# Propose with a Rose?

# Signaling in Internet Dating Markets

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## ABSTRACT

In order to improve efficiency, several markets have mechanisms in place that allow agents to signal their preferences (e.g., U.S. college application market and the economics junior market). However, empirically evaluating the impact of preference signaling proves difficult due to data limitations. Using a randomized field experiment, this paper provides evidence that a signaling system can affect matching outcomes. In our study on online dating, participants can use "virtual roses" to signal special interest in another participant. We find that attaching a rose to an offer increases the chance of acceptance, especially when the offer is made to medium attractive participants. Furthermore, participants endowed with more roses have a larger number of dates than their counterparts.

Keywords: experiment, matching, signaling, market design, online dating

# 1 Introduction

Many markets are imperfect and a major question is how to lessen inefficiency. A growing literature in market design focuses on the problem of limited information about preferences of market participants, and proposes signaling mechanisms as an instrument to reduce inefficiency. For example, job seekers often apply for many positions, as there is a low cost of applying, and a high value to receive a job, or even just an outside offer that might be used for bargaining (for instance Hall and Krueger, 2010, report that about a third of job seekers of a representative sample bargained for wages). Employers may only want to pursue candidates who fulfill their requirements and who they can hire with at least some probability. In such a market, employers would be helped by any mechanism that allows applicants to credibly signal information about their preferences. One interpretation of signaling and its effectiveness is that, e.g. in the hiring market, applicants have private information that affects how valuable an employee they would be (see Spence 1973). In addition, because pursuing candidates may be costly, information on the likelihood of an applicant accepting an offer may also be valuable and transmitted through a signaling mechanism (see Coles, Kushnir and Niederle, 2010).

In practice, many markets that suffer from this form of application congestion have mechanisms in place that allow candidates to show a sign of special interest for a select number of places. For example, since 2006, the American Economic association (AEA) has offered a signaling mechanism for the market for junior economists. Through a website, each applicant can send a signal to up to two potential employers, signaling special interest in receiving an interview. Coles et al (forthcoming) provide suggestive evidence that sending a signal increases the chances of receiving an interview. In college admissions, in the U.S., many universities have early admission programs where high school students send an early application to exactly one college. Hence, early admission can be viewed as a signaling mechanism (Avery and Levin, 2009). Furthermore, there is some evidence that suggests that colleges respond to such signals, in that it is easier to get into college using the early admissions program (see Avery and Levin, 2009, and Avery, Fairbanks, and Zeckhauser, 2003).

However, evaluating whether attaching a signal changes the outcome in market by affecting hiring, acceptance or dating decisions is an extremely challenging task. For example, in the market for junior economists, maybe Ph.D.'s send signals to places that would have interviewed them anyway (due to the subject of their job market paper, the related papers written by its own faculty, etc.). It is hard to compute a counterfactual, as there are many unobservables. This is an inherent problem of decentralized markets, the lack of information about characteristics

and behavior of participants.

In this paper we present a field experiment that overcomes this problem. A major online dating company organized two special dating events with 613 participants, of which about 50 percent are female. Participants were endowed with two "virtual roses", and a randomly chosen 20 percent with eight. A participant could send dating requests up to 10 different people by sending a pre-made electronic note, a *proposal*. The participant may attach at most one virtual rose, which is a digital image icon, when sending a proposal. The roses were described as a possible way to show special interest.

Our set-up offers two major advantages to test the impact of preference signaling. First, we were able to collect a wide range of information about participants and their behavior. This allows us to examine heterogeneous effects of using preference signaling depending on a participants' characteristics and various matching outcomes. Second, because participants with eight roses were ex-ante the same as those with two roses, any difference in outcomes between the two groups of participants will provide clean evidence that preference signaling with virtual roses has an impact on matching outcomes. Beside these two advantages, our study of online dating may itself be economically important as online dating services are rapidly growing throughout the world.[1]

The experiment consisted of two special online dating sessions for people who are college-educated, never-married, Korean, and aged between 26 and 38 for men, and 22 and 34 for women. The restrictions in participants' characteristics are used to reduce heterogeneity in observables, which may segment dating markets among participants. A person could participate in a session by paying the equivalent of about 50 U.S. dollars and providing information that constituted their online profile. For first five days of the event, a participant could send up to 10 proposals and a proposal could be sent with at most one rose. Once the period in which participants could send proposals ended, each participant received his or her proposals and observed whether they came with a rose. For the next four days, participants decided whether to accept each proposal: they could accept at most 10 proposals. After the acceptance phase, an accepted proposal resulted in the company sending a text message to inform the involved pair each other's contact information.

In our experiment, about 45.51 percent of participants sent a proposal, and, conditional on sending a proposal, a participant sent on average 6.89. Among participants who sent at least

[1] For example, in the U.S., major dating companies have been established since the mid-1990s and the market size is expected to be $932 million in 2011 (JupiterResearch, 2007). The popularity of online dating services is observed not only in developed countries but also in developing countries such as Korea, India and China.

one proposal (hereafter, senders), 79.93 percent used at least one rose and 65.92 percent of those who used a rose exhausted all endowed roses.[2] About 64.27 percent of participants received at least one proposal from other participants and, conditional on receiving a proposal, received on average 4.88. Among participants who received at least one proposal (hereafter, recipients), the fraction of proposals with a rose attached is 31.39. In total, 295 out of 1,921 proposals resulted in a date and 35.93 percent of them were sent with a rose attached.

To study the effect of a rose, we conduct the following analysis. Based on participants' observable characteristics, we predict the extent to which a participant would be attractive to the opposite sex as a dating partner. Using this prediction, we assign to a participant a grade out of bottom (the least attractive), middle, and top (the most attractive). Conditional on recipient's fixed effects and sender's grade, we find that overall, sending a proposal with a rose increases the probability that a recipient will accept the proposal by 3.3 percentage points. In particular, recipients who belong to the middle level attractiveness are positively responding to a proposal with a rose (10.2 percentage points for male recipients and 7.0 percentage points for female recipients).

Furthermore, compared to their counterparts endowed with 2 roses, both male and female participants who are endowed with 8 roses have a larger number of proposals accepted by recipients. In terms of the total number of first dates, male participants with 8 roses have strictly a larger number of dates than their counterparts with 2 roses, whereas female participants with 8 roses are not statistically different from their counterparts. This is because female participants with 8 roses accept a smaller number of proposals, compared to their counterparts, indicating that there is no statistical differences in terms of the total first dates.

This paper is related not only to the signaling literature, but also to studies on marriage. Marriage has received some attention following the seminal work by Becker (1973).[3] However, little is known about the way people search for their mate, due to data limitation. This paper provides information about who initiates a contact to whom for a date and how people select dating partners in an Internet environment, which can help us to understand more about mate search processes.

