Sharing is Caring, or Callous?

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Abstract. The practice of third-party applications (social apps) on social networks sites (SNSs) to collect information about users' friends has raised awareness of the problem known as *interdependent privacy*. Although studies have quantified the value which app users place on their friends' personal information, i.e., interdependent privacy value, few have investigated factors that affect the valuation of interdependent privacy. In particular, research indicates that social capital, which is an immaterial resource that can yield positive social outcomes, plays an important role in individuals' decision-making. Motivated by these works, we study the complex and yet undetermined relationship between interdependent privacy value and social capital. In addition, in order to gain a thorough understanding of interdependent privacy valuation, our study also examines its relationships with factors such as app data collection context (i.e., whether or not data collection is relevant to app performance), individuals' number of friends within SNSs, and demographics.

Keywords: Interdependent Privacy, Social App Adoption, Social Capital, Social Network Sites, App Data Collection Context

1 Introduction

Privacy risks associated with third-party applications (apps) on social network sites (SNSs) are increasing commensurate with apps' popularity. In addition, the growing relevance of interdependent privacy issues has introduced a new dimension of privacy concerns in the context of social apps. In a nutshell, interdependency of privacy refers to the phenomenon that within a networked system, privacy of individuals not only depends on their own behaviors, but is also influenced by decisions of others [1]. In particular, in the interconnected setting of SNSs we can observe that sharing decisions of users allow apps to easily collect personal information about their friends, thereby emphasizing the problem of interdependent privacy [13].

In our previous work, we have investigated the monetary value app users place on information about their friends within SNSs [14, 15], which we referred to as the *value of interdependent privacy*. We further conducted an exploratory study to build a model about the formation process of interdependent privacy valuation [14]. However, several questions remained about factors serving as antecedents of interdependent privacy value, and the impact of some factors

was only partially examined [14]. The current study reports the results from a secondary data analysis of our previously collected data (from [14]) capturing additional in-depth analysis of several explanatory factors of the valuation of interdependent privacy in the context of social app adoption.

A particular key motivator for our study is the complex and yet still empirically undetermined relationship between social capital and interdependent privacy [8]. Broadly speaking, social capital is a resource accumulated through individuals' interactions with others [5]. In particular, there are two kinds of social capital: bridging social capital and bonding social capital [16]. Bridging social capital, which is linked to loose connections between acquaintances, helps individuals to broaden world views and opens up opportunities for information gathering [22]. Bonding social capital, which derives from close-knit relationships between family members and close friends, is associated with trust and reciprocity, and provides strong emotional or substantive support for one another [16, 22].

In this study, we aim to empirically investigate how social capital, both bridging social capital and bonding social capital, influences the value of interdependent privacy in the context of social app adoption. In addition, in order to gain a thorough understanding of interdependent privacy valuation, we also want to explore how it is affected by other factors such as app data collection context, number of friends, concern for friends' privacy, and demographics. We conduct a series of regression analyses on data obtained from our previous work to address these research goals.

Although we fail to find a significant association between bridging social capital and interdependent privacy value, our analysis suggests that the value app users place on their friends' information is reversely related to their perceived level of bonding social capital. In addition, we find the impact of bonding social capital on interdependent privacy value varies with app data collection context. We further detect a cross-over interaction between number of friends and data collection context on interdependent privacy valuation. In particular, we find when app users notice data collection about friends is useful for app performance, the more friends they have, the less value they place on their friends' information.

2 Related Work

The emergence of SNSs provides individuals with many new ways to interact with a wide variety of others, ranging from close contacts to strangers [22], which raises the question how engaging with SNSs influences one's ability to form and maintain social capital. A stream of research provides empirical support for the positive relationship between the use of SNSs and accumulation of social capital [6, 18]. In contrast to these studies which treat SNS use as a monolithic activity, other works address how social capital is affected by different types of SNS use [2, 3, 7], finding that not all usage of SNSs results in social capital growth.

Only a few academic works explore how privacy is related to social capital. Particularly, Ellison et al. [8] argue that in order to accumulate social capital from interactions within SNSs, one must be willing to disclose information about

the self. Stutzman et al. [19] demonstrate that the relationship between privacy concern and social capital is mediated by one's willingness to disclose on SNSs.

These studies investigate how disclosure behaviors and privacy concerns influence social capital outcomes, but not the other way around. Our study examines whether and how social capital can be used to predict privacy valuation. Applied to our context of interest, we aim to uncover the impact of social capital on the value app users place on their friends' information.

