Can Reward Uncertainty Encourage Social Referrals?

Evidence from a Large-scale Field Experiment

Andy Tao Li[*], Rodrigo Belo[†], Ting Li[‡]

March 20, 2025

Abstract

Social referral programs, in which individuals recommend products or services within their networks in return for rewards, have been widely adopted across digital platforms. This study explores the impact of incorporating uncertainty into the rewards of such programs, focusing on how senders and recipients perceive and react to uncertain rewards. We run a randomized experiment involving over 160,000 users of a telecommunications operator in China and examine the effectiveness of different referral reward schemes. We find that referral programs are most successful when senders are incentivized with uncertain rewards and recipients are guaranteed certain rewards. Specifically, introducing uncertainty in the sender's reward leads to a 14% increase in the number of referrals, with recipients of these invitations more likely to engage in subsequent referrals. In contrast, uncertainty in the recipient's reward results in a 48% decrease in referrals, with invited recipients showing a reduced propensity to make further referrals. Additional online experiments identify distinct mechanisms driving these asymmetric effects: for senders, the uncertainty alleviates feelings of guilt, enhancing referral sharing and thus increasing the total number of referrals. For recipients, the adverse effects of uncertainty stem primarily from diminished perceptions of fairness and social pressure, which deter engagement in the referral process. Our study sheds light on the complex dynamics of reward uncertainty in referral programs, offering novel insights into how it can be optimized to foster more engaged referral networks.

Keywords: social referral, reward uncertainty, field experiment

[*]Andy Tao Li, School of Management, University of Science and Technology of China, andytaoli@ustc.edu.cn
[†]Rodrigo Belo, Nova School of Business and Economics, Universidade Nova de Lisboa, rodrigo.belo@novasbe.pt
[‡]Ting Li, Rotterdam School of Management, Erasmus University, tli@rsm.nl.

1 Introduction

Social referral programs incentivize individuals to make and accept recommendations via their social connections in exchange for rewards, creating a win-win situation for both the *sender* and the *recipient*. The sender receives rewards for successful referrals, while the recipient gains rewards for accepting the invitation. The recipient then becomes a new sender and can invite others, creating a virtuous cycle of referrals. Such programs have gained widespread adoption across digital platforms as a cost-effective strategy to acquire new customers, boost engagement, and harness network effects (Ghose et al., 2007; Jung et al., 2020; Burtch et al., 2021). They have also been shown to attract high-value users and contribute to overall platform growth (Van den Bulte et al., 2018; Schmitt et al., 2011; Garnefeld et al., 2013). Recently, platforms have begun experimenting with introducing uncertainty in referral rewards (Goldsmith & Amir, 2010; Wang et al., 2018). Investment platforms, such as Webull, Robinhood, Public, and Tornado, for instance, offer uncertain rewards to senders and recipients in the form of random stocks, vouchers, or cash.[1] Other strategies to add uncertainty include mystery gifts, random discounts, sweepstakes, and games of chance or instant-win games.

Despite extensive research on uncertainty in the fields of economics (e.g. Gneezy et al., 2006; Rabin & Thaler, 2001), psychology (e.g. Gibson & Sanbonmatsu, 2004; Hsee & Ruan, 2016), marketing (e.g. Goldsmith & Amir, 2010; Ruan et al., 2018), and decision sciences (e.g. Wakker, 2010; Weber & Chapman, 2005), the implications of integrating uncertainty on the design of referral incentives, particularly how senders and recipients perceive and react to uncertainty in rewards, remain largely unknown. The complexity arises from its social context, where individuals are both decision-makers and influencers. For example, senders not only consider their own rewards and related uncertainty, but also anticipate the reactions of recipients to the rewards and uncertainty faced by senders and recipients, leading to a rich interplay of factors that have not been studied in the literature.

[1] Platforms have been implementing reward uncertainty for senders and recipients in a multitude of ways. Whereas Webull offers uncertain rewards to senders (random stock) and certain rewards to recipients ($100 voucher), Robinhood, Public, and Tornado offer uncertain rewards (random stocks) for both senders and recipients. M1 Finance, on the other hand, awards certain rewards ($100) for both senders and recipients, without uncertainty.

In considering the sender's reward, while the literature generally portrays individuals as risk-averse and preferring certain rewards over uncertain ones with equal expected value (e.g., Gneezy et al., 2006), the act of referring introduces a tension. In this context, the sender may hesitate due to guilt or perceived social risk when receiving a monetary reward as a result of someone else's actions (Jung et al., 2021; Ryu & Feick, 2007). Claiming a reward that certainly benefits them might exacerbate this psychological concern, and thus the dichotomy between risk aversion and induction of guilt suggests that the net effect of uncertainty on the sender's reward is an empirical question. As for the recipient's reward, although there is evidence suggesting people's reluctance to impose uncertainty on others (Bolton & Ockenfels, 2010; Reynolds et al., 2009; Eeley, 2016), the application of these findings to the context of social referrals, especially where reciprocal behaviors are expected, remains a question. Complicating matters is that the allocation of reward uncertainty between the sender and recipient might induce the perception of fairness into the consideration of both the sender and the recipient (Hong et al., 2017).

Overall, there are countervailing forces regarding the effectiveness of incorporating uncertainty into the sender's and recipient's reward, and there remains no clear consensus on which reward scheme is best. To bridge this gap, this study conducts an empirical analysis of various referral reward schemes involving uncertainty, contributing to a deeper understanding of the subject. Accordingly, our study aims to answer the following questions: *How does reward uncertainty, both for the sender and recipient, affect the behavior of both parties involved in referrals? What are the underlying mechanisms through which reward uncertainty influences the sender's and recipient's decisions throughout the referral process? What are the effective boundaries for these effects, such as different kinds of users and reward sizes?*

To answer these questions, we conducted a randomized experiment in collaboration with a telecommunications operator in China, involving more than 160,000 users over two months, to identify the causal effects of uncertain rewards on social referrals and their underlying mechanisms. We focus on referrals where both the sender and recipient receive immediate rewards upon the recipient's

acceptance. We implemented a two-by-two between-subject randomization design, where each role receives a reward of equal expected value, but the nature of the reward varies and can be either certain (i.e., 50 points) or uncertain (i.e., 500 points with a 10% probability). Users were randomly allocated to one of the four referral reward schemes to invite others to join the program.

We find that more successful referrals are generated when senders face *uncertain rewards* and recipients face *certain rewards*. This result originates from the joint behavior of senders and recipients. Senders send more invites (1) when they are incentivized with an uncertain reward, and (2) when the recipients of their invites are assured with a certain reward. Meanwhile, recipients are more likely to accept the invitation when facing a certain reward, conditional on getting an invite.

The observed risk divergence between senders and recipients prompts the question: Why do senders and recipients, facing the same rewards, react differently to uncertain rewards in social referrals? Specifically, why do senders act as risk-seekers concerning their own reward while adopting a risk-averse stance when it comes to recipients' rewards, and why do recipients behave generally risk-averse? To gain deeper insights into these behaviors, we conducted additional online experiments, mirroring the conditions of the field experiment. Results show that the behavioral divergence in response to uncertain rewards between senders and recipients arises from the distinct motivations inherent to each role instead of their distinctions in risk preferences. Both groups place a higher value on certain rewards; however, senders exhibit a reduced willingness to share invites when their rewards are assured. This reluctance stems from senders' discomfort when their invitation clearly benefits them. Conversely, providing senders with an uncertain reward diminishes their sense of guilt and increases their likelihood of sharing. In contrast, the negative impact of uncertainty in recipients' rewards is partly due to a decrease in the recipient's perceived fairness and social pressure, discouraging them from accepting invitations.

We then delve deeper into the spillover effects of reward uncertainty and investigate its impact on the subsequent referrals made by each invited recipient. Our results reveal that recipients, who were initially referred under conditions where senders faced uncertain rewards and recipients faced

certain rewards, are more actively engaged in further referring others, especially when the stakes are high. Finally, our heterogeneity analyses shed light on the effective boundaries and provide directions for further optimization. We find that users who joined the program through referrals show a stronger response to uncertain rewards compared to those from organic traffic. Moreover, moderation analyses regarding reward size suggest that larger rewards amplify the effects of reward uncertainty on both the quantity and quality of referrals.

Our research contributes to existing literature and practice in the following ways. First, this study is the first to investigate the distinct behavior of senders and recipients in the context of reward uncertainty within social referrals. This contributes to the theoretical understanding of how uncertainty influences individual actions differently depending on the individual's role in the referral process. Second, our paper contributes to the behavioral economics literature by unpacking the underlying mechanisms through which reward uncertainty affects social referrals and spills over to the recipients. We provide empirical evidence on how feelings of guilt and perceptions of fairness influence uncertainty preferences in social referrals. By identifying the psychological mechanisms that drive senders to prefer uncertain rewards and recipients to favor certain ones, we offer a new perspective on the emotional and cognitive underpinnings of social referral behaviors. Last, our findings offer valuable insights for practitioners. This paper highlights the complex dynamics in referral programs and underscores the importance of designing rewards that align with the diverse motivations and perceptions of senders and recipients.

2 Related Literature

2.1 Social Referral Programs

The literature in information systems and marketing has shown that social referral programs provide strategic and economic benefits for platforms by capitalizing on participants' social networks and the associated network effects to attract new customers and boost user engagement (Jung et al., 2020; Sun, Viswanathan, & Zheleva, 2021). Users acquired through referrals tend to be more valuable on average,

with higher contribution margins (Van den Bulte et al., 2018), increased retention rates (Schmitt et al., 2011), higher engagement (Fernández-Loría et al., 2023), and greater customer lifetime value (Schmitt et al., 2011; Garnefeld et al., 2013). Some studies on social referral programs also focus on optimal program design for maximizing value. These include (1) identifying ideal target consumers (e.g., Hinz et al., 2011; Adamopoulos et al., 2018), (2) defining the most effective types of connections (e.g., Ryu & Feick, 2007), (3) determining optimal timing for referral link dissemination (e.g., Burtch et al., 2021), (4) developing viral features that foster social contagion (e.g., Aral & Walker, 2011; Belo & Ferreira, 2022), (5) optimizing incentive designs and their distribution between senders and recipients (e.g., Belo & Li, 2022; Sun, Viswanathan, Huang, & Zheleva, 2021; Hong et al., 2017), and (6) identifying the most effective call-to-action messages for referrals (e.g., Jung et al., 2020). Research shows that equal-split referral rewards and pro-social message framing tend to yield the best outcomes across various contexts (Sun, Viswanathan, Huang, & Zheleva, 2021; Hong et al., 2017; Jung et al., 2020).

2.2 Uncertainty in Rewards

Research across economics and psychology generally shows a preference among individuals for certain rewards over uncertain ones, even when their expected values are the same (Gneezy et al., 2006; Rabin & Thaler, 2001). However, exceptions exist, such as in low-stake decisions where individuals may display risk-seeking behaviors, valuing uncertain rewards more than certain equivalents (Goldsmith & Amir, 2010; Weber & Chapman, 2005). This can be attributed to optimism, where individuals focus on the potential for the higher reward while discounting its likelihood (Goldsmith & Amir, 2010), or curiosity, where individuals view the resolution of uncertainty as rewarding in itself (Ruan et al., 2018; Xu et al., 2020). Optimism bias, a well-documented phenomenon in psychology and behavioral economics, influences both microeconomic and macroeconomic activities (Sharot, 2011), such as repeated decisions to gamble (Gibson & Sanbonmatsu, 2004). Curiosity results from an information gap, when rewards are uncertain, stimulating individuals to seek resolution (Loewenstein,

1994), which can lead to positive utility upon resolving uncertainty (Ruan et al., 2018; Shen et al., 2019), especially when people focus more on the process than the outcomes (Hsee & Ruan, 2016; Shen et al., 2015).

2.3 Uncertainty in Social Referral Rewards

While many platforms have incorporated uncertainty in referral rewards, such as mystery gifts, random discounts, sweepstakes, games of chance, and instant-win games (Goldsmith & Amir, 2010), the actual effect of uncertain referral rewards in practice is rarely investigated. Wang et al. (2018) is the only study we know that examined the impact of uncertainty in referral rewards, finding that adding uncertainty to the sender's reward can increase sharing intention. However, their study did not account for the recipient's reward uncertainty or its impact on referral quality. Our study fills this gap by examining the effects of uncertainty on both the sender's and the recipient's rewards through a large-scale field experiment and exploring the underlying mechanisms. We also investigate the heterogeneity in the effects of reward uncertainty across different reward sizes and traffic types.

In social referrals, beyond their own attitudes toward risk, senders are concerned about their friends' satisfaction with their recommendations (Kornish & Li, 2010; Ames et al., 2004) and perceive their actions as altruistic, expecting the recipients to view it similarly (Wirtz et al., 2013; Jung et al., 2021). Previous research indicates that the anticipation of monetary rewards for someone else's actions might cause senders to feel guilty (Jung et al., 2020). In particular, when claiming referral rewards, senders anticipate that recipients will perceive this referral as being driven by a desire to get an extrinsic reward rather than for the intrinsic joy of sharing (Wirtz et al., 2013). This guilt can deter users from making referrals, thus diminishing the benefits of referral rewards (Ryu & Feick, 2007; Jung et al., 2020). Therefore, an effective reward scheme should minimize the sender's psychological cost of feeling guilty about gaining referral rewards (Jung et al., 2020, 2021). Introducing uncertainty into the sender's referral reward could mitigate this guilt perception, as the uncertainty can make the activity seem more like a game (Shen et al., 2019). This game-like feature of uncertainty may shift re-

cipients' attention from the sender's pursuit of extrinsic rewards to the excitement of the uncertainty resolution, reducing extrinsic motivation (Silver & Silverman, 2022) and enhancing perceptions of the sender's altruism and trustworthiness (Jordan et al., 2016; Capraro & Kuilder, 2016). Such perceptions can be anticipated by senders, thereby alleviating their psychological burden of guilt. In this study, we run online experiments to investigate whether uncertainty in referral rewards can alleviate the sender's guilt perception and increase the likelihood of sharing referrals.

Regarding the recipient's reward, behavioral economics shows that individuals often make more conservative choices for others than for themselves (Bolton & Ockenfels, 2010; Reynolds et al., 2009). Several mechanisms have been proposed to explain this phenomenon. Charness (2000) found this effect in the context of gift exchange and identified "responsibility alleviation" as the underlying mechanism. When making decisions on behalf of others, individuals often experience heightened concerns about responsibility, leading them to adopt more cautious and risk-averse choices to reduce the burden of responsibility (Lu et al., 2018; Charness & Jackson, 2009; Charness, 2000). Similarly, Selten (2001) discussed "blame avoidance," suggesting that decision-makers prefer safer options to avoid being blamed for any unfavorable outcomes (Baumeister et al., 2001). Moreover, research by Eeley (2016) indicates that introducing outcome uncertainty for others can negatively impact prosocial behaviors. In line with these findings, transferring uncertainty to recipients in referral programs might amplify the sender's perception of guilt, potentially deterring their willingness to make referrals.