The rest of this paper is organized as follows. In Section 2, we describe our experiment settings, main hypothesis, and empirical strategy for testing the hypothesis. Section 3 reports

[2] We consider a sender to have exhausted her roses if she sent all endowed roses or if she used as many rose as the number of proposals she sent.

[3] Examples include Abramitzky et al, 2009, Angrist, 2002; Banerjee et al., 2009; Choo and Siow, 2006; Fernandez et al., 2005; Fisman et al., 2006, 2008; Hitsch et al., 2010; Lee, 2009; and Wong, 2003.

participants' search behaviors and empirical results of the effect of sending a rose. In Section 4, we present the treatment effects on the total number of dates and other dimensions. Section 5 presents the counterfactual analysis of the matching outcomes if participants had used roses differently along with robustness checks. Section 6 concludes.

## 2 Experimental Design

### 2.1 Institutional Background

We conducted a field experiment at a major online dating company that operates in South Korea, China, Singapore and the United States. Since 1991, the company has been helping clients to find spouses from among users of the opposite sex. The company provides two types of memberships: regular and special. The main differences between the two are the length of service, the degree of the company's involvement in a member's search process and the range of legal documents users are required to submit prior to membership purchase. A regular membership costs about $900 per year, and members have to answer to provide detailed information, some backed by legal documents such as a birth certificate and a copy of one's college diploma. Based on this information, the company creates an index (herein, *attractiveness index*), which is a sex-specific weighted sum of a person's characteristics.[4] The attractiveness index is intended to predict the extent to which a person would be attractive to the opposite sex as a spouse. It ranges from 0, least attractive, to 100, most attractive. Using the attractiveness index, the company suggests potential dating partners during the membership period, which is at least one year. Lee (2009) shows that the attractiveness index is a good predictor of whether a member is desirable as a dating and ultimately as a marriage partner.

In contrast, a special membership allows only participation in an online or offline dating special dating event, which occurs at special times such as Valentine's Day, during the summer vacation season, and Christmas. Special members are asked the same range of information as regular members, but need not answer all questions nor submit legal verification, though many do so anyway. To inform participants about the accuracy of others' information, the company constructs a measure called a verification score and posts it to each participant's online profile. The verification score ranges from 0 (none of the information is verified) to 100 (key information such as age, education, employment, marital history is verified).[5]

[4] A person's attractiveness index is calculated based on earnings, assets, job security (full time job or not), height, weight, facial grade, a measure of score for the national college entrance exam, birth order, family backgrounds (parent's wealth, marital status, siblings' educational attainment).
[5] Here all that is legally verified for 100 percent verification.

### 2.2 Experiment Setting

#### 2.2.1 Timeline

In the summer of 2008, the company advertised the field experiment in Korea as one of its special dating events with a participation fee of $50 and conducted in two such sessions. We limited participants to be Korean, college educated, never married, and aged from 26 to 38 for men and 22 to 34 for women. We imposed these restrictions to reduce heterogeneity among participants and create a thick market. Recruitment for the event lasted 6 days for the first session and 20 days for the second. Participants were divided into four different treatments, which we describe below. However, participants were not aware that there were several treatments, nor did they receive information about the treatment status of other participants.

Each session of the experiment consisted of two stages: First is the proposal stage, which lasted five days; then there is a response stage of four days. In the proposal stage, each participant could browse profiles of other participants that contain their submitted information with a head-to-shoulder photo and their verification score. Specifically, participants could not observe if other participants sent proposals or if they were treated the same. Participants could also not access information about proposals that may have already been made to them. Each participant could send a pre-made electronic note (herein *proposal*) asking for a first date to up to ten participants of the opposite sex. Furthermore, each participant could attach up to one virtual rose per proposal. The virtual roses are a preference signaling mechanism specifically introduced for this event.

In the response stage, participants could access the proposals sent to them. Participants could determine whether a rose was attached to the proposal. Participants could accept up to 10 proposals, while not receiving any information the proposals they made were accepted. Hence, each participant could have at most 20 first dates, where a date is an accepted proposal. No new proposals can be made in the response stage. Right after the response stage, the company sent text messages to the participants' cell phones with the contact information of their dating partners.

By dividing the dating event into these two stages, we circumvent that a participant may base a decision on the behavior of other participants (other than the proposals received in the response stage). This greatly simplifies the empirical strategy.

#### 2.2.2 Treatment

We experiment had four treatments. Participants in the baseline treatment were endowed with two roses. The second treatment, called eight roses, generates the variation in the number of roses with which a participant is endowed. Twenty percent of participants received eight roses. For the third treatment, called *female empowerment*, we randomly selected 50 percent of female

participants. During the proposal stage, we showed them a banner with the aim of encouraging them to initiate a proposal.[6] The banner was built into the main webpage and not a pop-up window, so that whenever a treated participant was onto the website, the banner was shown to her. In the fourth treatment, called *perception*, we randomly selected 50 percent of male participants. During the response stage we exposed them to another banner with the aim of encouraging them to accept proposals from female participants.[7]

The goal of the third treatment was to examine whether a simple intervention such as showing a banner can change the behavior of a female participant. Likewise for the fourth treatment. These two examinations are interesting for two reasons. First, like many countries, Korea has been traditionally a male-dominant society but the gender-gap in several dimensions, including education has been reduced. However, it appears that women are still passive in the mate search process. If participants respond to our treatments, then it may suggest the possibility of improving gender equality in the mate search dimension, which may play an important role in household formation, and the household decision process. Second, similar to the endowment of eight roses, the third and fourth treatments may change expectations regarding the likelihood of being accepted by others or the quality of a potential dating partner, without changing any observable characteristics of participants. Therefore, we can compare the relative effect of sending a rose compared to these two types of treatments.

### 2.3 Participants and Empirical Strategy

#### 2.3.1 Treatment Status and Validity of Randomization

There were 212 participants in the first session and 401 participants in the second session. Roughly half of each session's participants were female. Thirty-three men and 25 women participated in both sessions. All participants met the participation criteria, apart from four high-school graduates. About 20 percent of participants of each sex received both 8 roses and the empowerment/perception treatment. About 37 percent of the remaining participants received 2 roses and the empowerment/perception treatment. All the remaining participants, except for three men, received only 2 roses.

To check the randomization into treatment status, we compare the important characteristics of the three groups of participants: 2 roses and no empowerment/perception

[6] The banner read, in translation: "Will you wait until a person destined to would ask you out? Or, will you take the lead to meet him? Dear customer, did you find someone you want to date? Are you hesitating in asking him out? Please do not let this opportunity pass you by. Contact him first and give him the opportunity to meet you."