3 Development of Research Question

Social capital and privacy have a complex relationship [8]. Considering also interdependent privacy, its relationship with social capital adds an additional layer of complexity. On the one hand, previous research indicates disclosure behaviors are positively related to social capital perceptions [8, 19]. In other words, the more information one releases online, the more likely one is going to accumulate social capital. In our study's context, app users who have a higher level of social capital might be more open to disclose information *about themselves*. However, it remains unknown as to which degree such individuals are also more willing to share *others' information*. In fact, we may posit the existence of a spill-over effect such that when individuals are more open to share their own information, they are also more likely to engage in disclosure behaviors about their friends' information. Applying this reasoning to the valuation of interdependent privacy, app users with a higher level of social capital may be more likely to value their friends' privacy less.

On the other hand, social capital, which is accumulated through interactions within communities, is an immaterial resource from which individuals gain benefits such as emotional support [16], exposure to diverse ideas [22], and chances of accessing non-redundant information [12]. In order to maintain such immaterial resources and continue to enjoy their benefits, individuals, including app users in our context, would likely think twice before taking actions that are harmful to other community members. In this manner, the higher the level of social capital app users have, the less likely they are going to reveal their friends' information to apps, i.e., they place a higher monetary value on their friends privacy. These two contradictory perspectives motivate us to investigate what role social capital plays in the valuation process of interdependent privacy.

In addition, prior research reveals that individuals' privacy concerns are influenced by whether or not information requests are context-relevant [10]. For example, Wang et al. [21] find users are typically unconcerned about giving away their friends' birthday information to a birthday app, but become uncomfortable when that app also tries to get access to information unrelated to its stated purpose. Therefore, in our study, we also examine how *app data collection context* impacts the value social app users place on their friends' information.

When we refer to the interdependent privacy *value*, we mean the monetary value an app user places on the profile information of all his/her friends within SNSs. As different app users have a different number of friends on SNSs, we

are interested in investigating the impact of the self-reported *number of friends* on interdependent privacy valuation. Further, our previous research reveals individuals' privacy concerns are significantly associated with privacy values [14]. Our secondary analysis aims to confirm this relationship. In addition, we study whether interdependent privacy values vary with demographic information such as app users' gender, age, education level, and income level.

To sum up, in order to better explain the valuation process of interdependent privacy in app adoption contexts, our study empirically addresses the following two-part research question:

> **RQ a**: *What roles do bridging and bonding social capital play in individuals' valuation of interdependent privacy in the scenario of social app adoption?*
> **RQ b**: *What roles do app data collection context, number of friends within SNSs, concern for friends' privacy, and demographics play in individuals' valuation of interdependent privacy in the scenario of social app adoption?*

4 Method

To address our two-part research question, we are conducting a secondary analysis of our collected data from an online survey with a population of social app users [14]. The survey included three parts.

In the first part, we collected participants' demographic information such as gender, age, education level, as well as income level. In addition, we also asked participants to report the number of friends they have on their primary SNS.

The second part implemented a conjoint analysis study to elicit the value participants place on their friends' information. In addition, in order to explore how app users' valuation of their *friends' privacy* is affected by different app data collection contexts, we introduced the following two treatment scenarios which were part of the conjoint study instructions:

> **T1:** *The information the app collects about user's friends is not useful for app's functionality.*
> **T2:** *The information the app collects about user's friends is useful for app's functionality.*

In the second part of our survey, we first randomly placed participants in one of the two treatment scenarios. Following the methodology of conjoint analysis (see details in [14]), we then asked participants to rank 9 different versions of an app which differed in the levels of four app attributes. Through analyzing participants' rankings of these app versions, we were able to quantify the value participants place on their friends' information (see details in [14]).

The last part of the survey included items that measure participants' perceptions of social capital, as well as concerns for interdependent privacy. To the extent possible, these items were based upon or motivated by previously validated instruments in order to increase reliability. With respect to social capital, both bridging social capital and bonding social capital were measured by five questions

based on scales proposed by Williams [22]. Adapting from 4 items in Smith et al. [17] that measure own privacy concern, a similar set of questions was developed to assess individuals' concerns for friends' privacy. All items were measured on a Likert-type scale with 1 = strongly disagree to 5 = strongly agree.

5 Data Description

Data collection was conducted in June 2015. Our final sample includes responses of 295 participants for data analysis. Of the participants, 50.2% are male and 49.8% are female. Our sample covers a wide range of age categories, from 18 to over 50, as well as education levels, ranging from less than high school to higher education degrees such as PhD. In terms of income level, our participants have yearly incomes that range from less than $25,000 to more than $100,000. A majority of participants reported to have 201-500 friends on their primary SNS.

In the sample, 144 participants were assigned to T1 (app-irrelevant data collection context), and 151 were assigned to T2 (app-relevant data collection context). Following the methodology of conjoint analysis (see details in [14]), we calculated the interdependent privacy value for each treatment. On average, participants in T1 value their friends' information at $1.01 ($SD = 2.00$), which is slightly larger than the monetary value, $0.68 ($SD = 1.56$), that their counterparts in T2 place on friends' privacy.