Alleviating the sender's guilt perception points to an asymmetric uncertainty arrangement, where senders face uncertain rewards for successful referrals, while recipients are assured of receiving certain rewards upon accepting the referral. However, this asymmetric reward configuration might influence perceptions of fairness for both the sender and the recipient (Hong et al., 2017; Bassellier & Ramaprasad, 2023). Fairness is often perceived when both parties receive equal rewards, encouraging more users to make referrals (Jung et al., 2021; Hong et al., 2017). Introducing uncertainty could diminish the perceived fairness, since the realized rewards may vary between senders and recipients. This fairness concern becomes more prominent in an asymmetric uncertainty arrangement, where

one party, facing uncertainty, observes that the other is guaranteed a certain reward. This situation presents a challenge in balancing the benefits of reduced guilt against the risks of reduced fairness. In this study, we further investigate how recipients perceive uncertainty in both senders' and recipients' rewards, and how this perception affects their referral acceptance decisions.

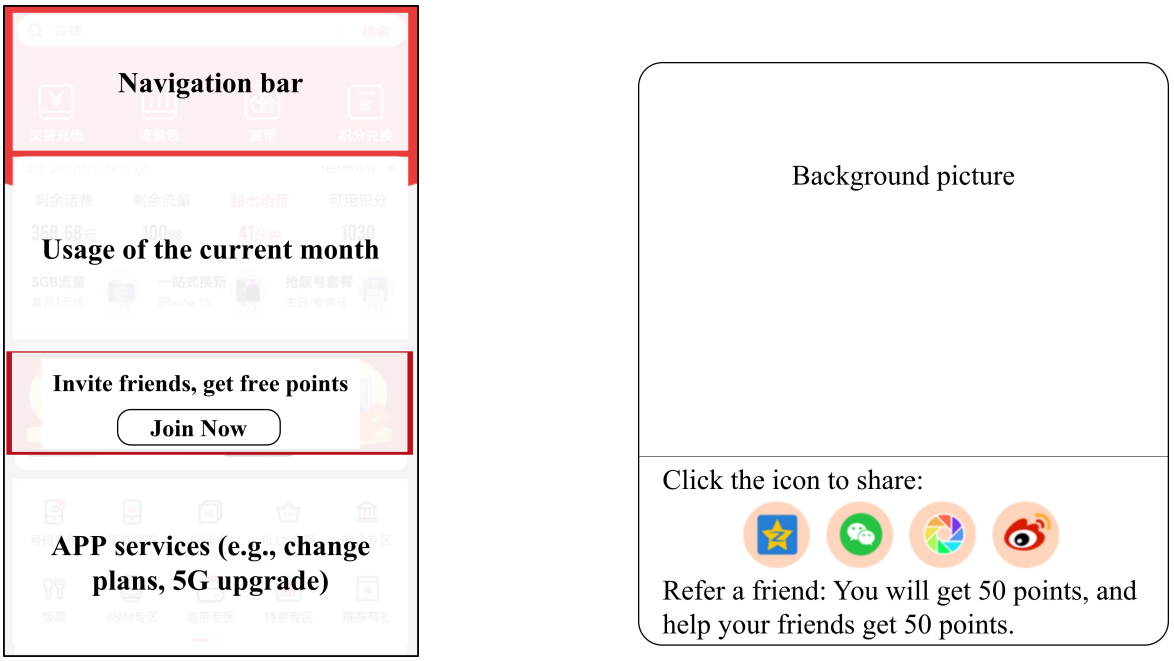
In sum, there are countervailing forces regarding the effectiveness of incorporating uncertainty into the rewards for senders and recipients, with no clear consensus on the optimal reward scheme. Senders and recipients may exhibit risk-seeking or risk-averse behavior regarding their reward uncertainty. Meanwhile, reducing the sender's guilt perception through asymmetric uncertainty allocation could compromise the fairness perceived by both parties. Reconciling these differing viewpoints is challenging without a robust, randomized experimental design. To address this gap, our work provides an empirical analysis of different referral reward schemes involving uncertainty, contributing to a broader understanding and a greater consensus on this ongoing debate.

3 Field Experiments and Data Description

3.1 Research Context and Experimental Design

We conducted a large-scale randomized field experiment in partnership with a leading telecommunications operator in China. We ran the experiment in the company's mobile app — a platform that allows users to check bill details, make payments, install home internet, monitor data usage, and manage subscription plans. To increase user retention and engagement, the app incorporates various gamification features. A notable feature is a loyalty-point system, where users earn points by performing certain actions such as daily logins, inviting new users, participating in promotional activities, making bill payments, and adjusting data plans. The points can be exchanged for goods and services at a rate of approximately 100 points to one Chinese RMB, with redemption options including electronics, toys, household items, outdoor accessories, jewelry, lottery entries, and mobile top-up credits. The company aims to encourage offline users to online services and increase activity among current online users. This strategy involves promoting new services through the app, while also reduc-

ing operational costs by diminishing the reliance on traditional call center support. Panel A of Figure



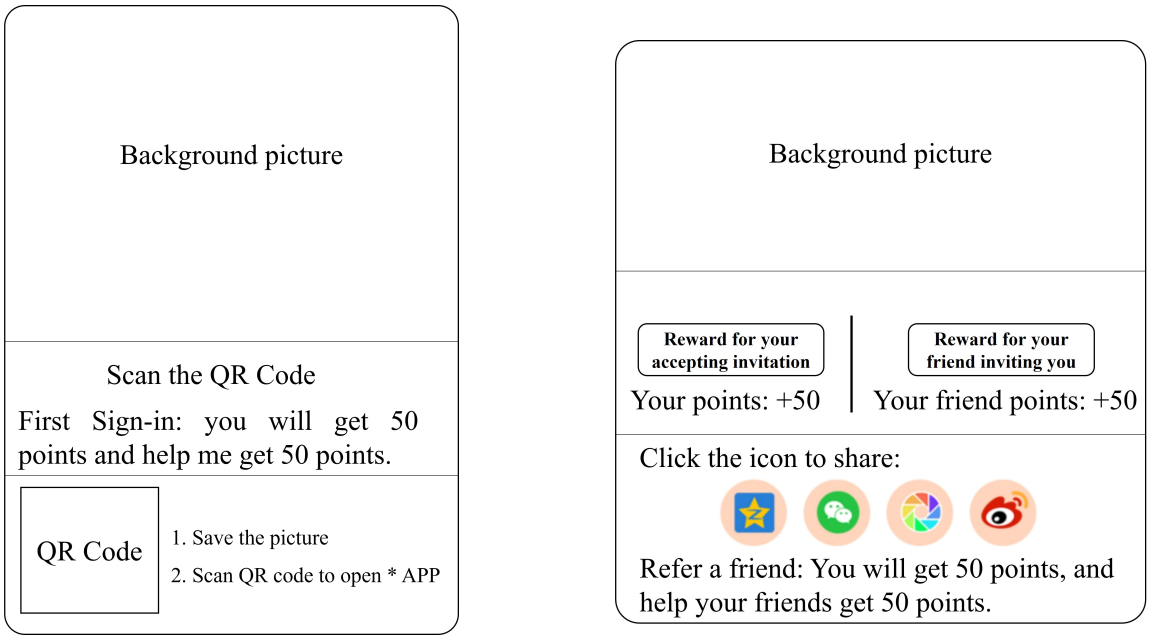
Panel A: APP homepage

Panel B: The referral page for organic traffic

Figure 1: Experimental context

1 showcases the app's homepage as it appeared during the experimental period. When users open the app, they see a prominent banner on the homepage promoting a reward for referring friends. Clicking this banner opens a pop-up window that directs users to the referral page, as shown in Panel B of Figure 1. The referral page customizes the referral message based on the user's group information, as detailed in Table 1. It also displays icons of major Chinese social networks — QQ Zone, WeChat Message, WeChat Moment, and Weibo — enabling users to share the referral. Selecting an icon generates a personalized invitation, including a QR code with encrypted referral information, which can be shared as a draft post on the chosen platform. Panel A of Figure 2 depicts an example of invitation image. For instance, choosing the Weibo icon takes the users to a pre-composed, unpublished post on Weibo. The system supports multiple shares, generating unique QR codes for each instance, and these codes can be scanned multiple times by different recipients. Upon accepting an invitation by scanning the QR code, new users are directed to the app's referral page, as illustrated in Panel B of Figure 2. If they have not installed the app, they are prompted to do so and then register. The app then displays a customized referral message encouraging new users to make further referrals and outlines

potential rewards.



Panel A: Invitation message

Panel B: The referral page for redirected recipients

Figure 2: Invitation message and the redirected page after recipient accepting invitation

We conducted the field experiment from November 5 to December 31, 2021. Participants included any app users who visited the referral page at least once during this timeframe. Some users encountered the referral page organically by clicking the in-app banner, while others were directed there through a referral link. We investigate the effects of reward uncertainty and its variation across different reward sizes by dividing the experiment into two periods. Initially, from November 5 to November 30, we conducted a two-by-two between-subject randomization at the user level for both senders and recipients while maintaining a constant expected reward value (i.e., 50 points for senders and 50 points for recipients).

Upon their first visit to the referral page during the experiment, users were randomly assigned to one of four groups: (1) Sender certain reward + Recipient certain reward: both the sender and the recipient received 50 points for each successful referral; (2) Sender certain reward + Recipient uncertain reward: the sender received 50 points for each successful referral, while the recipient had a 10% chance of receiving 500 points; (3) Sender uncertain reward + Recipient certain reward: the sender had a 10% chance of receiving 500 points for each successful referral, while the recipient

received 50 points; and (4) Sender uncertain reward + Recipient uncertain reward: both the sender and the recipient had a 10% chance of receiving 500 points for each successful referral. Table 1 outlines the specific referral messages for senders and the corresponding invitation messages for recipients in each group.

During the second period, from December 1 to December 31, we explored how varying the reward size influenced user behavior. This period introduced reward expectations set at 10, 50, and 500 points, expanding the study into a two-by-two-by-three design. Each original group from the first period was further segmented into three, creating twelve distinct experimental groups. We retained the 10% winning chance for uncertain rewards, maintaining consistency across the study periods. We utilize user historical data from the app before the experiment and conduct backward-looking analyses as randomization checks, demonstrating balanced in-app behaviors across different groups. Detailed randomization checks can be found in Appendix B.

A successful referral is determined when a new user (recipient) follows an invitation link, leading to the first app login during the study. Rewards are allocated based on the originating sender's assigned group, with immediate disclosure of any achieved rewards for both parties upon the recipient's first app entry. Since the recipient is redirected to the app, she can immediately see the rewards both she and her sender have obtained, as shown in Panel B of Figure 2. For the sender, the app sends a notification and details the rewards at the next login.

3.2 Data and Summary Statistics

In our experiment, 162,266 valid users participated, with a roughly equal sample size between two experimental periods: 49.2% in the first and 50.8% in the second period.[2] Table 2 provides variable descriptions and summary statistics. 50.2% of users encountered uncertainty in sender rewards (*Sender Uncertainty*), and 49.4% faced uncertainty in recipient rewards (*Recipient Uncertainty*), indicating well-balanced group sizes. About 10.8% of users shared the program at least once (*If Share*),

[2]Approximately 1.7% of users took part in both periods, with the uncertainty group remaining the same, but the expected reward size varying in the second period. We conduct a robustness check by removing the overlapping users in the analyses and find consistent results in Table A8 of Appendix D.

and each user, on average, shared 0.206 times (*Number of Shares*). In addition, 3.9% of users successfully referred at least one friend (*If Refer*), and on average, users made 0.183 direct referrals to the app (*Direct Referrals*) during the experiment.

We calculated total referrals per user, counting both direct and indirect referrals, averaging 0.386 (*Total Referrals* includes the focal user's direct referrals, the direct referrals of recipients, the direct referrals of recipients' recipients, and so forth). We calculated all the referrals indirectly invited by the focal user, which is 0.203 on average (expressed as *Indirect Referrals = Total Referrals - Direct Referrals*). The metric *Indirect Referrals* is the sum of all the recipients' *Total Referrals*, serving as a proxy for the quality of referrals and indicating whether the invited recipients actively engaged in referring others. Appendix C showcases a referral network and illustrates the computation of key variables.

We categorize users into two groups: those referred by others (*From Referral*) and those who joined organically. Among all participants, 76.9% joined organically, while 23.1% were referred, that is, 37,414 users referred to open the app. As shown in Panel B of Table 2, among these referrals, 55.3% were invited by users facing uncertainty in their own rewards (*Inviter's Sender Uncertainty*).[3] This percentage is higher than the remaining 44.7%, who were invited by users facing certainty in their own rewards, suggesting that uncertain rewards for senders may encourage more successful referrals. Upon the recipient accepting the invitation, the reward uncertainty was resolved for the 55.3% inviters, and in practice, 5.2% inviters received the large reward (*Lucky Inviter*), approximating the 10% threshold in our setting. Orthogonally, among these referrals, 32.8% were invited by users who faced uncertain rewards for the recipient (*Inviter's Recipient Uncertainty*), lower than the remaining 67.2%, indicating that users dislike referring when incorporating uncertainty into the recipient's referral reward. Regarding the resolution of uncertain rewards faced by 32.8% recipients, 2.9% recipients were fortunate to receive the large reward (*Lucky Recipient*).

[3]To distinguish the recipient's role as a new sender in subsequent referral decisions, we use the term *inviter* to denote the user who invited the recipient.

4 Main Results: Effect of Reward Uncertainty on Referrals

4.1 Model-free Evidence

We start by presenting model-free evidence of the impact of reward uncertainty on referrals. We look at the effects of reward uncertainty on a user's likelihood of sharing (*If Share?*), likelihood of successfully referring someone (*If Refer?*), number of shares (*Shares*), and number of direct referrals (*Direct Referrals*). We also take into account the subsequent referrals made by these recipients, and assess the impact on total referrals (*Total Referrals*). Figures 3 and 4 depict the effects of uncertainty on both senders and recipients among the four treatment groups, pooling users from both experimental periods.[4] These figures show that senders faced with uncertainty in their *own* rewards are more likely to share and successfully refer more friends compared to those with certain rewards. In contrast, senders facing uncertainty in their *recipients*' rewards are less likely to share and refer less. These results are confirmed by t-tests comparing the referral rates and referral quantities between certain and uncertain rewards for senders and recipients, respectively (see Table A4 in Appendix C).

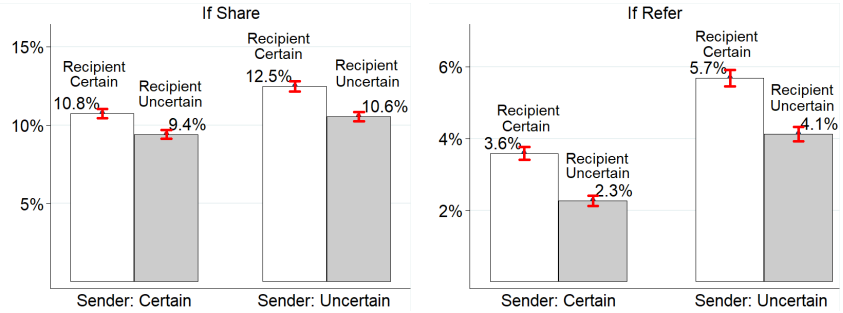


Figure 3: Model-free evidence: Impact of reward uncertainty on likelihood of sharing and successful referrals

4.2 Empirical Results

To test the effect of reward uncertainty on social referrals, we model the referral outcomes of an individual i as follows:

$$Y_i = \alpha + \beta_1 Sender\ Uncertainty_i + \beta_2 Recipient\ Uncertainty_i + \lambda_i + \epsilon_i \quad (1)$$

[4]The results look the same if we consider users from the first or the second experimental period separately.