[7] The banner read, in translation, "Congratulations! You received a first-date proposal. Please give an opportunity to the one who falls in love with your charm!"

treatment (Group1), 2 roses and empowerment/perception treatment (Group2), and 8 roses with empowerment/perception (Group3). Table 1 shows the average characteristics of each group and whether the average values across groups are statistically different from each other, using t-tests.[8] For women, participants in Groups 1 to 3 are not statistically different from one another in terms of their observables, at the 5 percent level. For men, participants in Group 1 and Group 2 have statistically the same characteristics except for the location of residence, whereas participants in Group 3 differ from those in Group 2 in several dimensions including age and likelihood of being a special member. Because these dimensions are correlated to each other, we examine whether there is a dominant dimension determining participant's treatment status and if so what. To do so, we generate an indicator that is 1 if a participant belongs to Group 3 and zero if the participant belongs to Group 2. We then regress the indicator on the subsets of all the characteristics listed in Table 1 and compare their adjusted R-squared. We find that whether a participant's characteristics are fully verified (full verification) is the most dominant dimension, and if we control for two dimensions, whether a participant is fully verified and whether the participant lives in the capital area, all the variations determining a participant's treatment status are captured: the adjusted R-sq with full controls is 0.088, that with indicators of full verification is 0.061, and that with both full verification and living in Seoul is 0.087.

### 2.3.2 Empirical Strategy

In Section 3, we first analyze participants' behaviors in each stage, including to whom they send a proposal with/without a rose and then test the main hypothesis that the likelihood of a proposal with a rose attached is different from that of its counterpart with no rose attached. To test the main hypothesis, we will regress whether or not a proposal is accepted on control variables that include whether a rose is attached and other observable characteristics of the sender and recipient. If the coefficient of whether a rose is attached is different from zero, then we can interpret the result as evidence that recipients take preference signaling into account in their decision. Note that in this analysis, we take a participant's unobservable characteristics into account in our analysis because we have multiple observations per participant and use a panel model to do so.

A valid concern regarding this evidence is that a sender may observe additional information about recipients that is not observed by econometricians but is correlated with the recipient's likelihood of accepting the proposal even after controlling for observables (i.e., correlation between dummy variable of a rose being attached and error term in the regression model). It is worth noting that we do not think this concern is important in our setting because we

[8] Permutation test results are qualitatively the same

know the same (or even more detailed) information about participants as other participants; and, thus, there is little room for the existence of additional unobservable information. However, we nevertheless address this concern by comparing the outcomes of participants with 2 roses and those of participants with 8 roses. If there is no difference between these two groups except the likelihood of using a rose, then we can test the main hypothesis by examining whether participants with 8 roses on average have the same number of first dates as those with 2 roses. We will conduct this test in Section 4.

# 3 Participants' Search Behaviors

## 3.1 Summary Statistics

Table 2 presents some descriptive statistics on participants' search behaviors and outcomes for each sex. The fraction of participants who initiated at least one proposal during the proposal stage is 0.54 for men and 0.37 for women. Conditional on sending at least one proposal, the average number of proposals that a participant initiated and the fraction of proposals with a rose attached are 7.64 and 0.43 respectively for men and 5.79 and 0.73 for women. The fraction of participants who received at least one proposal from other participants is 0.55 for men and 0.31 for women. Conditional on receiving at least one proposal, the average number of received and the fraction of received proposals that a participant accepted for a date are 3.93 and 0.29 respectively for men and 5.58 and 0.17 for women. The average number of first dates that a participant had is 0.97 for men and 0.95 for women.

These descriptive statistics suggest that participants in our experiment are rather careful in selecting their dating partners in both the proposal and response stages, which may surprise some readers who expect much more active dating responses. We think that this conservative selection can be explained by the high time cost of our participants: our participants' age is close to but slightly higher than the average age of first marriage in Korea and most participants are full-time employees, which implies that they may not want to waste their time on "not-so-good" dating partners. Note that if these conservative behaviors are due to the high opportunity cost, then participants may value a mechanism that would allow them to discern the degree of other people's interest in a relationship with them.

## 3.2 Participant's Type, Treatment Status, and Search Behavior

In this subsection, we will examine participants' behaviors in each stage depending on their characteristics and treatment status. In the analysis of the experiment, we will partition participants according to their attractiveness index into three categories within each sex: the

bottom 30 percent, the top 30 percent, and the remaining 40 percent (referred to as Bottom, Top, and Middle, respectively). We define a participant's type as the group a participant belongs to and a few other observables that are not included in the attractiveness index such as age and residential location. This approach to defining a participant's type allows us to interpret the results intuitively and, more importantly, the number of underlying characteristics we have is too large, compared to the size of sample in our experimental dataset. It is worth noting that using a different sample, Lee (2009) finds that a person's attractiveness index is highly positively correlated with the person's popularity as a dating partner, and the participants in our experiment are comparable to the company's other members in Lee's sample. Finally, our main findings remain qualitatively the same in several different definitions of a participant's type, which will be reported in Section 5.

### 3.2.1 Senders of Proposals and Roses

Altogether 1,921 proposals are made, of which 66% (1,261) are made by men and 34% (660) by women. A rose is attached to 670 proposals, of which 38.70 % (478) of proposals made by men come with a rose, compared to 27.58 % (182) of proposals made by women. To study the impact of a participant's type on his/her activity at the proposal stage, we show in Figure 1.A for each decile of the attractiveness index the percentage of proposals that are made by participants of that level of attractiveness or lower.[9] The average number of proposals sent is independent of the level of one's own attractiveness. This is confirmed by our regression analysis shown in Table 3. We estimate which participants are active (send at least one proposal), and how many proposals are sent (conditional on being active). This conclusion is robust to more flexible controls of a participant's attractiveness index (e.g., second order polynomial instead of dummy variables).

[9] We divide the attractiveness index grades by sex into deciles, where for each sex 1 corresponds to the bottom 10 percent of attractiveness index-rated individuals.

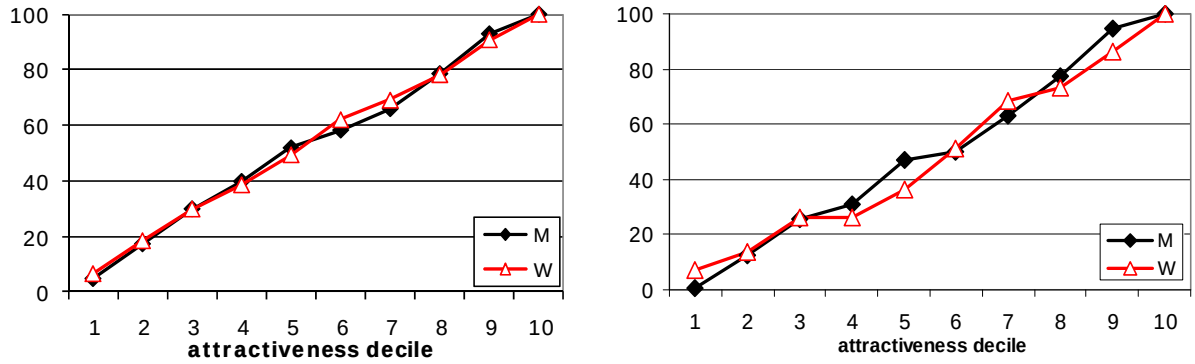


Figure 1.A: For each decile of attractiveness the percentage of proposals contributed by participants of that decile or lower, where 1 is the least and 10 the most attractive group.

