an offer only once.

Conclusion

Our study presented a scenario in which users were offered to publicly share their location in return for a money-valued coupon. The scenario was facilitated using a designated mobile phone application.

This work contributes to the literature showing location information is a valued commodity. We found the median price for a one-time share of a user's home location to be €8. Interestingly, in Cvrcek et al. 2006 study [4] users required only about 10 times more for a month's worth of 24/7 tracking (that will inevitably include their home and probably higher-sensitivity locations).

Straightforward exchange of location for monetary rewards in real life (such as facilitated through Foursquare) is only in its infancy. It is possible that as public awareness rises and more companies use this marketing channel, the competition will make location price higher. Companies might discover that soliciting such information is not only a question of privacy or law, but also an economical decision.

Acknowledgment

This work is partially supported by the Israel Ministry of Science Research Infrastructure Grant No. 3-8709.

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