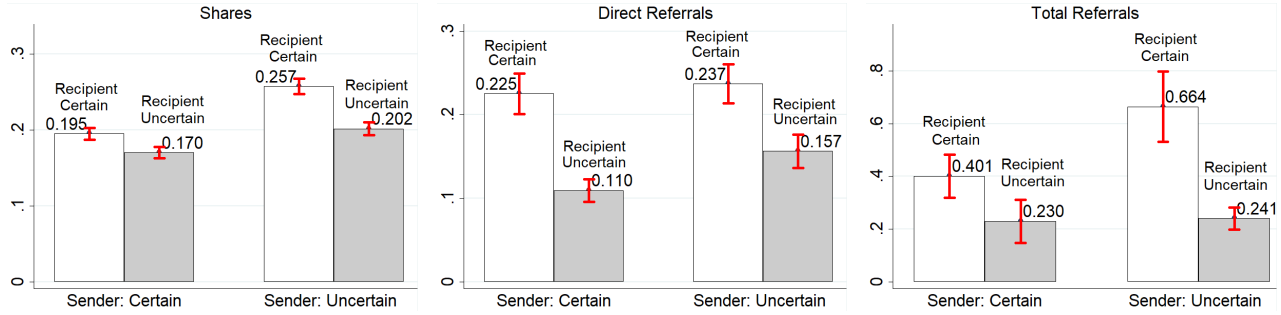


Figure 4: Model-free evidence: Impact of reward uncertainty on number of shares and successful referrals

where Y_i denotes the referral outcomes, and we include two dummy variables, namely $Sender\ Uncertainty_i$ and $Recipient\ Uncertainty_i$, to quantify the influence of sender's reward uncertainty and recipient's reward uncertainty. The parameter λ_i captures several fixed effects including which experimental period the user was in, the traffic source (referral or organic), and the expected reward size. While in general we omit the coefficients associated with the fixed effects for brevity, we still report the coefficients associated with the traffic source (*From Referral*) to highlight the differences between users from referral traffic and users from organic traffic. The error term ϵ_i reflects the idiosyncratic variation in potential outcomes that vary across individuals.

Table 3 presents our key findings. Columns (1)-(2) show the effect on the sender's sharing behaviors. In comparison to users with a certain reward for themselves, those with uncertainty regarding their own rewards (*Sender Uncertainty*) significantly increase the likelihood of sharing by 12% (a 1.3% increase over a baseline of 10.8%) and the number of shares by 21% (0.044 additional shares over a baseline of 0.206 shares). Conversely, users who face uncertainty regarding the recipient's rewards (*Recipient Uncertainty*) experience a significant decrease in sharing likelihood by 12% (a 1.3% decrease over a baseline of 10.8%) and the number of shares by 16% (0.033 fewer shares over a baseline of 0.206 shares). Columns (3)-(4) demonstrate the impact of reward uncertainty on referrals. *Sender Uncertainty* significantly heightens the likelihood of successfully referring others by 49% (a 1.9% increase over a baseline of 3.9%) and the number of direct referrals by 14% (0.025 additional referrals over a baseline of 0.183), while *Recipient Uncertainty* significantly diminishes the likelihood of successfully referring others by 31% (a 1.2% decrease over a baseline of 3.9%) and the number

of direct referrals by 48% (0.087 fewer referrals over a baseline of 0.183). In Columns (5)-(6), incorporating recipients' further referrals, we explore the effect of reward uncertainty on total referrals and indirect referrals. *Sender Uncertainty* significantly amplifies the number of total referrals by 33% (0.129 additional total referrals over a baseline of 0.386) and the number of indirect referrals by 51% (0.104 additional indirect referrals over a baseline of 0.203). Conversely, *Recipient Uncertainty* substantially decreases total referrals by 71% (0.274 fewer total referrals over a baseline of 0.386) and indirect referrals by 92% (0.187 fewer indirect referrals over a baseline of 0.203).

4.3 Robustness

We conduct several robustness checks to ensure the reliability of our results. First, we show that our results are robust to different model specifications. Given that multiple referral outcomes are countable variables (i.e., *Shares*, *Direct Referrals*, *Total Referrals*, *Indirect Referrals*) and exhibit over-dispersion, we take a log transform to mitigate the over-dispersion and skewness. We also incorporate the over-dispersion in the model estimation and use the negative binomial model for countable variables as well as the logit model for dummy variables (i.e., *If Share*, *If Refer*). Second, we implement winsorization to ensure that our results are not influenced by outliers. Specifically, we winsorize users whose referrals fall outside of three standard deviations, and we consistently observe similar results. Third, we account for the potential carryover effect from users participating in both experimental periods by conducting analyses that exclude such users. Fourth, we employ an alternative measure for referrals, encompassing all recipients who have accepted invitations, even those who may have already been referred by other users. This approach provides assurance that the results are not limited by a single measure. Fifth, we collect data on users' participation days during the experimental period, revealing that referred recipients not only accept invitations but also show a greater likelihood of retention and prolonged engagement with the app. Overall, the findings are consistent across all robustness checks. For a detailed description of the robustness checks, please refer to Appendix D.

4.4 Heterogeneity Analyses

Our study investigates how the results are influenced by reward size and traffic types in Appendix E, delineating the effective boundaries of our findings and providing insights for further optimizing the reward scheme. First, the moderating effect of reward size, detailed in Table A11, indicates that the positive effect of the sender reward uncertainty on referrals becomes more pronounced as the potential reward increases. This implies that a larger possible reward makes the uncertainty surrounding the sender's reward a stronger incentive for users to refer others. In addition, the aversion to the recipient's reward uncertainty also amplifies with the reward's magnitude. This suggests that users become increasingly cautious about making referrals when the uncertainty is transferred to the recipients, especially as the stakes rise. Thus, the USCR (**U**ncertain **S**ender **C**ertain **R**ecipient) reward scheme becomes increasingly beneficial with larger rewards.

Second, we investigate the nuanced dynamics between users originating from organic traffic and those from referrals. We find that the act of referring perpetuates itself: recipients who were themselves referred are more likely to invite others. For example, an invited recipient generates an average of 0.659 referrals, a substantial increase compared to the average of 0.04 referrals by organic users. The sustained referral network, as illustrated in Table A12, extends beyond mere sharing, fostering a continuous cycle of invitations and subsequent referrals. In contrast to organic traffic, where user engagement is spontaneous, recipients of referrals are selectively chosen by the senders, who are likely to identify an audience receptive to the referral program. Furthermore, the recipient's self-selection in accepting the referral invitation filters out disinterested individuals, leaving a pool of users inherently more engaged with the referral program and, consequently, more likely to refer others (Schmitt et al., 2011). Then, we explore how reward uncertainty affects referral behaviors differently between users from referral and organic traffic. As shown in Table A13, users from referral traffic experience a more positive effect from sender uncertainty and a more pronounced negative effect from recipient uncertainty. This implies that the USCR reward scheme is more effective for users acquired

through referrals than those from organic traffic.

5 Mechanism Explorations

In this section, we delve into the underlying mechanisms through which reward uncertainty impacts social referrals. Senders and recipients may perceive uncertain rewards differently: as more valuable due to optimism bias (Goldsmith & Amir, 2010; Weber & Chapman, 2005) or less valuable due to risk aversion (Gneezy et al., 2006; Rabin & Thaler, 2001). They may also consider feelings of guilt and fairness regarding the other party's reward or anticipate the other party's perception of their own rewards (Hong et al., 2017; Jung et al., 2020). Since successful referrals require mutual agreement between sender and recipient, we conducted two follow-up online experiments to examine how reward uncertainty impacts the sender's sharing decisions and the recipient's acceptance decisions.

5.1 How Does Reward Uncertainty Affect Sender's Sharing Decision?

We start by examining how reward uncertainty impacts the sender's decision to share. As shown in Column (1) of Table 3, our main results from the field experiment show that *Sender Uncertainty* increases, while *Recipient Uncertainty* decreases, the sender's likelihood to share. To understand the varying sharing intentions under different reward uncertainties, we conducted our first experiment. Participants were randomly assigned to one of four groups, mirroring the experimental conditions in the field experiment. Participants, after viewing their assigned referral messages, reported their sharing intentions and rationale for sharing or abstaining. Details of the experiment are presented in Appendix F.

Table 4 reveals that guilt perception mediates the effects of reward uncertainty on sharing intention. Column (1) replicates the findings of the field experiment, i.e., sender uncertainty increases and recipient uncertainty decreases sharing intention. Columns (2) and (4) show that sender's guilt perception acts as a significant barrier that impedes users from sharing (-0.464, $p < 0.001$). Sender uncertainty significantly reduces guilt perception (-0.830, $p < 0.001$), resulting in a higher sharing

intention (-0.464 $\times$ -0.830 = 0.385, $p < 0.001$). On the other hand, recipient uncertainty increases the sender's guilt perception (1.106, $p < 0.001$), leading to lower sharing intention (-0.464 $\times$ 1.106 = -0.513, $p < 0.001$).

Meanwhile, we examine whether fairness perception mediates the effect of reward uncertainty on sender's sharing intention. As shown in Columns (3) and (5), a high perception of fairness increases sharing intention (0.310, $p < 0.001$). However, recipient uncertainty reduces the sender's perception of fairness (-0.719, $p < 0.001$), resulting in decreased sharing intention (0.310 $\times$ -0.719 = -0.223, $p < 0.01$). Sender uncertainty does not significantly affect fairness perception (-0.219, ns) or indirectly affect sharing intentions through fairness (0.310 $\times$ -0.219 = -0.068, ns).

We also explore alternative mechanisms that might explain the impact of reward uncertainty on the sender's sharing intention. Specifically, we investigate the sender's risk preferences regarding both their own rewards and those of the recipient, as detailed in Table A18 within Appendix G. Our findings reveal that senders are generally risk-averse, valuing uncertain rewards less than certain ones with the same expected value. This risk aversion exists when senders evaluate their own reward and the recipient's reward. Although existing literature suggests that individuals might exhibit risk-seeking behaviors due to an overestimation of favorable future outcomes (Gibson & Sanbonmatsu, 2004), our findings of lower perceived value for uncertain rewards suggest that optimism bias is not a valid mechanism in the context of social referrals. In other words, while senders may exhibit risk-seeking behaviors and a greater sharing intention, this tendency is not driven by optimism bias regarding their own rewards. Next, we investigate whether curiosity plays a role in explaining the impact of reward uncertainty on the sender's sharing intention. Existing literature suggests that people may engage in risk-seeking behaviors due to their curiosity when faced with uncertain rewards, which can result in positive utility when the uncertainty is resolved (Shen et al., 2019; Ruan et al., 2018). However, our results, presented in Table A19, demonstrate that although reward uncertainty may increase curiosity, this increase does not serve as a valid mechanism for explaining the effect on sharing intentions.

In summary, our experiment shows that senders exhibit risk-seeking behavior in social referrals,

influenced not by optimistic bias or curiosity but by a reduction in guilt perception when their own rewards are uncertain. Conversely, transferring uncertainty to recipients increases the sender's guilt and decreases fairness perception, thereby reducing their willingness to share.

5.2 How Does Reward Uncertainty Affect Recipients' Acceptance Decision?

To better understand the recipient's decision-making process when they receive an invitation, and to address concerns of the influence of sender selection, we conducted our second experiment. This experiment aimed to examine how recipients respond to the invitation messages under different reward schemes. Similar to our field experiment, we randomly assigned subjects to one of four groups, with each group receiving an invitation message that mirrored the design shown in Table 1. Upon viewing the invitation, participants were asked to rate their likelihood of accepting it and explain their decision. More details on the experiment can be found in Appendix F.

As suggested by Hong et al. (2017), the perception of fairness plays a pivotal role in the acceptance of referral invitations. Furthermore, receiving an invitation from a friend can trigger social pressure, supporting the concept of social conformity (Asch, 1955; Bond & Smith, 1996). Specific reward schemes in the invitation message received by recipients may intensify this social pressure, consequently increasing the likelihood of conforming to the referral action (Bernheim, 1994; Sun, Viswanathan, & Zheleva, 2021). Given these insights, we also explore the influence of social pressure in explaining how uncertain reward designs affect the recipient's decision to accept the invitation.

Table 5 reports our results. In Column (1), we observe that recipient uncertainty decreases their intention to accept the invitation, while sender uncertainty does not affect the recipient's decision. To delve deeper into the reasons behind the negative effect of recipient reward uncertainty on acceptance, we probed recipients' attitudes after viewing the invitation. Our findings reveal that fairness and social pressure play significant roles in mediating the impact of recipient reward uncertainty on acceptance rates. Fairness perception is an important motivator for recipients to accept the invitation (0.300, $p < 0.001$). However, recipient uncertainty significantly diminishes the recipient's perception of

fairness (-0.755, $p < 0.001$), leading to a decreased acceptance rate (-0.755 $\times$ 0.300 = -0.226, $p < 0.01$). Meanwhile, social pressure is another contributing factor for recipients to accept the invitation (0.515, $p < 0.001$), but recipient uncertainty significantly releases the recipient's social pressure (-0.302, $p < 0.01$), thereby resulting in a reduced acceptance rate (-0.302 $\times$ 0.515 = -0.156, $p < 0.05$).

We also investigated alternative mechanisms that might clarify how reward uncertainty influences the recipient's willingness to accept an invitation, including their risk preferences and the potential curiosity induced by uncertainty. We report detailed analyses in Appendix H. We observed that recipients, like senders, tend to be risk-averse. As shown in Table A20, recipients generally view uncertain rewards as less valuable than certain ones, significantly reducing their likelihood of accepting the invitation. Furthermore, Table A21 demonstrates that curiosity is not a valid mediator for explaining the impact of recipient uncertainty on the reduced acceptance rate.