Figure 1.B: for each attractiveness decile the fraction of roses sent by participants of that decile or lower (among all roses sent).

Similarly, Figure 1.B suggests that roses are somewhat evenly sent by participants of all levels of attractiveness. Indeed, Table 4 shows that while women are significantly less likely to send at least one rose, participants of all levels of attractiveness are equally likely to do so. Men who make more offers are also significantly more likely to use at least one rose (the effect is not significant for women, though similar to that of men). Conditional on using at least one rose, women and men send similar numbers of roses, although less attractive women send significantly fewer roses than more attractive ones.

### 3.2.2 Senders: To whom a sender sent a proposal and a rose?

***Proposals***

We now study whether participants of different levels of attractiveness differ in deciding to whom to send a proposal. Table 5 shows, for each attractiveness level of the sender, the distribution of proposals among recipients of different attractiveness groups. Senders of all groups are more likely to send proposals to more attractive potential mates, although this tendency is exacerbated the more attractive the sender is. Men spread their proposals over a larger grouping of attractiveness, with a third of proposals sent at least to the medium group and a third to the top group. Women on the other hand, always send at least half their proposals to the most attractive group of men.

In Table 6, we use probit regressions to predict, on the proposal level, which 1,921 of the 102,064 possible proposals were made (where we restrict our attention to proposals made to participants with attractiveness index: note that 2 women in the second session have no

attractiveness index assignment: that is, 2*104*108 in session 1 and 2*200*199 in session 2). In the last three probit regressions, we restrict the sample of senders to those who sent at least one proposal.[10] Table 6 shows that a participant with 8 roses is more likely to initiate a proposal than his/her counterpart with 2 roses, but the effect of female empowerment is not statistically different from zero. For both sexes, a participant is more likely to send a proposal to a person belonging to the top group, followed by the middle group (e.g., 0.012 for top, 0.006 for middle in column 1). But this tendency is stronger for women than for men (0.007 for men: top vs. 0.016 for women: top, columns 2 and 3, add statistical significance testing whether the two are the same.)

We examine whether there is any difference among participants depending on their treatment status, in terms of to whom they send proposals. We run a regression that is identical with the regression in Table 6, but includes additional variables: the interaction terms between a sender's treatment status and discrete variables indicating a sender's and a recipient's type (e.g., S_Bottom X R_Bottom times 1(sender = 8 roses), S_Bottom X R_Middle times 1(sender = 8 roses), S_Bottom X R_Top times 1(sender = 8 roses)). If endowment of 8 roses makes a participant send more proposals but does not change what types of persons the participant is more likely to send a proposal, then the coefficients of the additional interaction terms will not be statistically different from zero. For each type of senders and treatment status (e.g., sender in the bottom group), we find no statistical difference for male senders. However, for women in the top group, participants who endowed with 8 roses and empowerment send more proposals to the bottom and top groups, related to the rest.

***Roses***

Among 1,921 proposals, 34.87 percent are accompanied by a rose. Among participants who sent at least one proposal, 79.92 percent use at least one rose. Conditional on sending at least one rose, the average number of roses that a sender used is 1.81 among the senders with 2 roses and 7.09 among the senders with 8 roses. In Table 7, we examine who sent a rose to whom. To do this, we regress whether a rose accompanied a proposal on characteristics of the sender and the recipient. For both sexes, a proposal sent by a sender with 8 roses is more likely to be accompanied by a rose. However, there is no statistically significant relationship between the likelihood of a proposal being accompanied by a rose and female dummy (or female empowerment). Another important pattern shown in Table 7 is that the likelihood of a proposal being accompanied by a rose is not correlated with any of the recipients' characteristics (e.g., the

[10] Hence we have 41*108 + 124*201 observations for men and 23*104+91*200 for women.

coefficient of R_Top is not statistically different from zero.). This implies that, conditional on receiving a proposal, the likelihood of receiving a rose is same regardless of the recipient's type; thus, the number of roses a recipient received is proportionate to the number of proposals that the recipient received. Note that the finding that the likelihood that a proposal being accompanied by a rose is not correlated with a recipient's characteristics still holds across several specifications such as a panel linear model with sender's fixed effects.

In a manner similar to our analysis of proposals, we examine the possibility that to whom a sender sent a rose may vary across the sender's treatment status. We run a regression that is identical with the regression in Table 7 except for the inclusion of the interaction between a sender's treatment status and sender and recipient's types. Overall, we find no statistical difference except for female senders who are endowed with 8 roses and belong to the middle group. They sent relatively more roses to men in the middle group in terms of attractiveness index.

### 3.2.3 Recipient's Acceptance and Rejection Decisions

***Types of Responses***

After the offer stage in which proposals are made, participants had four days to respond to proposals they received. There were three potential answers. Participants could accept a proposal (they could accept at most 10), actively reject a proposal, or simply not respond. Among 1,921 proposals, 295 were accepted, 445 received explicit rejections, and the remaining proposals were not responded to. Among the 394 participants who received at least one proposal, 152 always gave explicit rejections or acceptances, 104 gave mixed explicit and implicit responses, and the remaining participants did not respond to any proposal. Since a large fraction of proposals received no response, it is worth determining whether "no response (NR)" is a way to reject a proposal, or is due to some random events that occurred to a recipient. If NR is used to reject a proposal, then the use of NR should depend on a sender's characteristics in a way similar to explicit rejection.

In column 1 of Table 8, we regress a dummy variable of acceptance of a proposal from among proposals with explicit responses on recipient's fixed effects and other control variables. In column 2, we generate a dummy variable that is zero if there is no explicit response and one if the proposal is accepted, and we regress it on the same regressors as in column 1. In column 3, we regress a dummy variable that is one if a proposal is explicitly rejected and zero if it is not responded to using the same set of regressors as in columns 1 and 2. Table 8 shows two patterns. First, the signs of coefficients in columns 1 and 2 are the same for all regressions. Second, as

shown in column 3, most of a sender's characteristics cannot explain whether a proposal is explicitly rejected or not responded to. These patterns support the hypothesis that NR is used as a way to reject a proposal. Thus, in our baseline analysis, we use all proposals and treat NR as a rejection. Note that our baseline results do not change qualitatively even if we use alternative assumptions (see Section 5).

***Effect of Roses***

Among all the proposals made, 15.36 percent were accepted. The fraction of accepted proposals among those with a rose attached is 15.82 percent and among those without a rose is 15.11 percent. In Table 9, we report the difference in the fraction of accepted proposals between proposals with a rose and those without a rose, depending on the type of senders and recipients. Table 9 suggests that the effect of attaching a rose may be positive overall, but vary across sender's and recipient's characteristics, and that recipients in the middle group may the most positively respond to a proposal with a rose.