We established three instruments to measure bridging social capital ($Mean = 3.57, SD = 0.66$), bonding social capital ($Mean = 3.07, SD = 0.87$), and interdependent privacy concern ($Mean = 4.37, SD = 0.72$). Each of these three instruments demonstrates a high value of Cronbach's alpha (0.78 for bridging social capital, 0.82 for bonding social capital, and 0.92 for interdependent privacy concern), indicating high reliability of these survey instruments.

6 Results

To investigate the two-part research question as to how the measured factors affect the value of interdependent privacy in social app adoption scenarios, we conduct a series of regression analyses. Specifically, we treat the value of interdependent privacy as the dependent variable, gender and treatment as categorical independent variables, and age, income level, education level, number of friends, privacy concern, bridging and bonding social capital as continuous independent variables.

Besides studying main effects of each independent variable, we also explore the possible interactions between these variables. Following the methodology used by Steinfield et al. [18], we analyze each new interaction term with a different regression model, i.e., Model 1 & 2. Specifically, besides independent variables, Model 1 explores how number of friends interacts with treatment. By including another interaction term, Model 2 considers both the interaction between number of friends and treatment, and the interaction between bonding social capital and treatment. We show results of both regression models in Table 1.

6.1 Model 1

Regarding the effects of demographic factors in Model 1, female participants value friends' information higher than male ($p < 0.05$); and older individuals are more likely to express a higher interdependent privacy valuation than younger participants ($p < 0.01$). However, neither education level nor income level are significantly related to the value of friends' information.

When it comes to main effects of social capital, we find both bridging and bonding social capital have negative effects on privacy valuation. However, only the impact of bonding social capital is significant ($p < 0.1$). The influence of bridging social capital on interdependent privacy valuation is not only small, i.e., $\beta = -0.02$, but also insignificant.

Table 1: Regressions explaining value of interdependent privacy

Independent Variables	Coefficients	
	Model 1	Model 2
Intercept	-1.47	-1.00
Gender:		
–Male	-0.50^{**}	-0.48^{**}
–Female	0.50^{**}	0.48^{**}
Age	0.20^{***}	0.20^{***}
Education level	-0.01	-0.01
Income level	0.04	0.06
Number of friends	0.27^{**}	0.30^{***}
Treatment:		
–T1	-1.32^{*}	-0.15
–T2	1.32^{*}	0.15
Bridging social capital	-0.02	0.002
Bonding social capital	-0.24^{*}	-0.47^{***}
Interdependent privacy concern	0.30^{**}	0.30^{**}
Number of friends × Treatment:		
–Number of friends × T1	0.39^{**}	0.42^{***}
–Number of friends × T2	-0.39^{**}	-0.42^{***}
Bonding social capital × Treatment:		
–Bonding social capital × T1	–	-0.42^{*}
–Bonding social capital × T2	–	0.42^{*}
$N = 295$	$R^2 = 0.12$	$R^2 = 0.13$
	$F = 4.03^{***}$	$F = 3.99^{***}$

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

$^{-}$ Variable not included in regression model

In addition, interdependent privacy concern is positively and significantly associated with the value of interdependent privacy ($p < 0.05$), which is in line with our previous findings [14].

For treatment and number of friends, we not only observe significant main effects ($p < 0.1$ and $p < 0.05$, respectively), but we also notice a significant

interaction between them ($p < 0.05$). We plot the interaction effect in Figure 1, where a larger value on the horizontal line indicates a higher self-reported number of friends. We notice that for individuals in T1, where friends' data is irrelevant for apps' functionality, the more friends participants have, the higher the value they place on interdependent privacy. However, in the case of relevant data collection, social app users with a larger number of friends on their primary SNS tend to value the privacy of all their friends less.

6.2 Model 2

Model 2 extends the previous model by also exploring the interaction between bonding social capital and treatment. Compared with the results in Model 1, significances of all variables (except treatment) remain the same or improve when the new interaction term is added. Since the newly introduced interaction term involves treatment, we are not surprised at the change of the significance level associated with the treatment main effect. In terms of the direction of impact, only that of bridging social capital changes from negative to positive. Since the influence of bridging social capital on interdependent privacy value is very small and not significant, we believe its direction to be influenced by chance.