6 Spillover Effect on the Invited Recipient's Further Referrals

Upon accepting the invitation, the recipient transitions into a new sender and can invite others, thus fostering a positive cycle of referrals. How does the reward uncertainty introduced by an inviter impact the subsequent referral behaviors of the invited recipients? To delve deeper into the dynamics of referral networks and understand the cascading influence of reward schemes, this section investigates the spillover effects of reward uncertainty from inviters to their invited recipients. Specifically, we aim to explore how different reward schemes set by the inviter affect the recipients' decisions to continue referring others. Notably, the findings in Table 3 reveal that reward uncertainty affects indirect referrals, indicating that it influences the subsequent referrals taken by the invited recipients. However, *Indirect Referrals* is an aggregate measure that includes all referrals made by all recipients invited by a specific user. This means it takes into account the influence of reward uncertainty not just on each invited recipient's own referrals but also on the total number of recipients who were directly invited. In this section, we focus on the behavior of individual invited recipients. By examining the referral behaviors of each recipient, we assess how the initial inviter's reward scheme shapes the

recipient's referral behaviors. Thus, we model the determinants of an invited recipient's subsequent referral behaviors, denoted as Y_j as follows.

$$Y_j = \alpha + \beta_1 Sender\ Uncertainty_j + \beta_2 Recipient\ Uncertainty_j + \phi_1 Inviter's\ Sender\ Uncertainty_j + \phi_2 Inviter's\ Recipient\ Uncertainty_j + \phi_3 Lucky\ Sender_j + \phi_4 Lucky\ Recipient_j + \lambda_j + \delta_j \quad (2)$$

where Y_j represents the measures of the invited recipient's subsequent referral behaviors (i.e., *If Share*, *Number of Shares*, *If Refer*, *Direct Referrals*, *Total Referrals*, and *Indirect Referrals*). In addition to a recipient j's own reward scheme as the role of a new sender, which comprises $Sender\ Uncertainty_j$ and $Recipient\ Uncertainty_j$, we also investigate the impact of her inviter's reward scheme, denoted as $Inviter's\ Sender\ Uncertainty_j$ and $Inviter's\ Recipient\ Uncertainty_j$. Additionally, we consider how the resolution of uncertain rewards upon her acceptance, represented by $Lucky\ Sender_j$ and $Lucky\ Recipient_j$, impacts these behaviors further.

Table 6 presents the results of 37,414 invited recipients. The positive impact of *Sender Uncertainty* and the negative impact of *Recipient Uncertainty* validate our findings within the sub-sample of invited recipients, affirming the consistency of our results. Results support that reward uncertainty from the inviter influences recipients' referral decisions. Specifically, compared to users with certainty in their own rewards, users facing uncertainty in their own rewards (*Inviter's Sender Uncertainty*) tend to invite recipients who generate more follow-up referrals. Conversely, when comparing users with uncertain recipient rewards to those with certain recipient rewards (*Inviter's Recipient Uncertainty*), the former tend to invite recipients with fewer follow-up referrals.[5] We also examine whether the spillover effect varies across different reward sizes. The results, presented in Table A22 of Appendix I, suggest that a larger reward tends to amplify this spillover effect. Specifically, when the reward size is small, the effect of reward uncertainty on the recipient's further referral is insignificant; however, as the reward size increases, the impact becomes significant.

[5]We conduct robustness by using alternative measures of spillover effect and find consistent results in Table A24 of Appendix I.

Meanwhile, the resolution of reward uncertainty has a significant impact on recipients' further referral behaviors. Lucky outcomes for both the sender's (*Lucky Sender*) and the recipient's (*Lucky Recipient*) rewards positively impact the recipient's decision to make further shares and direct referrals. However, this impact is not significant when considering the total referrals and indirect referrals made by recipients. In other words, while lucky rewards encourage immediate and direct referrals, their effect does not extend to the broader network of referrals that happen indirectly through recipients.

Two possible mechanisms might explain how reward uncertainties spill over and influence the subsequent referrals made by the invited recipients. From the sender's perspective, the way senders target recipients might explain how reward uncertainty affects the referral network. Senders benefiting from a desirable reward scheme may choose recipients who are more likely to appreciate the app and thus are more likely to refer it to others. Considering that feeling guilty can deter people from making online referrals, those who feel less burdened by this guilt might engage in more effective advocacy. This could manifest in a more thoughtful selection of potential app users among their peers, greater effort in explaining the app's benefits, or a combination of both (Jung et al., 2020). From the recipient's perspective, the reward scheme in the invitation message could also impact their willingness to refer others. As senders who invite others despite uncertain outcomes for themselves are seen as altruistic and trustworthy (Jordan et al., 2016; Capraro & Kuilder, 2016), recipients may perceive their invitations as driven by a genuine attempt to share something of value rather than a mere self-interested action. As a result, recipients might be more likely to share the app with others, reciprocating the original sender's intent.

7 Discussion

This study explores the influence of reward uncertainties on user referrals. By combining large-scale field experiments, user historical data, and follow-up experiments, we find uncertainty plays different roles from the sender's and recipient's perspectives. Senders are more inclined to initiate a referral

when faced with uncertainty regarding their own rewards, yet they are less likely to invite recipients if the recipients' rewards are uncertain. Moreover, recipients are more likely to accept a referral invitation if it offers a certain reward. Underlying mechanisms reveal that the apparent inconsistency comes from the fact that users, in the role of a sender, prefer an uncertain reward as it diminishes their guilt associated with claiming referral rewards, rather than being driven by egoistic benefits such as optimism or curiosity. However, as recipients do not have such a guilt concern, they prefer a certain reward due to their risk aversion. This preference is somewhat anticipated by senders, who are less likely to invite others if they are required to pass the uncertainty to the recipients. We thus suggest an Uncertain Sender Certain Recipient (USCR) reward scheme to encourage more referrals, particularly for users acquired through referrals, with larger rewards amplifying its advantages. Furthermore, the benefits of such a reward scheme spill over into the referral network, thereby attracting high-value recipients who actively refer others and fostering the creation of a dynamic ecosystem.

7.1 Theoretical Implications

Our research contributes to prior literature in two key ways. First, our study enriches the social referral literature by analyzing the impact of incorporating uncertainty into the referral reward design, and how such effects vary in different reward sizes and traffic types. This study is the first to use large-scale field experiments to causally distinguish the impacts of uncertainty in rewards for senders versus recipients on social referrals. Our finding also highlights how reward uncertainty can improve referral quality by attracting high-value recipients, a critical objective for long-term platform growth.

Second, our paper adds to the findings of decision-making literature by unpacking the underlying mechanisms through which reward uncertainty influences decisions within social contexts such as referrals. In such contexts, senders consider not only their own rewards and related uncertainties but also how recipients might perceive and respond to these rewards and uncertainties, and vice versa. Unlike previous studies that often attribute risk-seeking behavior to optimism and curiosity from an egotistic perspective, our research suggests that people may exhibit risk-seeking behaviors in a social

context in the absence of any egoistic benefits. Instead, making their reward uncertain can reduce the psychological burden of guilt associated with accepting tangible rewards for influencing others' actions, thereby motivating people to engage in desired behaviors. Additionally, our findings suggest that fairness plays an important role when incorporating uncertainty in a social context, as the realized rewards may differ among different parties, especially in asymmetric uncertainty arrangements where one party, faced with uncertainty, observes that the other party is guaranteed certain rewards.

7.2 Practical Implications

Our findings have important managerial implications. First, our findings call for a clear recommendation of a USCR reward scheme in referral programs. By strategically incorporating uncertainty into the referral reward without altering the expected unit cost, platforms can substantially boost the number of referrals. Additionally, the discovery of sustained referrals suggests that invited recipients are more likely to perpetuate the referral process, and spillover effects reveal that the USCR scheme can further amplify this sustained behavior. Thus, leveraging the USCR scheme can attract a large number of active users, who, in turn, are more likely to continue spreading the referrals, leading to a chain reaction of increased referrals within the network. This tailored approach to referral rewards can serve as a powerful managerial tool to help platforms efficiently expand their user base and foster a vibrant, active community. Considering that uncertainty is scalable and can be applied to various forms of social rewards across different types of platforms, we would expect that this reward scheme offers strong implications for platform practitioners.

The findings of moderating effects in reward sizes and traffic types have important implications for practitioners in determining the appropriate reward size and targeting specific user segments to maximize the effectiveness of referral programs. The positive effects of the USCR scheme are more pronounced with rewards that are not perceived as too small by participants and are especially significant for users acquired through referral channels. A larger reward can not only increase the referral rate but also amplify the positive impact of reward uncertainty on promoting social referrals. When

faced with budget constraints, practitioners are advised to allocate a larger, uncertain reward to users acquired through referrals, rather than distributing a relatively small referral reward to all users. As the platform expands, encouraging invited users to actively refer others becomes crucial to attracting high-value acquisitions. Offering a substantial uncertain reward to this user segment can help achieve this goal. By incorporating uncertainty into the reward structure and strategically providing appropriate reward sizes for targeted audiences, platform operators can effectively tap into their social networks to promote social contagion. This personalized approach to referral schemes can fully harness the potential of uncertain referral rewards to fuel platform growth.

7.3 Limitations

We acknowledge that this study has several limitations that offer opportunities for future research. First, our study primarily focuses on incorporating reward uncertainty within a risk framework, where users are informed of possible rewards and their probabilities. An alternative approach could introduce uncertainty through ambiguity, by withholding certain information. Drawing insights from decision-making theory, which suggests varying behaviors in response to risk versus ambiguity, future research could explore how the varying level of information disclosure influences the perception and reaction to uncertain referral rewards.

Second, beyond exploring reward size, another important consideration is reward distribution. In our current uncertain scenario, there is no minimum guaranteed reward, and it would be valuable to investigate how the inclusion of a small reserved reward might influence user perceptions of uncertain rewards. Future studies could set up experiments to delve into this aspect and refine the distribution of uncertain rewards.

Third, future research could explore how the uncertainty in referral rewards affects the sender's selection of recipients. Factors such as the potential recipient's demographics or the closeness of their relationship with the sender could play a significant role, especially when the rewards are uncertain. However, privacy constraints in our field experiments limited our ability to collect data on these

aspects, including information on recipients who declined invitations. To gain a more holistic view of the sender's selection process, future studies could include recipients who rejected the invitation and compare them with those who accepted across different reward schemes, possibly in a controlled lab environment.

Finally, while our empirical study yields consistent results across two experimental periods and two follow-up experiments, its scope is confined to a telecommunications app. The generalizability of our findings across different types of platforms (e.g., hedonic versus utilitarian platforms) and different forms of rewards is worth future research.

References

Adamopoulos, P., Ghose, A., & Todri, V. (2018). The impact of user personality traits on word of mouth: Text-mining social media platforms. *Information Systems Research*, *29*(3), 612-640.

Ames, D. R., Flynn, F. J., & Weber, E. U. (2004). It's the thought that counts: On perceiving how helpers decide to lend a hand. *Personality and Social Psychology Bulletin*, *30*(4), 461-474.

Aral, S., & Walker, D. (2011). Creating social contagion through viral product design: A randomized trial of peer influence in networks. *Management Science*, *57*(9), 1623–1639.

Asch, S. E. (1955). Opinions and social pressure. *Scientific American*, *193*(5), 31–35.

Bassellier, G., & Ramaprasad, J. (2023). All external reference prices are not the same: How magnitude, source, and fairness shape payment for digital goods. *Information Systems Research*, *34*(4), 1761-1774.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology*, *5*(4), 323–370.

Belo, R., & Ferreira, P. (2022). Free riding in products with positive network externalities: Empirical evidence from a large mobile network. *MIS Quarterly*, *46*(1), 401–430.

Belo, R., & Li, T. (2022). Social referral programs for freemium platforms. *Management Science*, *68*(12).

Bernheim, B. D. (1994). A theory of conformity. *Journal of Political Economy*, *102*(5), 841–877.

Bolton, G. E., & Ockenfels, A. (2010, March). Betrayal aversion: Evidence from brazil, china, oman, switzerland, turkey, and the united states: Comment. *American Economic Review*, *100*(1), 628-33.

Bond, R., & Smith, P. B. (1996). Culture and conformity: A meta-analysis of studies using asch's (1952b, 1956) line judgment task. *Psychological Bulletin*, *119*(1), 111.

Burtch, G., Gupta, D., & Martin, P. (2021). Referral timing and fundraising success in crowdfunding. *Manufacturing & Service Operations Management*, *23*(3), 676–694.

Capraro, V., & Kuilder, J. (2016). To know or not to know? looking at payoffs signals selfish behavior, but it does not actually mean so. *Journal of Behavioral and Experimental Economics*, *65*, 79-84.

Charness, G. (2000). Responsibility and effort in an experimental labor market. *Journal of Economic Behavior & Organization*, *42*(3), 375-384.

Charness, G., & Jackson, M. O. (2009). The role of responsibility in strategic risk-taking. *Journal of Economic Behavior & Organization*, *69*(3), 241-247.

Eeley, C. L. (2016). Excusing selfishness in charitable giving: The role of risk. *The Review of Economic Studies*, *83*(2), 587–628.

Fernández-Loría, C., Cohen, M. C., & Ghose, A. (2023). Evolution of referrals over customers' life cycle: Evidence from a ride-sharing platform. *Information Systems Research*, *34*(2), 698-720.

Garnefeld, I., Eggert, A., Helm, S. V., & Tax, S. S. (2013). Growing existing customers' revenue streams through customer referral programs. *Journal of Marketing*, *77*(4), 17–32.

Ghose, A., Mukhopadhyay, T., & Rajan, U. (2007). The impact of internet referral services on a supply chain. *Information Systems Research*, *18*(3), 300-319.

Gibson, B., & Sanbonmatsu, D. M. (2004). Optimism, pessimism, and gambling: The downside of optimism. *Personality and Social Psychology Bulletin*, *30*(2), 149–160.

Gneezy, U., List, J. A., & Wu, G. (2006). The uncertainty effect: When a risky prospect is valued less than its worst possible outcome. *The Quarterly Journal of Economics*, *121*(4), 1283-1309.

Goldsmith, K., & Amir, O. (2010). Can uncertainty improve promotions? *Journal of Marketing Research*, *47*(6), 1070-1077.

Hayes, A. (2017). *Introduction to mediation, moderation, and conditional process analysis, second edition: A regression-based approach*. Guilford Publications.

Hinz, O., Skiera, B., Barrot, C., & Becker, J. U. (2011). Seeding strategies for viral marketing: An empirical comparison. *Journal of Marketing*, *75*(6), 55–71.

Hong, Y., Pavlou, P. A., Shi, N., & Wang, K. (2017). On the role of fairness and social distance in designing effective social referral systems. *MIS Quarterly*, *41*(3), 787–810.

Hsee, C. K., & Ruan, B. (2016). The pandora effect: The power and peril of curiosity. *Psychological Science*, *27*(5), 659–666.

Jordan, J. J., Hoffman, M., Nowak, M. A., & Rand, D. G. (2016). Uncalculating cooperation is used to signal trustworthiness. *Proceedings of the National Academy of Sciences*, *113*(31), 8658-8663.

Jung, J., Bapna, R., Golden, J. M., & Sun, T. (2020). Words matter! toward a prosocial call-to-action for online referral: Evidence from two field experiments. *Information Systems Research*, *31*(1), 16-36.

Jung, J., Bapna, R., Gupta, A., & Sen, S. (2021). Impact of incentive mechanism in online referral programs: Evidence from randomized field experiments. *Journal of Management Information Systems*, *38*(1), 59-81.

Kornish, L. J., & Li, Q. (2010). Optimal referral bonuses with asymmetric information: Firm-offered and interpersonal incentives. *Marketing Science*, *29*(1), 108–121.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, *116*(1), 75.