In Table 10, we use a regression analysis to examine whether these patterns from descriptive statistics would hold after controlling for various factors. In particular, we regress whether a proposal is accepted on whether the proposal is embellished with a rose, recipient's fixed effects, and other control variables. As expected, the likelihood of a recipient's accepting a proposal increases according to the degree of a sender's attractiveness. For example, compared to a proposal from a sender in the bottom group, all else equal, a recipient is more likely to accept a proposal from a Top-group sender by 17.9 percentage points, and a proposal from a Middle-group sender by 4.6 percentage points.

Now we examine the effect of sending a rose on acceptance probability. We find that attaching a rose increases the probability of being accepted by 3.4 percentage points and this effect is statistically significant at 5 percent level (column 1 of panel titled Model A in Table 10). In addition, this positive effect of sending a rose is economically important for two reasons. First, because the fraction of accepted proposals is only 15.3 percent in the sample, this 3.4 percentage-point increase in the probability of being accepted roughly means a 20 percent increase in the acceptance rate. Second, this positive effect of sending a rose is magnitude-wise comparable to the benefit of being in the Middle group of attractiveness index relative to being in the Bottom group of attractiveness index. This implies that, by sending a rose, a Bottom-group sender will be almost equally as attractive as his or her counterpart belonging to the Middle group. Qualitatively, these findings hold across various specifications. For example, we limit our sample to the proposals whose recipients actively responded to at least one proposal (column 4) and find similar

results; in column 5, instead of using recipients' fixed effects, we use a linear regression controlling for recipients' characteristics such as the total number of received proposals and the total number of received roses (see the list in the note of Table 10); in column 6, as the dependant variable is binary, we use a logit regression with recipient's fixed effects and report the coefficients predicting the latent index. The result confirms that attaching a rose increases the likelihood of being accepted by a recipient and the magnitude is smaller than but comparable to belonging to the Middle group instead of belonging to the Bottom group.

In the panel titled Model B, we allow for the possibility that a recipient's response to a rose may depend on what attractiveness group he or she belongs to. As shown in column 1, we find that for recipients in the middle group of attractiveness index, attaching a rose raises the acceptance rate by 7.8 percentage points and this effect is statistically significant at 5 percent level. For recipients in either the top or the bottom group of attractiveness index, the effect of attaching a rose is positive but not statistically different from zero at the conventional level. In Model C, we allow for the possibility that the effect on the acceptance rate of attaching a rose depends on both recipient's and sender's group of attractiveness index. Similar to the patterns shown in the aforementioned descriptive analysis, the effect of attaching a rose is positive and significant in four cases: a rose sent to a middle recipient from a top sender, a rose sent to a middle recipient from a bottom sender to a middle recipient, a rose sent to a bottom recipient from a top sender, and a rose sent to a bottom recipient from a middle sender.

There is a concern that there may exist a sender's characteristic missing from our analysis above that is correlated with the likelihood of attaching a rose and a recipient's acceptance. For example, conditional on the attractiveness index, a sender who is more attractive may be more likely to send a rose. If this concern is correct, then the coefficient of being accompanied by a rose does not reflect the true causal effect of sending preference signaling. To examine this possibility, we run the same regression analysis as Model A but include dummy variables indicating how many proposals a sender of a proposal received from other participants, instead of indicators of the three groups of attractiveness index. We find that the coefficient of a rose is 0.034 (p-value: 0.027), statistically not different from the original estimate (0.033). In addition, we run the same regression as Model A but include fixed effects of senders, instead of using the indicators of a sender's group of attractiveness index. We find that the estimated coefficient of a rose is 0.031 (p-value: 0.104), qualitatively the same as our baseline result and with relatively high precision, considering that we include exceptionally large control variables due to including fixed effects of recipients and senders. Therefore, we conclude that our causal interpretation of the coefficient of a rose is appropriate.

## 4. Treatment Effects

In this section, we examine whether treatments have any impact on matching outcomes, including whether and how many dates a person went on via the online dating event. To do this, we take two approaches. First, using a t-test, we compare the average outcomes in the treated group with those in the control group in each treatment. In particular, we separately analyze men and women. For men, we use only people who live in Seoul and who provided the full level of legal documentation because there are no statistical differences in participants' observables across treatment status (see Section 2.3.1). Over 64 percent of male participants live in Seoul and provided full level of legal documentation. As there are no observable differences for women, we use all female participants. To examine the effect of perception treatment,[11] we perform a t-test in outcomes between men with 2 roses but no perception treatment and men with 2-roses with perception treatment. To examine the effect of preference signaling, we perform a t-test in outcomes between men with 2 roses and perception treatment and men with 8 roses and perception treatment. Likewise, we examine the effect of empowerment and preference signaling for female participants.

Table 11 presents our results. The black asterisks in column 2 indicate the significance level of the hypothesis that the average outcome of Group 1 is the same as that of Group 2 (two-sided test). The red asterisks in column 2 indicate the significance level of the hypothesis that the average outcome of Group 1 is larger (smaller) than that of Group 2 (one sided test). Similarly, we use black and red asterisks in column 4 to compare the average outcomes of Group 2 with those of Group 3. Comparison between columns 2 and 3 of Table 11 shows that endowment with 8 roses increases a participant's likelihood of having at least one date, the number of dates, and the number of dates originally initiated by the participant. However, endowment with 8 roses does not change the number of dates that other participants suggested and the participant accepted. On the other hand, for men, perception treatment does not generate any statistical difference in these four dimensions (columns 1 and 2 of Table 11). For women, women endowed with 8 roses and who received empowerment treatment had more dates that were originally initiated by themselves compared to women endowed with 2 roses and who received

[11] Note that although the treatment status of having 8 roses is positively correlated with the treatment status of empowerment/perception, this correlation does not threaten our goal of testing whether preference signaling has any impact on matching outcomes. This is because if there is no impact of preference signaling, the outcomes of people with eight roses and empowerment/perception treatments will be the same as those of people only with empowerment/perception treatments. However, this experiment cannot allow us to compare the impact of having 8 roses with the joint effect of having 8 roses and receiving empowerment/perception treatment.

empowerment. On average, women who received only empowerment treatment (i.e., endowed with 2 roses) had a greater number of first dates and were more likely to have a date, although these effects are not statistically significant at the conventional level.