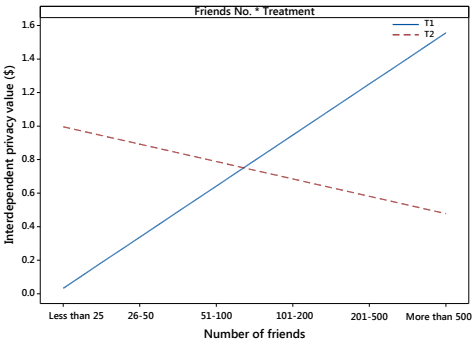

Fig. 1: Interaction of number of friends and treatment

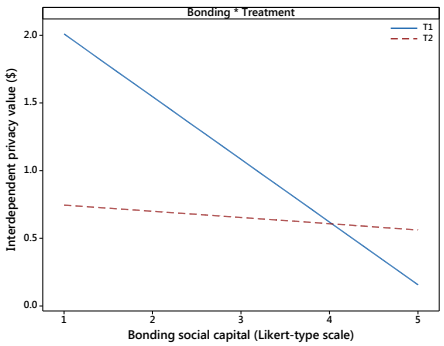

Fig. 2: Interaction of bonding social capital and treatment

As expected, the interaction between bonding social capital and treatment is significant ($p < 0.1$), indicating the relationship between bonding social capital and interdependent privacy value varies with app data collection context. We visualize the interaction effect in Figure 2. The horizontal line marks a Likert-type scale of bonding social capital, where a larger scale value indicates a higher level of bonding social capital. We observe that although in both treatments interdependent privacy value decreases with an increase of bonding social capital, the value changes more quickly in T1 than in T2.

7 Discussion

Our regression analysis first contributes to uncover the relationship between bonding social capital and interdependent privacy value. Specifically, we find that the value social app users place on friends' personal information is reversely related to their perceptions of bonding social capital. Recall the two contradictory views we have discussed regarding the association between interdependent privacy value and social capital. Our finding partly supports the view that individuals with a high level of social capital (in our case only bonding social capital) express a lower valuation for interdependent privacy; perhaps because they are more used to and are more willing to engage in disclosure behaviors. As to the other view that individuals are reluctant to reveal information about others in order to maintain and protect social capital, we believe such reluctance either does not exist or is outweighed by individuals' eagerness to grow bonding social capital through information disclosure behaviors.

Bonding social capital also significantly interacts with our treatment manipulation, i.e., app data collection context. Specifically, the difference as to the value of interdependent privacy between people with a high level of bonding social capital and others is larger in T1 (irrelevant data collection) than in T2 (relevant data collection). One possible explanation is that compared with app users with a high level of bonding social capital, the willingness to disclose friends' data by those with low bonding social capital perceptions is more sensitive to app data collection context. In particular, although individuals with a low level of bonding social capital are reluctant to disclose friends' data in the situation where such information is not useful to apps' functionality, they nevertheless become willing to reveal friends' data to apps when they believe such disclosure behaviors improve app performance. In contrast, individuals with a perceived high level of bonding social capital may assume that bonding social capital can consistently be gained through disclosure behaviors and may therefore be more used to and more prone to reveal information to others even if such information sharing is not useful to an app's functionality.

Although bonding social capital significantly impacts the valuation of interdependent privacy, our work suggests that bridging social capital does not. A possible explanation might be that bridging social capital is valued less or can be much more easily gained than bonding social capital [6]. As such, individuals are less likely to disclose information or to sacrifice privacy for gaining weak ties that correspond to bridging social capital.

We further find that the impact of number of friends on how much individuals value friends' information depends on app data collection context. Specifically, we detect a significant cross-over interaction between number of friends and treatment. As anticipated, when data collection is not useful for an app's functionality (T1), the more friends individuals have, the more value they place on information of all their friends. However, we observe an opposite association in T2, i.e., individuals with more friends actually value their friends' information less. One possible explanation of this seemingly counter-intuitive finding is that in the case where shared data is relevant for an app's functionality, individuals might believe that

sharing information about *more* friends results in even better app performance. As such, under this particular data collection context, individuals with more friends would be more willing to share all their friends' information, thereby reducing the value they place on such information. This further indicates that people might trade off friends' privacy for benefits they gain from apps, suggesting individuals can be considered as "privacy egoists" [15].

8 Conclusions

By conducting a secondary data analysis on data collected from a comprehensive online survey, our paper contributes to a better understanding of the valuation of interdependent privacy in social app adoption contexts, which in turn benefits the policy discussion on app privacy. Our results suggest that app users are "privacy egoists" [15] not only because they appear to trade off their friends' information for accruing social capital, but also due to the fact that they seem eager to reveal friends' data when they believe such disclosure behaviors result in better app performance. Given that, it seems to be unwise to rely on individuals themselves to protect *their friends'* privacy. Rather, interventions need to be considered for the problem space of interdependent privacy in social app adoption scenarios. For example, it is important that baseline policies are introduced to rigorously limit apps' unfettered access to friends' personal information [20].

Several limitations should be considered. Although our paper empirically detects the negative association between interdependent privacy value and bonding social capital, additional work is needed to further examine the relationship between social capital and the valuation of other types of personal information. Further, we restrict our investigation of interdependent privacy valuation to app adoption scenarios. To contribute to the generalizability of our findings, it is prudent to also study the valuation process of interdependent privacy in other settings (e.g., genetic privacy [9], location privacy [11] or data analytics [4]).

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