Lu, J., Shang, X., & Li, B. (2018). Self–other differences in decision-making under risk. *Experimental Psychology*, *65*(4), 226-235.

Rabin, M., & Thaler, R. H. (2001). Anomalies: risk aversion. *Journal of Economic Perspectives*, *15*(1), 219–232.

Reynolds, D. B., Joseph, J., Sherwood, R., et al. (2009). Risky shift versus cautious shift: determining differences in risk taking between private and public management decision-making. *Journal of Business & Economics Research*, *7*(1), 63-78.

Ruan, B., Hsee, C. K., & Lu, Z. Y. (2018). The teasing effect: An underappreciated benefit of creating and resolving an uncertainty. *Journal of Marketing Research*, *55*(4), 556–570.

Ryu, G., & Feick, L. (2007). A penny for your thoughts: Referral reward programs and referral likelihood. *Journal of Marketing*, *71*(1), 84–94.

Schmitt, P., Skiera, B., & Van den Bulte, C. (2011). Referral programs and customer value. *Journal of Marketing*, *75*(1), 46–59.

Selten, R. (2001). Blame avoidance as motivating force in the first price sealed bid private value

auction. In G. Debreu, W. Neuefeind, & W. Trockel (Eds.), *Economics essays: A festschrift for werner hildenbrand* (pp. 333–344). Springer Berlin Heidelberg.

Sharot, T. (2011). The optimism bias. *Current Biology*, *21*(23), R941–R945.

Shen, L., Fishbach, A., & Hsee, C. K. (2015). The Motivating-Uncertainty Effect: Uncertainty Increases Resource Investment in the Process of Reward Pursuit. *Journal of Consumer Research*, *41*(5), 1301-1315.

Shen, L., Hsee, C. K., & Talloen, J. H. (2019). The fun and function of uncertainty: Uncertain incentives reinforce repetition decisions. *Journal of Consumer Research*, *46*(1), 69-81.

Silver, I., & Silverman, J. (2022). Doing good for (maybe) nothing: How reward uncertainty shapes observer responses to prosocial behavior. *Organizational Behavior and Human Decision Processes*, *168*, 104113.

Sun, T., Viswanathan, S., Huang, N., & Zheleva, E. (2021). Designing promotional incentive to embrace social sharing: Evidence from field and lab experiments [Journal Article]. *MIS Quarterly*, *45*(2), 789–820.

Sun, T., Viswanathan, S., & Zheleva, E. (2021). Creating social contagion through firm-mediated message design: Evidence from a randomized field experiment. *Management Science*, *67*(2), 808-827.

Van den Bulte, C., Bayer, E., Skiera, B., & Schmitt, P. (2018). How customer referral programs turn social capital into economic capital. *Journal of Marketing Research*, *55*(1), 132–146.

Wakker, P. P. (2010). *Prospect theory: For risk and ambiguity* [Book]. Cambridge university press.

Wang, Q., Sun, Y., Zhu, J., & Zhang, X. (2018). The impact of uncertain rewards on customers' recommendation intention in social networks. *Internet Research*, *28*(4), 1029-1054.

Weber, B. J., & Chapman, G. B. (2005). Playing for peanuts: Why is risk seeking more common for low-stakes gambles? *Organizational Behavior and Human Decision Processes*, *97*(1), 31–46.

Wirtz, J., Orsingher, C., Chew, P., & Tambyah, S. K. (2013). The role of metaperception on the effectiveness of referral reward programs. *Journal of Service Research*, *16*(1), 82–98.

Xu, H., Chen, Z., & Mao, J. (2020). Inhibition or facilitation? a review of research on the effects of uncertainty stimuli on user psychology and behavior. *American Journal of Industrial and Business Management*, *10*, 1586-1604.

A A Review of Referral Programs with Uncertain Rewards

Table A1 showcases various platforms with asymmetric uncertain reward structures in their referral programs, where the reward for either the sender or the recipient is uncertain. This review was conducted on July 30, 2024. For referral programs that had expired prior to our review, we have indicated their respective effective periods. For programs that remained active as of the review date, their effective period is marked as "Until Now."

Table A2 presents some platforms that feature uncertain referral rewards for both the sender and the recipient.

B Randomization Checks

Due to privacy regulations in the field experiments, we were unable to collect user characteristics. Instead, we portrayed users based on their in-app behaviors before the start of our experiment and examined whether there were any significant differences in these antecedent behaviors among users in different experimental groups. These backward analyses served as randomization checks. In specific, the app had an early version of the referral program, denoted as the *pre-referral* period, which spanned 14 days and ended one year before our experiment. No experiments were conducted during this period, and the referral rewards were certain for both senders and recipients. We retrieved the participation and referral behaviors of our experimental users during the pre-referral period, summarized in Table A3. Additionally, t-tests are performed to compare the sender uncertain group with the sender certain group, and the corresponding coefficients and p-values (in brackets) are reported. Similarly, coefficients and p-values, resulting from t-tests comparing the recipient uncertain group with the recipient certain group, are also presented.

Among the total 162,266 users enrolled in our field experiment, 8,144 users (5%) engaged in the pre-referral program (*If Participate*). Among all the users, 0.4% had at least one successful referral (*If Refer*) during the pre-referral period, with an average of 0.008 successful referrals per user (*Direct Referrals*). Within the subset of 8,144 participating users, 7.2% had at least one successful referral, and each participating user, on average, successfully invited 0.159 referrals. The p-values collectively indicate there is no significant difference between the four groups.

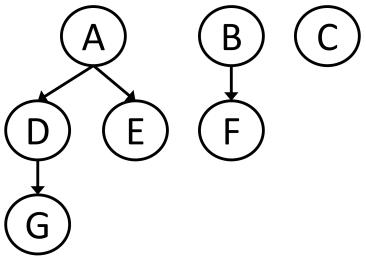
In addition to the pre-referral program, we also compared users' participation in a game. Specifically, before the start of our experiment, the app introduced a wheel game that offered users a daily chance to spin a wheel and earn random points ("pre-game" in short hereafter). This game lasted for 30 days, during which no experimental variations were implemented, and it ended before the start of our experiment. Table A3 presents the average participation rates (*If Participate Pre-game*), along with the corresponding p-values for group comparisons. Overall, out of the 162,266 experimental

users, 7,061 (4.4%) participated in pre-game. The two experimental indicators did not exhibit any significant differences in terms of user participation in pre-game.

C Variable Calculation and Model-free Evidence

C.1 A Demo of Variable Calculation

Figure A1 provides an illustration of a referral network and demonstrates the calculation of key variables. In this example, users A, B, and C come from organic traffic, while users D, E, F, and G are acquired through referrals. Firstly, we consider whether a focal user has successfully referred at least one friend (*If Refer*). Then, we calculate the number of referrals directly invited by the focal user (*Direct Referrals*). Next, we trace all the referrals who have been directly or indirectly invited by the focal user (i.e., all the descendants of the focal user in the referral tree) and compute the total number of referrals (*Total Referrals*). Finally, we calculate the number of referrals who have been indirectly invited by the focal user (i.e., *Indirect Referrals = Total Referrals - Direct Referrals*). *Indirect Referrals* represents the cumulative number of subsequent referrals made by all the recipients invited by the focal user.



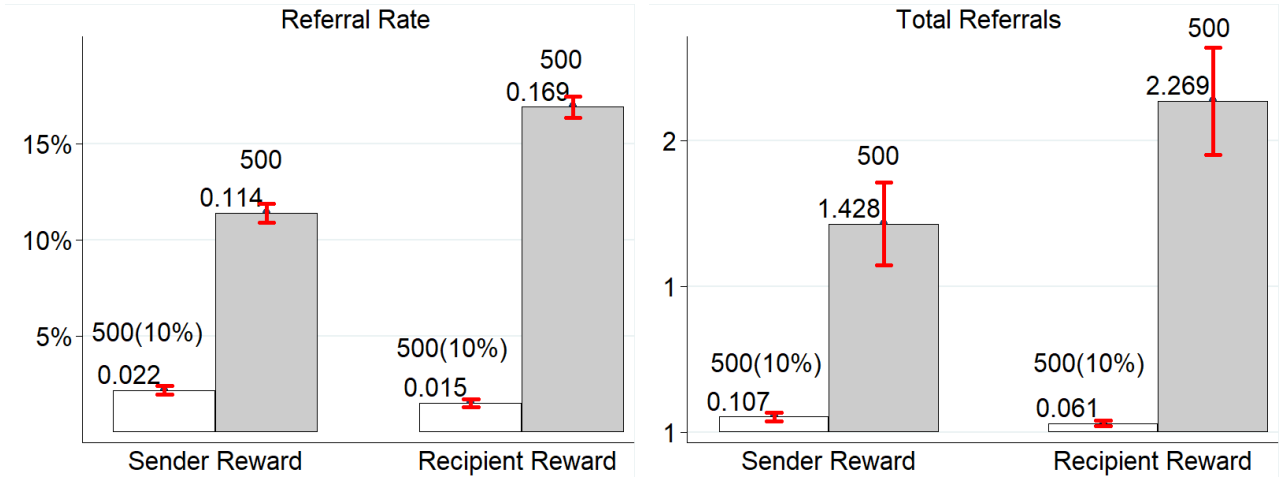
	A	B	C	D	E	F	G
From Referral	0	0	0	1	1	1	1
If Refer	1	1	0	1	0	0	0
Direct Referrals	2	1	0	1	0	0	0
Total Referrals	3	1	0	1	0	0	0
Indirect Referrals	1	0	0	0	0	0	0

Figure A1: A demo of the referral network and variable calculation

C.2 Manipulation Checks

We investigate whether users incorporate probability into their referral decisions by comparing those offered a certain 500-points reward with those offered a 500-points reward with a 10% chance. Panel A of Figure A2 illustrates the comparison of referral rates between these two reward schemes, from

both the sender's and the recipient's perspectives. For the sender's reward, users offered a 500-points sender reward exhibit an 11.4% referral rate, significantly higher than the 2.2% referral rate observed for users offered a 500-points sender reward with a 10% chance. Similar patterns apply to the recipient's reward. Likewise, these trends are also reflected in the total number of referrals, as depicted in Panel B. These results collectively indicate that users indeed take the rewarding probability into account when making their referral decisions.



Panel A: Referral rate Panel B: Total Referrals

Figure A2: Probability matters

C.3 Model-free Evidence

Table A4 displays the mean values for each of the four groups. Additionally, t-tests are performed to compare the sender uncertain group with the sender certain group, and the corresponding coefficients and p-values are reported. Similarly, coefficients and p-values resulting from t-tests comparing the recipient uncertain group with the recipient certain group are also presented.

D Robustness Checks

D.1 Alternative Model Specifications for Main Results

In the main text, we use linear regressions to analyze the observed actions related to discrete countable variables, such as *Number of Shares, Direct Referrals, Indirect Referrals*, and *Total Referrals*. However, as these countable variables might exhibit over-dispersion, we utilize three different methods

to ensure the robustness of our results when using alternative model specifications. Firstly, we apply a log transformation to the countable variables to reduce the over-dispersion. Secondly, we employ negative binomial models to account for the over-dispersion in the estimation of the models. Thirdly, we winsorize the users whose referrals fall beyond three standard deviations to mitigate the impact of over-dispersion. Furthermore, to assess the robustness of the results for dummy variables (*If Share, If Refer*), we also utilize logit models as additional checks.

Table A5 exhibits consistent results after applying log transformations to the countable variables.

Table A6 reports consistent results when we use logit regressions for dummy variables and negative binomial regressions for countable variables.

Table A7 presents consistent results after winsorizing the referrals outside the three standard deviations.

D.2 Robustness Check after Removing Users in Both Experimental Periods

As a robustness check, we excluded the 2,637 users, who participated in both experimental periods, to mitigate the potential carryover effect of users' performance from the first period to the second period. Removing these users, we found consistent results in Table A8.

D.3 Robustness Check Using Alternative Measure of Referrals

A referral program only awards invitations if the recipient has not previously participated. Thus, if a sender invites a recipient who has already participated either through organic traffic or another user's invitation, neither the sender nor the invited recipient will receive referral rewards. Despite these invited recipients not meeting the criteria for a successful referral, these invitations may still signal the sender's inclination to refer friends. Hence, we include these recipients as a robustness check. Table A9 considers all recipients invited by the focal user, including both newly registered recipients and those who have previously participated. The results align consistently with the main analyses.

D.4 Effect of Reward Uncertainty on User Participation

We collected users' in-app behaviors during the experimental periods to investigate whether the referral reward spills over and impacts user engagement. We specifically examined the retention rate, measured by whether users revisited the app, and the number of days they participated during the experimental period. Table A10 demonstrates that, compared to organic traffic, users from referrals (*From Referral*) show a higher likelihood of retention and prolonged participation in the app.

Additionally, we observe that users with a desired referral reward scheme (i.e., uncertain sender and certain recipient) also exhibit extended participation in the app. This behavior may be attributed to the app's push notifications, triggered by each successful referral, which could prompt senders to open the app and check their realized referral rewards. Specifically, senders with uncertain rewards

for themselves generate more referrals, resulting in more frequent notifications of realized referral rewards and a higher likelihood of returning to the app.

E Heterogeneity Analyses

E.1 Moderating Effect of the Reward Size

We explore how the impact of reward uncertainty on referrals is moderated by the reward size. Investigating the moderating effect of reward size can help us understand the effective boundaries of our findings. Additionally, gaining insight into the conditions under which positive effects can be amplified offers valuable guidance for platform practitioners seeking to optimize reward scheme design. Table A11 reports our findings. Firstly, we observe a large reward ($RewardSize$) encourages users to share with more friends and ultimately generates more referrals. Secondly, we find that reward size positively moderates the effect of sender uncertainty and negatively moderates the effect of recipient uncertainty on referrals. In other words, the reward size amplifies the positive impact of sender uncertainty and exacerbates the negative impact of recipient uncertainty on referrals. As the reward increases, the benefits of using USCR reward scheme become more pronounced.

E.2 Heterogeneity of Traffic Types

Table A12 compares the referral behaviors between users from organic traffic and users acquired from a referral. Results indicate that the referral behavior is sustained, and users from referrals are more likely to invite others. A sustained referral network exists to generate more shares and invite more referrals. For instance, an invited recipient averagely generates 0.659 further referrals (*Direct Referrals*), significantly higher than the average of 0.04 referrals by organic users. Compared to organic traffic, referral recipients are selected by senders who can target the right audience for the referral program. Meanwhile, recipient's self-selection in acceptance filters out uninterested ones. Thus, the users participating through referral are those who are interested in the referral program and are thus more likely to refer others (Schmitt et al., 2011).

Then we explore whether and how the reward uncertainty differently influences the referral behaviors of users from referral and organic traffic. Table A13 reports our findings. The positive interactions between *Sender Uncertainty* and *From Referral* indicate that the positive effect of sender

uncertainty is amplified for users from referrals, compared to users from organic traffic. The negative interactions between *Recipient Uncertainty* and *From Referral* suggest that the negative effect of recipient uncertainty is also amplified for users from referrals, compared to users from organic traffic. In other words, the effect of *USCR* reward scheme is significantly greater for users from referrals than for users from organic traffic.