Next, we further examine the extent to which endowment of 8 roses helped a participant have more dates by making other participants accept his/her proposals, depending on participant's sex and attractiveness index group. To do so, we use regression analysis to examine the relationship between outcomes and treatment status, controlling for observable characteristics. In this analysis, we use all participants in order to examine treatment effects instead of excluding some participants, such as men who neither live in Seoul nor provided the full level of legal documentation, assuming that including control variables, such as location of residence and verification level in our regression, removes the difference in observables across Groups 1 to 3. We examine two outcomes: whether a participant has at least one date, and the number of dates. We classify dates into three categories: (i) a date that resulted because the participant proposed to a person in our experiment and the sender accepted it – sender's perspectives; (ii) a date that resulted because the participant received a proposal and accepted it – recipient's perspectives; and (iii) a date resulted due to either (i) or (ii) – overall. In each outcome, we regress the outcome on a person's treatment status and other control variables, and report the coefficients in front of the treatment status variables. Note that the list of other control variables appears under Table 12.

Table 12 reports our results. Column 1 examines the likelihood of having at least one date and column 2 examines the number of dates generated either by a participant's own initiation of a proposal or by acceptance of a received proposal. It shows that in both outcomes, the endowment of 8 roses significantly raises the likelihood of having at least one date and increases the number of dates for men who are endowed with 8 roses and who belong to the top group of attractiveness index have a higher likelihood compared to their counterparts with 2 roses. In order to understand the mechanism behind this finding, we examine the dates that are generated by a participant's initiation in columns 3 and 4. The results show that the top-group men with 8 roses and the middle-group women with 8 roses have a significantly larger number of dates, compared to their counterparts with 2 roses. In columns 5 and 6, we examine the dates generated by a participant's acceptance, and find that there is no systematic pattern associated with the endowment of roses. These results show that the effect of having 8 roses on the total number of dates is largely accounted for by the aforementioned finding that having 8 roses affects a participant's outcomes as a sender but not much as a recipient.

## 5 Counterfactuals and Robustness Checks

### 5.1 Counterfactuals

We examine how many proposals that a participant sent would have been accepted if the participant had used roses differently. To do so, we select participants who sent at least one proposal during our experiment and report the average number of proposals that are accepted in the row titled "Data" in Panel 1 of Table 13. Next, we use our regression results (Model C of Table 9 – column 2 for men and column 3 for women) and predict the likelihood of each proposal being accepted. Then, we aggregate the results up to a participant-level and report the model prediction in the row titled "Model Prediction" in Panel 1. The row titled (i) reports the average number of accepted proposals in the dataset depending on sex. The row titled (ii) reports the model prediction, and the row titled "[pvalue- (ii) vs. (i) ]" presents two p-values: the former is the p-value of testing whether the model fit of the average number of dates is the same as one in the actual data (two-sided test), and the latter is the p-value of testing whether the model fit is larger (smaller) than the actual data (one-sided test). All these p-values show that each of the model fits are statistically not different from the actual data. As our empirical model fits the data well, we use the estimation results to predict the number of proposals that would have been accepted in the two counterfactual scenarios (panel 2): when all participants do not use any roses and when participants use their endowment of roses to maximize the number of accepted proposals. If no senders used any roses, the average number of accepted proposals would have been 0.962 rather than 1.057, and this difference is statistically significant at the 10 percent level for a two-sided test. If the senders used roses optimally in order to maximize the number of proposals, then the average number of dates would have been 1.18, which is statistically different from 1.06 (the actual data), or the predicted value for the case in which people did not use any roses. These results mean that the optimal use of roses increases the number of accepted proposals by 12 percent compared to the current use of roses in the dataset, and by 23 percent compared to not using any roses.

Next, we examine how use of roses may change the quality-adjusted number of accepted proposals in the following ways. We compute the weight of a proposal as the attractiveness index of the recipient of the proposals divided by 82.33, the average attractiveness index of all the recipients in our sample. Then, we compute the probability of a proposal being accepted times its weight and sum these probabilities up to each sender. Note that if we use the actual data, instead of predicted probability, and set the weight as one, then the statistic we calculate is simply the total number of accepted proposals for each sender. Similar to the aforementioned analysis, we report data, our model prediction, and counterfactual results in panels 3 and 4 of Table 13. When

we adjust the recipient's quality for a proposal, the average number of quality-adjusted accepted proposals is 1.02 in our dataset and our model predicts the same. Regardless of whether we divide our sample based on sex. Our model predictions are not statistically different from the actual data in terms of standard confidence levels. In the first row of panel 4, we report the quality-adjusted number of accepted proposals if senders did not use any roses. For both men and women, the quality-adjusted number of accepted proposals is smaller than that in our dataset, and for women, the difference is statistically significant at conventional levels. Next, we perform a similar analysis assuming that senders use roses to maximize the quality-adjusted number of accepted proposals. We find that the optimal use of roses increases the quality-adjusted number of accepted proposals by 15 percent compared to the current use of roses in the dataset, and by 25 percent compared to not using any roses.

### 5.2 Heterogeneous Response to Roses

In this section, we examine the possibility that a recipient's response to a rose attached to a proposal depends on the number of roses that the recipient is endowed with. Ex ante, it is not clear whether a person with 8 roses will appreciate the value of a rose less than his or her counterpart with 2 roses. The reason is because if the person with 8 roses receives a proposal without a rose, the person may infer that the sender of the proposal may not consider the person a preferable dating partner. As the effect of roses is the difference between a proposal with 2 roses and that with 8 roses, the difference for recipients with 8 roses can be even larger than for the recipient with 2 roses.

To examine this possibility, we re-estimate Model A in Section 3.2.2 but include the interaction between a rose and whether a recipient has 8 roses or not. We find that the difference between the 2-rose and the 8-rose groups is not statistically significant. Similarly, we examine whether a recipient's response to a rose differs based on what fraction of proposals the recipient has. We include the interaction between a rose and the fraction of the proposals with a rose attached in Model A in Section 3.2.2. For men, we find that the larger the fraction of proposals with a rose attached, the smaller positive response a recipient shows.

### 5.3 Learning

We have 56 individuals who participated two sessions and 39 of them received at least one proposal in the second session. We examine whether recipients respond to a rose differently in their second session. To do so, we run Model A in Section 3.2.2 but include the interaction between a rose and a dummy variable that indicates the second session and two-time participants.

Note that 215 out of 1,921 proposals are sent to the two-time participants. We find that there is no statistical difference in terms of recipients' responses to a rose in their second participation.

### 5.4 Participant' Type

In this section, we use alternative variables to measure a participant's attractiveness and examine the sensitivity of our results in terms of the effect of receiving a rose on the recipient's acceptance probability. First, instead of our baseline cutoffs ($30^{th}$ percentile and $70^{th}$ percentile), we use $20^{th}$ and $80^{th}$ percentiles to classify participants into three groups. We re-estimate Model of Section 3.2.2 but include the new definition of a sender's attractiveness level. We find that a recipient accepts a proposal by 3.3 percentage points more if the proposal is accompanied by a rose (see column 1 of the table below), which is qualitatively the same as our baseline specification.

Second, we use the number of proposals that a participant received in the experiment as a proxy for the participant's attractiveness. We re-estimate Model A in Section 3.2.2 but include dummy variables of the total number of proposals that a sender received, instead of our attractiveness measure based on their attractiveness index. Qualitatively, the effect of roses is the same as our baseline results (columns 4 to 6).