F Follow-up Experiments

Following the field experiment, we conducted two online experiments. Subjects were familiar with similar referral programs, and the majority had previously participated in such programs. Participants were asked to imagine that an app they frequently use had a referral program where they could earn points by inviting others, with 100 points roughly equivalent to 1 RMB. A total of 213 valid subjects passed two manipulation checks, each corresponding to one of the two experiments conducted. We summarize their characteristics in Table A14.

F.1 Experiment 1: Understanding the Sender's Sharing Reasons

Consistent with the field experiment, subjects were randomly assigned to one of the four groups. Table A15 demonstrates that subjects exhibit balanced characteristics without significant differences among the four groups. Each subject was presented with a corresponding message explaining the reward rules from the sender's perspective, mirroring the conditions in the field experiment (see Table 1 in the main text). Specifically, the following information was provided to the subjects:

"Assume that the APP that you frequently use is conducting a promotion program, and you can invite

your friend to join the program. Once your friend accepts your invitation, both you and your friends will

get some referral rewards. The rewarding rule is as follows.

[Reward rule according to the user's randomly assigned group] "

After presenting the reward rules, we conducted a manipulation check to assess whether the subjects could accurately identify the reward type for both the sender and the recipient, based on the following multiple-choice question:

Did you notice the rules for sharing rewards?

- *By inviting friends: The points I receive are certain, and the points my friends receive are also certain.*
- *By inviting friends: The points I receive are certain, and the points my friends receive are uncertain.*
- *By inviting friends: The points I receive are uncertain, and the points my friends receive are certain.*
- *By inviting friends: The points I receive are uncertain, and the points my friends receive are also uncertain.*

In our analyses, we included those valid subjects who accurately selected the reward type in accordance with their assigned group. Then, following Jung et al. (2020), we ask the subjects about their sharing intention and the reasons that people choose to share or not share. Table A16 demonstrates the questions and summary statistics.

F.2 Experiment 2: Understanding the Reasons of Recipient's Acceptance

In the second experiment, we recruited the same subjects and randomly reassigned them into four distinct groups to act as referral recipients. Each group was presented with an invitation message, which mirrored those used in the field experiment, as outlined in Table 1 in the main text. After presenting the invitation message, we also conducted a manipulation check to confirm that valid subjects were aware of both their reward type and the reward type of their inviters.

Did you notice the rules for sharing rewards?

- *By accepting the invitation: The points I get are certain, and the points that my friends get are also certain.*
- *By accepting the invitation: The points I get are certain, and the points that my friends get are uncertain.*
- *By accepting the invitation: The points I get are uncertain, and the points that my friends get are certain.*
- *By accepting the invitation: The points I get are uncertain, and the points that my friends get are also uncertain.*

Subsequently, we queried the subjects regarding their intention to accept and their potential intention for further referrals. Additionally, we sought to understand the reasons for either their acceptance or rejection of the invitation (Jung et al., 2020). Table A17 presents the posed questions along with summary statistics.

F.3 Mediation Tests and Conditional Indirect Effects

Adhering to the method by Hayes (2017), we conducted mediation tests to examine whether certain variables, such as guilt perception and fairness perception, function as valid mediators in elucidating the impact of reward uncertainty on the sender's sharing intentions. For each mediator ($Mediator_i$), we investigate whether it is affected by the reward uncertainty ($Sender\ Uncertainty_i$, $Recipient\ Uncertainty_i$) as follows.

$$Mediator_i = \phi_0 + \phi_1 Sender\ Uncertainty_i + \phi_2 Recipient\ Uncertainty_i + \lambda_i + \delta_i \qquad \text{(A1)}$$

where λ_i captures the effect of user characteristics such as gender, age, educational background, and referral experiences. δ_i reflects the idiosyncratic variation in potential outcomes that vary across individuals.

Then, we study the effect on the sender's sharing intention ($Share\ Intention_i$), which is affected by both the reward uncertainty ($Sender\ Uncertainty_i$, $Recipient\ Uncertainty_i$) and the mediator ($Mediator_i$) as follows.

$$Share\ Intention_i = \beta_0 + \beta_1 Sender\ Uncertainty_i + \beta_2 Recipient\ Uncertainty_i + \gamma Mediator_i + \lambda_i + \epsilon_i \qquad \text{(A2)}$$

For each mediator, we can calculate the indirect effect of $Sender\ Uncertainty_i$ ($Recipient\ Uncertainty_i$) on their $Share\ Intention_i$, conditional on the $Mediator_i$: $\phi_1 \cdot \gamma$ ($\phi_2 \cdot \gamma$). The significance of the conditional indirect effect captures whether the mediator is a valid mechanism in explaining the effect of reward uncertainty on the sharing intention.

Similarly, from a recipient j's perspective, we investigate the indirect effect of their inviter's reward scheme ($Inviter's\ Sender\ Uncertainty_j$, $Inviter's\ Recipient\ Uncertainty_j$) on their decision to accept the invitation ($Accept\ Intention_j$) and further refer others ($Further\ Refer\ Intention_j$), conditional on each mediator.

G Additional Analyses on Sender's Sharing Intention

Decision theory suggests that other mechanisms might be in play. Consequently, we explore whether these mechanisms are valid in explaining the effect of reward uncertainty on sharing intention. Existing literature indicates that users tend to be risk-averse, which may diminish the impact of reward uncertainty, as uncertain rewards are often perceived as less valuable than certain rewards with the same expected value. However, exceptions exist, with users sometimes exhibiting risk-seeking behavior. In such cases, users attribute greater value to an uncertain reward compared to an equivalent certain reward. One potential explanation for this phenomenon is optimism, wherein users focus on the potential for a higher reward while discounting its probability (Goldsmith & Amir, 2010), particularly when stakes are low (Rabin & Thaler, 2001). Another possible explanation is curiosity. Uncertain rewards could invoke people's interest through curiosity, while certain rewards do not have this property (Ruan et al., 2018). Uncertainty represents an information gap, which can induce curiosity and lead to a positive utility when the uncertainty is resolved (Loewenstein, 1994). For instance, Hsee & Ruan (2016) conducted an experiment demonstrating that people repeatedly exposed themselves to adverse stimuli for no apparent benefit other than to resolve the uncertainty. This positive resolution utility could offset the uncertainty of the outcomes, especially when people focus more on the process than on the outcomes (Shen et al., 2015, 2019). We leverage the first follow-up experiment to investigate each of the two potential explanations.

G.1 Sender's Risk Attitude and Sharing Intention

Table A18 displays the sender's perceived values of uncertain rewards. Generally, a high perceived value of the sender's reward significantly increases sharing intention (0.444, $p < 0.01$), but senders perceive a significantly lower value of uncertainty in their own rewards compared to certain rewards (-0.717, $p < 0.001$), resulting in a decreased sharing intention (-0.717 $\times$ 0.444 = 0.319, $p < 0.001$). Similarly, a high perceived value of the recipient's reward also significantly increases sharing intention (0.310, $p < 0.01$), but incorporating uncertainty also reduces the sender's perceived value

of the recipient's reward (-0.582, $p < 0.001$), resulting in a decreased sharing intention (-0.582 $\times$ 0.310=0.181, $p < 0.001$). Taken together, our findings do not support the optimism. Instead, users exhibit risk aversion, perceiving uncertain rewards as less valuable than certain rewards with the same expected value. This risk aversion is evident both in the evaluation of the sender's own reward and in the evaluation of the recipient's reward.

G.2 The Role of Curiosity on Sender's Sharing Intention

Table A19 presents whether curiosity plays a role in explaining the effect of reward uncertainty on increased sharing intention. The results indicate that while reward uncertainty can indeed increase curiosity, curiosity itself is not a valid mechanism for explaining the effect on sharing intention.

H Additional Analyses on Recipient's Response

By utilizing the second follow-up experiment, we investigate how recipients evaluate uncertain rewards and whether curiosity influences their decision to accept the invitation.

H.1 Recipient's Risk Attitude and Acceptance

Table A20 reveals that upon receiving an invitation, recipients are indifferent to their inviter's reward scheme (*Inviter Sender Uncertainty*), but they do care about their own reward scheme (*Inviter Recipient Uncertainty*). Introducing uncertainty not only reduces the evaluation of their own reward (-0.628, $p < 0.001$) but also underestimates their inviter's reward (-0.490, $p < 0.01$), thereby significantly reducing the likelihood of accepting the invitation.

H.2 The Role of Curiosity on Recipient's Acceptance

Table A21 presents the role of curiosity on recipient's decision to accept the invitation. Generally, introducing uncertainty into the inviter's reward (*Inviter Sender Uncertainty*) stimulates the recipient's curiosity about their inviter's reward realization (0.890, $p < 0.001$), and this curiosity regarding the sender's reward encourages the recipient to accept the invitation (0.168, $p < 0.01$).

However, the impact of recipients' uncertainty on curiosity is twofold. Introducing uncertainty into their own reward (*Inviter Recipient Uncertainty*) may foster curiosity about their own reward (0.595, $p < 0.05$), but it diminishes curiosity about their inviter's reward (-0.438, $p < 0.05$), offsetting the potential benefits of incorporating uncertainty into the recipient's reward. Thus, curiosity does not aid recipients in capitalizing on the advantages of reward uncertainty.

I Additional Analyses on Spillover Effect

I.1 Moderation of Reward Size on Spillover Effect

We also examine the impact of reward uncertainty on the recipient's subsequent referrals in the context of different reward sizes. Table A22 presents the results, highlighting the positive interaction between *Reward Size* and *Inviter's Sender Uncertainty*, as well as the negative interaction between *Reward Size* and *Inviter's Recipient Uncertainty*. These findings suggest that a larger reward amplifies the positive effect of sender uncertainty on the invitation of active recipients and exacerbates the negative effect of recipient uncertainty on the invitation of inactive recipients.

As an illustrative example, Table A23 demonstrates the impact of reward uncertainty on the referral rate and the recipient's subsequent referral rate, with sub-sample analyses conducted for different reward sizes. We observe that the reward size amplifies both the positive impact of sender uncertainty and the negative impact of recipient uncertainty. This suggests that as the potential reward becomes larger, the positive effect of the sender's uncertainty in motivating referrals, as well as the negative effect of the recipient's uncertainty in inhibiting referrals, are intensified. Meanwhile, the reward size also magnifies the impact of reward uncertainty on the subsequent referral rate of the invited recipient. When the reward size is small (e.g., 10 points), the effect of reward uncertainty on the recipient's further referral rate is insignificant. However, as the reward size increases, the impact becomes significant. This implies that when the potential reward is larger, the uncertainty surrounding that reward has a stronger influence on the recipient's decision to make further referrals.

In summary, while providing a larger referral reward can incentivize users to make referrals, it may also intensify the psychological cost associated with feeling guilty about claiming extrinsic rewards in exchange for others' actions. Introducing reward uncertainty can alleviate such a guilt perception. This suggests that the benefits of reward uncertainty are particularly pronounced when the referral reward is substantial. Overall, these findings highlight the interplay between reward uncertainty and reward size in influencing the referral behavior of individuals. They imply that when designing referral programs, the potential impact of reward uncertainty should be considered, especially when the reward size is significant.

I.2 An Alternative Specification of Spillover Effect

As a robustness check of the spillover effect of senders' reward uncertainty on the invited recipient's subsequent referrals, we compute the average number of referrals of recipients invited by a focal user. For instance, if a focal user invites three recipients with direct referrals of 1, 2, and 6, the average direct referrals of those recipients would be 3. This metric aids us in investigating whether the user's reward scheme affects the recipients' average level of direct referrals. Additionally, we calculate the

other metrics for further referral behaviors of invited recipients, including their average sharing rate, shares, referral rate, total referrals, and indirect referrals. We find that the spillover effect exists in terms of the recipient's direct referrals but does not impact their indirect referrals.

Table 1: Experimental design

Sender Uncertainty	Recipient Uncertainty	Reward messages to senders	Reward messages to recipients
No	No	You will get 50 points, and help your friends get 50 points.	You will get 50 points, and help me get 50 points.
No	Yes	You will get 50 points, and help your friends get 500 points with a 10% chance.	You will get 500 points with a 10% chance, and help me get 50 points.
Yes	No	You will get 500 points with a 10% chance, and help your friends get 50 points.	You will get 50 points, and help me get 500 points with a 10% chance.
Yes	Yes	You will get 500 points with a 10% chance, and help your friends get 500 points with a 10% chance.	You will get 500 points with a 10% chance, and help me get 500 points with a 10% chance.

Table 2: Variable description and summary statistics

Panel A: All users (N=162,266)					
Variable	Description	Mean	SD	min	max
Sender Uncertainty	=1 if the sender's reward is uncertain	0.502	0.500	0	1
Recipient Uncertainty	=1 if the recipient's reward is uncertain	0.494	0.500	0	1
If Share	=1 if the user shared the program at least once	0.108	0.311	0	1
Number of Shares	The number of shares that the user had during the experiment	0.206	0.885	0	49
If Refer	=1 if the user invited at least recipient	0.039	0.194	0	1
Direct Referrals	The number of successful referrals directly invited by the user	0.183	2.131	0	274
Total Referrals	The user's all descendants in the referral tree, including child nodes, grandchild nodes, etc.	0.386	9.357	0	1325
Indirect Referrals	The number of referrals who are indirectly invited by the user	0.203	8.345	0	1256
From Referral	=1 if the user joined the program via referral	0.231	0.421	0	1

Panel B: The successful referrals (i.e., users from the referral traffic) (N=37,414)					
Variable	Description	Mean	SD	min	max
Inviter's Sender Uncertainty	=1 if the inviter's self reward is uncertain	0.553	0.497	0	1
Inviter's Recipient Uncertainty	=1 if the inviter's recipient reward is uncertain	0.328	0.470	0	1
Lucky Inviter	=1 if the inviter's realized reward is large	0.052	0.222	0	1
Lucky Recipient	=1 if the recipient's realized reward is large	0.029	0.167	0	1

Table 3: Effect of reward uncertainty on the referrals

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.013***	0.044***	0.019***	0.025*	0.129**	0.104*
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Recipient Uncertainty	-0.013***	-0.033***	-0.012***	-0.087***	-0.274***	-0.187***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
From Referral	0.088***	0.201***	0.066***	0.276***	0.651***	0.375***
	(0.00)	(0.01)	(0.00)	(0.02)	(0.08)	(0.07)
Constant	0.042***	0.033***	-0.005*	-0.010	-0.021	-0.011
	(0.00)	(0.01)	(0.00)	(0.02)	(0.10)	(0.09)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
R^2	0.073	0.053	0.090	0.021	0.006	0.002

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Mediation effect of guilt and fairness perceptions on sender's sharing intention

	(1) Share Intention	(2) Guilt	(3) Fairness	(4) Share Intention	(5) Share Intention
Sender Uncertainty	0.357^{+}	-0.830***	-0.219	-0.028	0.425*
	(0.20)	(0.22)	(0.20)	(0.17)	(0.19)
Recipient Uncertainty	-1.182***	1.106***	-0.719***	-0.669***	-0.959***
	(0.19)	(0.22)	(0.20)	(0.18)	(0.19)
Guilt				-0.464***	
				(0.05)	
Fairness					0.310***
					(0.06)
Female	0.226	-0.084	-0.225	0.187	0.295
	(0.20)	(0.23)	(0.21)	(0.17)	(0.19)
Age	-0.002	-0.015	0.001	-0.010	-0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.614***	2.046*	3.957***	6.564***	4.387***
	(0.70)	(0.80)	(0.73)	(0.61)	(0.71)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.203	0.186	0.150	0.425	0.286

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Mediation tests of fairness and social pressure on recipient's intention to accept the invitation

	(1) Accept Intention	(2) Fairness	(3) Social Pressure	(4) Accept Intention	(5) Accept Intention
Inviter's Sender Uncertainty	-0.036	0.245	0.126	-0.109	-0.100
	(0.18)	(0.23)	(0.12)	(0.17)	(0.17)
Inviter's Recipient Uncertainty	-1.153***	-0.755***	-0.302**	-0.927***	-0.997***
	(0.17)	(0.22)	(0.11)	(0.17)	(0.17)
Fairness				0.300***	
				(0.05)	
Social Pressure					0.515***
					(0.10)
Female	-0.493**	-0.317	-0.226^{+}	-0.398*	-0.377*
	(0.18)	(0.23)	(0.12)	(0.17)	(0.17)
Age	-0.004	0.020	-0.005	-0.011	-0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.645***	3.424***	3.423***	4.619***	3.880***
	(0.63)	(0.81)	(0.41)	(0.61)	(0.69)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.291	0.132	0.190	0.395	0.370

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Effect of reward uncertainty on the invited recipient's further referrals

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.040***	0.123***	0.056***	0.049	0.413*	0.364*
	(0.00)	(0.01)	(0.00)	(0.04)	(0.20)	(0.18)
Recipient Uncertainty	-0.032***	-0.095***	-0.032***	-0.279***	-0.989***	-0.710***
	(0.00)	(0.01)	(0.00)	(0.04)	(0.20)	(0.18)
Inviter's Sender Uncertainty	0.070***	0.175***	0.060***	0.381***	0.807***	0.425*
	(0.00)	(0.02)	(0.00)	(0.04)	(0.20)	(0.18)
Inviter's Recipient Uncertainty	-0.051***	-0.125***	-0.053***	-0.395***	-0.835***	-0.440*
	(0.00)	(0.02)	(0.00)	(0.05)	(0.22)	(0.19)
Lucky Sender	0.024*	0.092**	0.030***	0.269**	0.118	-0.151
	(0.01)	(0.03)	(0.01)	(0.10)	(0.45)	(0.41)
Lucky Recipient	0.059***	0.121**	0.052***	0.143	-0.035	-0.178
	(0.01)	(0.05)	(0.01)	(0.13)	(0.61)	(0.54)
Constant	0.024	0.052	0.371***	0.891***	1.745**	0.854
	(0.01)	(0.05)	(0.01)	(0.14)	(0.66)	(0.59)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	37414	37414	37414	37414	37414	37414
R^2	0.019	0.013	0.069	0.010	0.003	0.001

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A1: A Review of Referral Programs with One-sided Uncertain Rewards

Company	Category	Sender Uncertainty	Recipient Uncertainty	Reward of sender	Reward of recipient	Effective Period
Gabb	Electronics	No	Yes	1 free month service	A lottery chance to win $1000 and 1 free month service	Nov. - Dec. 2022
Public	Finance	No	Yes	$20	$20 and a random stock valued from $3 to $300.	Aug. 2023
Burt's Bees Baby	Online Retailer	Yes	No	A 20% discount and a entry to win one of three prizes ($500, $250, $100)	A 20% discount	Nov. 2022
View Sonic	Electronics	Yes	No	A lottery chance to win one of three gaming monitors	None	Until now
PipeFlare	Game	Yes	No	A entry of multiple lucky draws	None	Until now
Team Race for ALS	Marathon Event	Yes	No	A $100 Amex gift card and a entry to win a second $100 Amex gift card	A $100 Amex gift card	Nov. 16 - Nov. 22, 2017
Axios	News	Yes	No	A tote bag and a lottery chance to win up to a $600 Apple e-gift card.	None	Nov. 3- Nov. 19, 2023
Tesla	Automotive	Yes	No	Tesla credit and a lottery chance to win a Cybertruck	Tesla credit	Oct. 25, 2022 - Dec. 31, 2023
POND5	Stock Media Marketplace	Yes	No	A lottery chance to win a DJI Drone	None	Oct. 19 – Nov. 12, 2021
Deputy	Software	Yes	No	$100 gift card and a lottery chance to win Apple products.	$100 gift card	Nov. 29 - Dec. 19, 2022
Juniper	Finance	Yes	No	$5 and a lottery chance to get $250 bonus.	$5	Jul. 4, 2024 - Until now
Public Mutual	Finance	Yes	No	Bonus Cash and a lottery chance to win up to RM3,000	Bonus Cash	Jan. 2 - Dec. 31, 2024
Webull	Finance	Yes	No	Three free stocks	$100 voucher	Feb. 20 - Mar. 31, 2020

Table A2: A Review of Referral Programs with Two-sided Uncertain Rewards

Company	Category	Reward of sender	Reward of recipient	Effective Period
Firstrade	Finance	A random stock and a lottery chance to win another free stock (1% chance).	A random stock	Oct. 2019
Robinhood Crypto Europe	Finance	A random reward value up to 1 BTC (98% of rewards are worth €30 in BTC)	A random reward value up to 1 BTC (98% of rewards are worth €30 in BTC)	Until now
Robinhood UK	Finance	A random stock	A random stock	Until now
Simple	Finance	A random reward value of up to 100 EUR.	A random reward value of up to 100 EUR.	Oct. 2023 - Until now
Tornado	Finance	A random stock valued from $5-$1000.	A random stock valued from $5-$1000.	Until now
Bitget	Crypto currency	A 15 USDT trial coupon and a blind box worth up to 500 USDT.	A 15 USDT trial coupon and a blind box worth up to 500 USDT.	Oct. 18 - Oct. 30, 2022
Pretty Little Thing	Fashion Retailer	A entry to win a 500 GDP voucher	an entry to win a 500 GDP voucher	Jun. 14 - Jun. 24, 2021
First Call Inc	Job search	A lottery chance to win a $100 Gift Card	A lottery chance to win $100 Gift Card	Apr. 2022 - Until now
Your School Lottery	Lottery	A lottery chance to win a £200 Amazon gift voucher (1 winner per month)	A lottery chance to win a £200 Amazon gift voucher (1 winner per month)	Dec. 2023 - Until now
Morning Brew	News	A lottery chance to win a MacBook Pro	A lottery chance to win a MacBook Pro	Sep. 2020
PayByPhone	Payment	A $5 Starbucks eGift + A lottery chance to win $250 CAD Visa gift card (100 winners in total)	A $5 Starbucks eGift + A lottery chance to win $250 CAD Visa gift card (100 winners in total)	Apr. 9 - May 31, 2018
Yacht Club Salon	Salon	A entry of the raffle to win $600 coupon	A entry of the raffle to win $600 coupon	Jan. 1 - Feb. 29, 2020
Whatnot	Online Retailer	A lottery chance to win credits valued between $10 and $200	A lottery chance to win credits valued between $10 and $200	Jul. 20, 2023 - Feb. 16, 2024

Table A3: Randomization checks in pre-referral and pre-game records

	Variable	Description	Mean (SD)	Min (Max)	Uncertain-Certain (p-value)	
					Sender	Recipient
All users (162266)	If Participate	=1 if the user participated the pre-referral; =0 otherwise.	0.050 (0.218)	0 (1)	-0.000 (0.91)	-0.000 (0.91)
	If Refer	=1 if the user successfully referred at least once in pre-referral; =0 otherwise.	0.004 (0.060)	0 (1)	0.000 (0.30)	-0.000 (0.94)
	Direct Referrals	the number of direct referrals in pre-referral	0.008 (0.338)	0 (45)	-0.001 (0.53)	-0.000 (0.89)
Participated Users (8144)	If Refer	=1 if the participated user successfully referred at least once in pre-referal; =0 otherwise.	0.072 (0.259)	0 (1)	0.006 (0.27)	-0.000 (0.96)
	Direct Referrals	the number of direct referrals of the participated users in pre-referral	0.159 (1.500)	0 (45)	-0.021 (0.54)	-0.004 (0.89)
All Users (162266)	If Participate Pre-game	=1 if the participated in the pre-game; =0 otherwise.	0.044 (0.204)	0 (1)	0.000 (0.91)	-0.001 (0.61)

Table A4: Model-free evidence (add more pairwise comparisons)

Sender Uncertain	No	No	Yes	Yes	Sender's Reward		Recipient's Reward	
Recipient Uncertain	No	Yes	No	Yes	Uncertain − Certain		Uncertain − Certain	
	mean	mean	mean	mean	Coefficient	p-value	Coefficient	p-value
If Share	0.108	0.094	0.125	0.106	0.014	<0.001	-0.016	<0.001
Shares	0.195	0.170	0.257	0.202	0.047	<0.001	-0.040	<0.001
If Refer	0.036	0.023	0.057	0.041	0.020	<0.001	-0.014	<0.001
Direct Referrals	0.225	0.110	0.237	0.157	0.029	0.006	-0.098	<0.001
Total Referrals	0.401	0.230	0.664	0.241	0.139	0.003	-0.298	<0.001
Indirect Referrals	0.176	0.120	0.427	0.084	0.110	0.008	-0.200	<0.001

Table A5: Effect of reward uncertainty on the referrals (Log transformation)

	(1)	(2)	(3)	(4)	(5)	(6)
	If Share (OLS)	Log (1+ Number of Shares) (OLS)	If Refer (OLS)	Log(1+ Direct Referrals) (OLS)	Log(1+ Total Referrals) (OLS)	Log(1+ Indirect Referrals) (OLS)
Sender Uncertainty	0.013***	0.017***	0.019***	0.018***	0.024***	0.011***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Recipient Uncertainty	-0.013***	-0.015***	-0.012***	-0.020***	-0.026***	-0.015***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
From Referral	0.088***	0.092***	0.066***	0.080***	0.099***	0.042***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.042***	0.029***	-0.005*	-0.005	-0.005	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
R^2	0.073	0.081	0.090	0.078	0.074	0.023

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6: Effect of reward uncertainty on the referrals (Logit and Negative Binomial)

	(1)	(2)	(3)	(4)	(5)	(6)
	If Share (Logit)	Number of Shares (Neg. Bin)	If Refer (Logit)	Direct Referrals (Neg. Bin)	Total Referrals (Neg. Bin)	Indirect Referrals (Neg. Bin)
Sender Uncertainty	0.149***	0.183***	0.569***	0.413***	0.545***	0.699***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.08)
Recipient Uncertainty	-0.151***	-0.114***	-0.378***	-0.572***	-0.727***	-1.017***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.08)
From Referral	0.727***	0.844***	1.510***	2.209***	2.673***	3.183***
	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.08)
Constant	-2.984***	-2.770***	-5.234***	-5.634***	-5.923***	-8.053***
	(0.04)	(0.04)	(0.09)	(0.09)	(0.10)	(0.23)
log(α)		1.740***		3.105***	3.423***	4.831***
		(0.01)		(0.02)	(0.02)	(0.03)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
pseudo R^2	0.091	0.063	0.212	0.132	0.126	0.112

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A7: Effect of reward uncertainty on the referrals (Winsorizing outliers outside 3σ)

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.013***	0.029***	0.019***	0.037***	0.059***	0.043***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Recipient Uncertainty	-0.013***	-0.025***	-0.012***	-0.046***	-0.120***	-0.062***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
From Referral	0.088***	0.154***	0.066***	0.156***	0.356***	0.159***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Constant	0.042***	0.043***	-0.005*	-0.009	-0.013	-0.013
	(0.00)	(0.01)	(0.00)	(0.01)	(0.02)	(0.01)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
R^2	0.073	0.081	0.090	0.069	0.043	0.016

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A8: Effect on referral quantity after removing the users who exist in both experiments

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.014***	0.043***	0.019***	0.029**	0.138**	0.109*
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Recipient Uncertainty	-0.013***	-0.032***	-0.012***	-0.086***	-0.275***	-0.189***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
From Referral	0.081***	0.171***	0.057***	0.214***	0.548***	0.334***
	(0.00)	(0.01)	(0.00)	(0.02)	(0.08)	(0.07)
Constant	0.044***	0.040***	-0.003	0.005	0.008	0.003
	(0.00)	(0.01)	(0.00)	(0.02)	(0.10)	(0.09)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	156992	156992	156992	156992	156992	156992
R^2	0.078	0.064	0.093	0.021	0.006	0.002

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A9: Impact of reward uncertainty on all the invited recipients

	(1) OLS	(2) Negative Binomial	(3) OLS after Log Transformation
Sender Uncertainty	0.036**	0.391***	0.022***
	(0.01)	(0.03)	(0.00)
Recipient Uncertainty	-0.109***	-0.514***	-0.021***
	(0.01)	(0.03)	(0.00)
From Referral	0.423***	2.293***	0.112***
	(0.02)	(0.03)	(0.00)
Constant	-0.029	-5.343***	-0.010**
	(0.03)	(0.08)	(0.00)
ln(α)		2.968***	
		(0.02)	
Exp. Period Fixed Effect	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES
N	162266	162266	162266
R^2 / pseudo R^2	0.024	0.133	0.093

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A10: Effect of referral reward uncertainty on user participation

	(1) Come Back? (OLS)	(2) Participated Days (OLS)
Sender Uncertainty	0.007***	0.070***
	(0.00)	(0.01)
Recipient Uncertainty	-0.003*	-0.044***
	(0.00)	(0.01)
From Referral	0.105***	1.084***
	(0.00)	(0.02)
Constant	-0.001	0.616***
	(0.00)	(0.02)
Exp. Period Fixed Effect	YES	YES
Reward Size Fixed Effect	YES	YES
N	162266	162266
R^2	0.021	0.025

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A11: Heterogeneity of reward size on referrals

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.013***	0.044***	0.019***	0.025*	0.129**	0.104*
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Sender Uncertainty	0.018***	0.057***	0.022***	0.013	0.192***	0.179***
× Reward Size	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Recipient Uncertainty	-0.013***	-0.033***	-0.012***	-0.087***	-0.274***	-0.187***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Recipient Uncertainty	-0.020***	-0.059***	-0.019***	-0.144***	-0.481***	-0.337***
× Reward Size	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Reward Size	0.046***	0.120***	0.033***	0.278***	0.613***	0.335***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
From Referral	0.089***	0.200***	0.066***	0.277***	0.657***	0.380***
	(0.00)	(0.01)	(0.00)	(0.02)	(0.08)	(0.07)
Constant	0.074***	0.129***	0.022***	0.151***	0.325***	0.174***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.04)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
R^2	0.075	0.055	0.096	0.022	0.006	0.003