## 6. Conclusion

Using a field experiment in online dating markets, this paper provides evidence that using preference signaling improves a person's match outcomes in a two-sided market. Our findings raise some interesting questions for future research. As our results suggest that preference signaling can change a person's matching outcome, it will be useful to further investigate the extent to which the introduction of a mechanism of preference signaling can change the equilibrium outcomes of a matching market. Moreover, there are multiple mechanisms for preference signaling. For example, in our experiment settings, we could have allowed participants to attach multiple virtual roses to a proposal, instead of only one. Alternatively, we could have provided different number of roses to participants instead of 2 or 8 roses. It will be interesting to examine what mechanism affects overall perform better than other feasible mechanisms.

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## Tables

**Table 1 Randomization of Treatment Status**

| | Group 1 | Group 2 [b)] | Group 3 [c)] |
|---|---|---|---|
| **Treatment Status** | | | |
| - Number of roses | 2 | 2 | 8 |
| - Perception or Empowerment | No | Yes | Yes |
| ***Male participants*** | | | |
| Number of participants | 146 | 97 | 58 |
| Age | 32.14 | 32.07 | 33.10** |
| Seoul or near Seoul (percent) | 84.93 | 94.85** | 81.03*** |
| Master's or PhD (percent) | 29.45 | 24.74 | 18.97 |
| Annual Income (10,000 won) | 5,100.31 | 4,329.38 | 4,526.38 |
| Attractiveness index by the company | 75.28 | 74.45 | 76.43 |
| Special members | 47.26 | 42.27 | 19.97*** |
| Verification – maximum level | 69.86 | 61.86 | 86.21** |
| Verification – medium + level | 97.26 | 97.94 | 1.00 |
| ***Female participants*** | | | |
| Number of participants | 153 | 95 | 61 |
| Age | 29.54 | 29.48 | 30.13* |
| Seoul or near Seoul (percent) | 88.24 | 86.32 | 81.97 |
| Master's or PhD (percent) | 25.49 | 23.16 | 36.07* |
| Annual Income (10,000 won) | 3,107.43 | 3,041.58 | 2,951.64 |
| Attractiveness index by the company | 78.58 | 79.62 | 79.97 |
| Special members | 30.72 | 21.05* | 22.95 |
| Verification – maximum level | 67.32 | 68.42 | 75.41 |
| Verification – medium + level | 96.73 | 94.74 | 98.36 |

a) Sum of the number of participants in Groups 1 to 3 does not add up 304 because three men were endowed with eight roses but not perception treatment.
b) We test whether Group 2 is statistically different from Group 1. *, **, and *** indicate the difference is significant at 10%, 5%, and 1%, respectively.
c) We test whether Group 3 is statistically different from Group 2. *, **, and *** indicate the difference is significant at 10%, 5%, and 1%, respectively.

**Table 2 Summary Statistics**

| | Men | Women |
|---|---|---|
| ***First Dates*** | | |
| Avg no of first dates | 0.970 | 0.954 |
| Max no of first dates | 10 | 14 |
| Avg no first dates initiated by the participant | 0.520 | 0.443 |
| Max no of first dates initiated by the participant | 6 | 8 |
| Avg no of first dates initiated by others | 0.451 | 0.511 |
| Max no of first dates initiated by others | 8 | 8 |
| Likelihood of having at least one date | 0.391 | 0.366 |
| Likelihood of having at least one date accepted by others | 0.280 | 0.239 |
| ***Proposal Stage*** | | |
| Avg no of initiating proposals | 4.148 | 2.136 |
| Max no of initiated proposals | 10 | 10 |
| Fract. initiating at least one proposal | 0.543 | 0.369 |
| Fract. of initiating 10 proposals | 0.293 | 0.100 |
| Fract. of initiating 10 proposal if ever proposed | 0.539 | 0.272 |
| Avg no proposals if ever | 7.642 | 5.789 |
| Fraction of proposals with a rose | 0.429 | 0.307 |
| Fraction of exhausting roses (i.e, no rose used = min(no proposals, endow) | 0.679 | 0.307 |
| ***Response Stage*** | | |
| Avg. no of received proposals | 2.171 | 4.081 |
| Max no of received proposals | 28 | 37 |
| Fraction of received at least one proposal | 0.553 | 0.731 |
| No of received proposals if ever | 3.929 | 5.580 |
| Avg. fract. received proposal with a rose | 0.243 | 0.366 |
| Max fract. received proposals with a rose | 1 | 1 |
| Avg. no of received roses if ever received a proposal | 1.083 | 2.159 |
| Max no of received roses if ever received a proposal | 12 | 17 |
| Avg. no of proposals that a recipient accepted | 0.815 | 0.699 |
| Max no of proposals that a recipient accepted | 8 | 8 |
| Avg. frac received proposals that a person accepted if ever received | 0.287 | 0.165 |
| Max. fract received proposals that a person accepted if ever received | 1 | 1 |

**Table 3 Sending Proposals**

| Dependant variable | Sending a proposal | | | Number of proposals (if > 0) | | |
|---|---|---|---|---|---|---|
| Model | | OLS | | | OLS | |
| Sender | All | Men | Women | all | men | women |
| Female | -0.115** | | | -1.050* | | |
| | [0.054] | | | [0.610] | | |
| Male with 8 roses | 0.239*** | 0.208*** | | 0.677 | 0.709 | |
| | [0.071] | [0.070] | | [0.563] | [0.549] | |
| Female with 8 roses | 0.035 | | 0.056 | 0.388 | | 0.369 |
| | [0.080] | | [0.080] | [0.838] | | [0.898] |
| Female empowerment | 0.037 | | 0.048 | -0.23 | | -0.271 |
| | [0.064] | | [0.064] | [0.706] | | [0.749] |
| Attractiveness - Middle | 0.001 | -0.058 | 0.055 | -0.264 | 0.269 | -1.007 |
| | [0.048] | [0.068] | [0.067] | [0.493] | [0.630] | [0.805] |
| Attractiveness - Top | 0.061 | 0.073 | 0.028 | -0.138 | -0.028 | -0.318 |
| | [0.053] | [0.074] | [0.074] | [0.521] | [0.651] | [0.879] |
| No. of observations | 611 | 304 | 307 | 278 | 165 | 113 |
| R-sq | 0.070 | 0.100 | 0.030 | 0.118 | 0.060 | 0.065 |