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A12: Comparison between users from referral and organic users

	Organic (N=124,852)		Referral (N=37,414)		Referral-Organic	
Variable Name	Mean	SD	Mean	SD	Difference	p-value
If Share	0.067	0.251	0.244	0.430	0.176***	0.000
Number of Shares	0.109	0.604	0.531	1.428	0.421***	0.000
If Refer	0.011	0.106	0.133	0.339	0.121***	0.000
Direct Referrals	0.040	0.844	0.659	4.127	0.618***	0.000
Total Referrals	0.065	2.247	1.458	19.010	1.394***	0.000
Indirect Referrals	0.025	1.870	0.800	17.027	0.775***	0.000

Table A13: Heterogeneity of traffic type on referrals

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.005**	0.020***	0.006***	0.014	0.037	0.023
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.05)
Sender Uncertainty	0.034***	0.103***	0.056***	0.048^{+}	0.399***	0.351***
$\times$ From Referral	(0.00)	(0.01)	(0.00)	(0.02)	(0.11)	(0.10)
Recipient Uncertainty	-0.008***	-0.015**	-0.006***	-0.030*	-0.061	-0.031
	(0.00)	(0.00)	(0.00)	(0.01)	(0.05)	(0.05)
Recipient Uncertainty	-0.022***	-0.078***	-0.026***	-0.246***	-0.921***	-0.675***
$\times$ From Referral	(0.00)	(0.01)	(0.00)	(0.02)	(0.11)	(0.10)
From Referral	0.082***	0.186***	0.051***	0.370***	0.890***	0.521***
	(0.00)	(0.01)	(0.00)	(0.02)	(0.11)	(0.10)
Constant	0.044***	0.037***	-0.001	-0.031	-0.075	-0.044
	(0.00)	(0.01)	(0.00)	(0.02)	(0.10)	(0.09)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	162266	162266	162266	162266	162266	162266
R^2	0.074	0.054	0.095	0.022	0.006	0.003

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A14: Variable description and summary statistics of the experiment

Variable	Description	N	Mean	SD	Min	Max
Female	=1 if the user is a female	213	0.54	0.5	0	1
Age	The age of the user	213	35.42	8.5	25	60
Education	=1 if below high school =2 if high school =3 if bachelors =4 if master or phd	213	1.2	0.63	1	4
Experience	=1 if the user never participates similar programs =2 if the user rarely participates similar programs =3 if the user occasionally participates similar programs =4 if the user always participates similar programs	213	2.54	0.91	1	4

Table A15: Balance tests of the experiment

Group	N	Female	Education	Age	Experience
Sender Certain + Recipient Certain	52	0.519	1.173	34.62	2.423
Sender Uncertain + Recipient Certain	53	0.585	1.208	36.32	2.547
Sender Certain + Recipient Uncertain	53	0.547	1.264	35.75	2.623
Sender Uncertain + Recipient Uncertain	55	0.509	1.145	35.00	2.545
F-test		Insignificant	Insignificant	Insignificant	Insignificant

Table A16: Variable description and summary statistics from the sender side (N=213)

Variable	Description	Mean	SD	Min	Max
Sender Uncertainty	=1 if the sender's reward is uncertain	0.51	0.50	0	1
Recipient Uncertainty	=1 if the recipient's reward is uncertain	0.51	0.50	0	1
Share Intention	Would you like to share with your friends or family?	5.26	1.54	1	7
We are interested in learning more about the reasons people accept the invitation or reject the invitation. Please indicate how much you agree with the following statements (7-point Likert: not at all – very much)					
Guilty	Because I feel guilty about receiving referral reward	2.64	1.73	1	7
Fairness	Because the incentive offered is fair enough to justify sharing	4.66	1.55	1	7
Perceived Sender Reward	Because I can earn rewards for myself	5.40	1.44	1	7
	Because I feel I can earn many referral rewards	4.39	1.57	1	7
Perceived Recipient Reward	Because I can help friend(s) get rewards	5.42	1.38	1	7
	Because I feel my friend(s) can earn many referral rewards.	4.33	1.47	1	7
Curiosity Sender	Because I am curious about how many rewards I can get	4.35	1.71	1	7
Curiosity Recipient	Because I am curious about how many rewards my friend(s) can get	4.19	1.63	1	7

Table A17: Variable description and summary statistics from the recipient side

Variable	Description	Mean	SD	Min	Max
Assume that one of your friends sends you a program invitation. If you accept the invitation, both you and your friend will get some referral rewards. The invitation message is as follows. [The invitation message according to the user's randomly assigned group]					
Accept Intention	Would you like to accept the invitation?	5.14	1.44	1	7
Further Refer Intention	Will you further share the invitation with your friends or family?	4.95	1.49	1	7
We are interested in learning more about the reasons people accept the invitation or reject the invitation. Please indicate how much you agree with the following statements (7-point Likert: not at all – very much)					
Social Pressure	Because my friend hopes me to accept the invitation.	5.44	1.25	1	7
	Because I feel uneasy about rejecting referral invitation	2.33	1.2	1	7
Fair	Because the incentive offered is fair enough to justify participation	4.65	1.66	1	7
Perceived Recipient Reward	Because I can earn rewards for myself due to my acceptance	5.11	1.46	1	7
	Because I feel I can earn many referral rewards	4.16	1.51	1	7
Perceived Sender Reward	Because I can help my friend get rewards due to my acceptance	5.47	1.32	1	7
	Because I feel my friend can earn many referral rewards.	4.38	1.45	1	7
Curiosity Recipient Reward	Because I am curious about how many rewards I can get	4.54	1.68	1	7
Curiosity Sender Reward	Because I am curious about how many rewards my friend can get	4.44	1.55	1	7

Table A18: Mediation effect of sender's attitude toward uncertainty

	(1) Share Intention	(2) Perceived Sender Reward	(3) Perceived Recipient Reward	(4) Share Intention	(5) Share Intention
Sender Uncertainty	0.357^{+}	-0.717***	-0.177	0.676***	0.412*
	(0.20)	(0.16)	(0.15)	(0.19)	(0.19)
Recipient Uncertainty	-1.182***	0.050	-0.582***	-1.204***	-1.001***
	(0.19)	(0.16)	(0.15)	(0.18)	(0.20)
Perceived Sender Reward				0.444***	
				(0.08)	
Perceived Recipient Reward					0.310***
					(0.09)
Female	0.226	0.008	-0.280^{+}	0.222	0.312
	(0.20)	(0.16)	(0.16)	(0.19)	(0.20)
Age	-0.002	-0.006	0.011	0.000	-0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.614***	4.344***	4.103***	3.684***	4.342***
	(0.70)	(0.57)	(0.55)	(0.75)	(0.77)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.203	0.194	0.155	0.305	0.250

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A19: Mediation effect of sender's curiosity

	(1) Share Intention	(2) Curiosity Sender Reward	(3) Curiosity Recipient Reward	(4) Share Intention	(5) Share Intention
Sender Uncertainty	0.357^{+}	0.889***	-0.382^{+}	0.273	0.366^{+}
	(0.20)	(0.23)	(0.21)	(0.20)	(0.20)
Recipient Uncertainty	-1.182***	-0.077	1.051***	-1.175***	-1.206***
	(0.19)	(0.23)	(0.21)	(0.19)	(0.21)
Curiosity Sender Reward				0.095	
				(0.06)	
Curiosity Recipient Reward					0.023
					(0.07)
Female	0.226	-0.286	-0.321	0.253	0.233
	(0.20)	(0.24)	(0.22)	(0.20)	(0.21)
Age	-0.002	-0.019	-0.002	-0.001	-0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.614***	4.291***	3.039***	5.208***	5.545***
	(0.70)	(0.82)	(0.75)	(0.75)	(0.73)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.203	0.129	0.201	0.213	0.204

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A20: Mediation effect of recipient's attitude toward uncertainty on acceptance

	(1) Accept Intention	(2) Perceived Sender Reward	(3) Perceived Recipient Reward	(4) Accept Intention	(5) Accept Intention
Inviter's Sender Uncertainty	-0.036	-0.140	0.140	0.034	-0.112
	(0.18)	(0.15)	(0.17)	(0.16)	(0.16)
Inviter's Recipient Uncertainty	-1.153***	-0.490**	-0.628***	-0.911***	-0.811***
	(0.17)	(0.15)	(0.16)	(0.16)	(0.16)
Perceived Sender Reward				0.494***	
				(0.07)	
Perceived Recipient Reward					0.544***
					(0.07)
Female	-0.493**	-0.252	-0.429*	-0.369*	-0.260
	(0.18)	(0.16)	(0.17)	(0.17)	(0.16)
Age	-0.004	-0.001	-0.003	-0.004	-0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.645***	5.145***	4.681***	3.104***	3.099***
	(0.63)	(0.54)	(0.58)	(0.69)	(0.63)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.291	0.175	0.218	0.419	0.469

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A21: Mediation effect of curiosity on recipient's acceptance

	(1) Accept Intention	(2) Curiosity Sender Reward	(3) Curiosity Recipient Reward	(4) Accept Intention	(5) Accept Intention
Inviter's Sender Uncertainty	-0.036	0.890***	0.185	-0.185	-0.066
	(0.18)	(0.21)	(0.24)	(0.18)	(0.18)
Inviter's Recipient Uncertainty	-1.153***	-0.438*	0.595*	-1.079***	-1.251***
	(0.17)	(0.20)	(0.23)	(0.17)	(0.17)
Curiosity Sender Reward				0.168**	
				(0.06)	
Curiosity Recipient Reward					0.166**
					(0.05)
Female	-0.493**	-0.211	-0.185	-0.458*	-0.463*
	(0.18)	(0.21)	(0.24)	(0.18)	(0.18)
Age	-0.004	-0.002	-0.002	-0.004	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	5.645***	3.699***	3.094***	5.022***	5.132***
	(0.63)	(0.74)	(0.83)	(0.66)	(0.64)
Education Fixed Effect	YES	YES	YES	YES	YES
Experience Fixed Effect	YES	YES	YES	YES	YES
N	213	213	213	213	213
R^2	0.291	0.163	0.093	0.319	0.325

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A22: Heterogeneity of reward size on recipient's further referrals

	(1) If Share (OLS)	(2) Number of Shares (OLS)	(3) If Refer (OLS)	(4) Direct Referrals (OLS)	(5) Total Referrals (OLS)	(6) Indirect Referrals (OLS)
Sender Uncertainty	0.041***	0.124***	0.057***	0.051	0.418*	0.367*
	(0.00)	(0.01)	(0.00)	(0.04)	(0.20)	(0.18)
Recipient Uncertainty	-0.032***	-0.097***	-0.032***	-0.281***	-0.991***	-0.711***
	(0.00)	(0.01)	(0.00)	(0.04)	(0.20)	(0.18)
Reward Size	-0.006^{+}	0.040***	0.025***	0.183***	0.489***	0.306*
	(0.00)	(0.01)	(0.00)	(0.03)	(0.15)	(0.13)
Inviter's Sender Uncertainty	0.014*	0.055*	0.034***	0.152*	0.280	0.128
	(0.01)	(0.02)	(0.01)	(0.06)	(0.30)	(0.27)
Inviter's Sender Uncertainty	0.045***	0.097***	0.021***	0.183***	0.421*	0.238
$\times$ Reward Size	(0.00)	(0.01)	(0.00)	(0.04)	(0.17)	(0.16)
Inviter's Recipient Uncertainty	-0.038***	-0.051*	-0.035***	-0.240***	-0.453	-0.214
	(0.01)	(0.02)	(0.01)	(0.07)	(0.30)	(0.27)
Inviter's Recipient Uncertainty	-0.012**	-0.064***	-0.015***	-0.131***	-0.322^{+}	-0.190
$\times$ Reward Size	(0.00)	(0.01)	(0.00)	(0.04)	(0.18)	(0.16)
Lucky Sender	0.023*	0.088**	0.030***	0.261**	0.100	-0.161
	(0.01)	(0.03)	(0.01)	(0.10)	(0.45)	(0.41)
Lucky Recipient	0.059***	0.123**	0.053***	0.145	-0.031	-0.176
	(0.01)	(0.05)	(0.01)	(0.13)	(0.61)	(0.54)
Constant	0.131***	0.333***	0.425***	1.260***	2.533***	1.273*
	(0.01)	(0.04)	(0.01)	(0.12)	(0.56)	(0.51)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
N	37414	37414	37414	37414	37414	37414
R^2	0.022	0.015	0.071	0.011	0.003	0.002

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A23: Effect of reward uncertainty in different reward sizes

	(1)	(2)	(3)	(4)	(5)	(6)
Samples		All Users			Referral Recipients	
Dependent Variable		If Refer			If Refer	
Reward Size	10	50	500	10	50	500
Sender Uncertainty	0.005**	0.008***	0.063***	0.019**	0.084***	0.057***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)
Recipient Uncertainty	0.000	-0.003***	-0.048***	0.003	-0.042***	-0.035***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)
From Referral	0.044***	0.171***	-0.027***			
	(0.00)	(0.00)	(0.00)			
Inviter's Sender Uncertainty				-0.001	0.046***	0.074***
				(0.01)	(0.01)	(0.00)
Inviter's Recipient Uncertainty				0.001	-0.047***	-0.065***
				(0.01)	(0.01)	(0.00)
Lucky Sender				-0.007	0.024	0.037***
				(0.01)	(0.02)	(0.01)
Lucky Recipient				0.007	0.068**	0.058***
				(0.02)	(0.03)	(0.01)
Constant	-0.000	0.004***	0.159***	0.036***	0.394***	0.107***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
Exp. Period Fixed Effect	NO	YES	NO	NO	YES	NO
N	18751	110592	32923	4799	6230	26385
R^2	0.028	0.126	0.014	0.002	0.204	0.029

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A24: Effect of sender's reward uncertainty on the invited recipients' further referrals

	(1)	(2)	(3)	(4)	(5)	(6)
	If Share	Number of Shares	If Refer	Direct Referrals	Total Referrals	Indirect Referrals
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)
Sender Uncertainty	0.001	0.086**	0.039***	0.228***	0.321^{+}	0.093
	(0.01)	(0.03)	(0.01)	(0.06)	(0.17)	(0.13)
Recipient Uncertainty	-0.050***	-0.121***	-0.070***	-0.335***	-0.479**	-0.144
	(0.01)	(0.03)	(0.01)	(0.06)	(0.17)	(0.13)
From Referral	-0.039***	0.040	0.072***	0.195**	0.487*	0.291^{+}
	(0.01)	(0.04)	(0.01)	(0.07)	(0.20)	(0.15)
Constant	0.206***	0.303**	0.500***	0.625**	1.212*	0.587
	(0.03)	(0.11)	(0.03)	(0.22)	(0.61)	(0.46)
Exp. Period Fixed Effect	YES	YES	YES	YES	YES	YES
Reward Size Fixed Effect	YES	YES	YES	YES	YES	YES
N	5991	5991	5991	5991	5991	5991
R^2	0.010	0.005	0.179	0.013	0.006	0.003

Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$