Note: For all specifications, we additionally control for each individual's verification level (full verification, medium verification, or other), whether the person lives in the capital area, age, and constant. For columns 1 to 3, the marginal effects from logit and probit models are very similar to the presented results from the linear probability model. Standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 4 Sending Roses**

| | Sending at least one rose | | | Number of roses if rose>=1 | | |
|---|---|---|---|---|---|---|
| | | OLS | | | OLS | |
| Sender's sex | all | men | women | all | men | women |
| Female | -0.222*** | | | -0.006 | | |
| | [0.072] | | | [0.238] | | |
| Male with 8 roses | 0.031 | 0.035 | | 4.936*** | 4.973*** | |
| | [0.066] | [0.051] | | [0.197] | [0.175] | |
| Female with 8 roses | 0.170* | | 0.163 | 3.239*** | | 3.263*** |
| | [0.098] | | [0.127] | [0.340] | | [0.411] |
| Female empowerment | -0.061 | | -0.073 | 0.112 | | 0.168 |
| | [0.083] | | [0.106] | [0.301] | | [0.356] |
| No of proposals sent | 0.019*** | 0.017** | 0.019 | 0.219*** | 0.207*** | 0.234*** |
| | [0.007] | [0.007] | [0.014] | [0.023] | [0.026] | [0.045] |
| Attractiveness - Middle | 0.012 | 0.056 | -0.043 | 0.368** | -0.061 | 1.272*** |
| | [0.058] | [0.059] | [0.114] | [0.183] | [0.197] | [0.379] |
| Attractiveness - Top | -0.022 | -0.079 | 0.066 | 0.307 | -0.092 | 1.132*** |
| | [0.061] | [0.061] | [0.124] | [0.196] | [0.211] | [0.402] |
| No. of Observations | 278 | 165 | 113 | 223 | 149 | 74 |
| R-sq | 0.140 | 0.080 | 0.080 | 0.8219 | 0.8740 | 0.7012 |

Note: For all specifications, we additionally control for each individual's verification level (full verification, medium verification, or others), whether the person lives in the capital area, age and constant. For columns 1 to 3, the marginal effects from logit and probit models are very similar to the presented results from the linear probability model. Standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 5 Distribution of Proposals**

| | Male Sender | | | | Female Sender | | | |
|---|---|---|---|---|---|---|---|---|
| | Recipient's Attractiveness | | | | Recipient's Attractiveness | | | |
| | # Prop. | Bottom | Middle | Top | # Prop. | Bottom | Middle | Top |
| S_Middle | 371 | 23.72 | 40.43 | 35.85 | 198 | 9.09 | 37.88 | 53.03 |
| S_Middle | 450 | 13.11 | 42.22 | 44.67 | 259 | 5.79 | 25.48 | 68.73 |
| S_Top | 424 | 10.61 | 37.26 | 52.12 | 200 | 2.00 | 22.50 | 75.50 |
| S_All | 1,245 | 15.42 | 40.00 | 44.58 | 657 | 5.63 | 28.31 | 66.06 |

**Table 6 Who Sent a Proposal to Whom?**

| | All | | | Ever Proposed | | |
|---|---|---|---|---|---|---|
| | All | Men | Women | All | Men | Women |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| S_rose | 0.031*** | 0.037*** | 0.019*** | 0.039*** | 0.038*** | 0.036*** |
| | [0.003] | [0.004] | [0.004] | [0.005] | [0.006] | [0.013] |
| S_female empowerment | -0.010* | | -0.003 | -0.008 | | 0.000 |
| | [0.005] | | [0.005] | [0.016] | | [0.016] |
| R_Middle | 0.006*** | 0.005* | 0.006** | 0.013*** | 0.010* | 0.017*** |
| | [0.002] | [0.003] | [0.002] | [0.004] | [0.005] | [0.006] |
| R_Top | 0.012*** | 0.007** | 0.016*** | 0.028*** | 0.013** | 0.045*** |
| | [0.002] | [0.003] | [0.002] | [0.004] | [0.006] | [0.006] |
| S_Middle X R_Middle | 0.003 | 0.008* | -0.003 | 0.004 | 0.016** | -0.011 |
| | [0.002] | [0.004] | [0.003] | [0.005] | [0.007] | [0.007] |
| S_Middle X R_Top | 0.010*** | 0.012*** | 0.008*** | 0.019*** | 0.023*** | 0.008 |
| | [0.003] | [0.004] | [0.003] | [0.005] | [0.008] | [0.008] |
| S_Top X R_Middle | 0.003 | 0.009** | -0.003 | 0.003 | 0.012 | -0.010 |
| | [0.003] | [0.004] | [0.003] | [0.005] | [0.007] | [0.008] |
| S_Top X R_Top | 0.016*** | 0.023*** | 0.009*** | 0.026*** | 0.032*** | 0.017** |
| | [0.003] | [0.004] | [0.003] | [0.006] | [0.007] | [0.008] |
| Controls | Y | Y | Y | Y | Y | Y |
| No. of Observations | 102,064 | 51,032 | 51,032 | 49,496 | 29,104 | 20,392 |
| No. of participants | 553 | 271 | 282 | 255 | 147 | 108 |
| R-sq | 0.010 | 0.010 | 0.010 | 0.020 | 0.020 | 0.030 |

Note: Controls include constant, Same Location dummy, R_age, R_capital area, Squared age difference, R_full proof, R_medium proof

**Table 7: Who Sends a Rose to Whom?**

Observation: all proposals actually made
Dependant variable: 0 (a rose is not attached), 1 (a rose is attached)
S and R indicate whose characteristics are: S: sender (initiator) R: receiver (person who received a proposal) Omitted categories : S_top * R_top

| | All proposals | | | Proposals by senders who used at least one rose | | |
|---|---|---|---|---|---|---|
| Sender's sex | All | Men | Women | All | Men | Women |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| S_female | -0.043 | | | 0.037 | | |
| | [0.040] | | | [0.048] | | |
| S_male with 8 roses | 0.577*** | 0.576*** | | 0.585*** | 0.584*** | |
| | [0.025] | [0.026] | | [0.027] | [0.027] | |
| S_female with 8 roses | 0.454*** | | 0.441*** | 0.463*** | | 0.448*** |
| | [0.043] | | [0.043] | [0.053] | | [0.057] |
| S_female empowerment | -0.017 | | -0.009 | 0.016 | | 0.022 |
| | [0.038] | | [0.038] | [0.049] | | [0.051] |
| S_Middle | 0.068 | 0.056 | 0.151 | 0.045 | 0.027 | 0.206 |
| | [0.062] | [0.071] | [0.142] | [0.066] | [0.072] | [0.177] |
| S_Top | -0.059 | -0.083 | 0.202 | -0.066 | -0.089 | 0.203 |
| | [0.072] | [0.078] | [0.227] | [0.079] | [0.083] | [0.252] |
| R_Middle | -0.082* | -0.049 | -0.070 | -0.073 | -0.044 | -0.036 |
| | [0.049] | [0.056] | [0.106] | [0.052] | [0.057] | [0.131] |
| R_Top | -0.027 | -0.056 | 0.109 | 0.006 | -0.029 | 0.205 |
| | [0.049] | [0.058] | [0.104] | [0.053] | [0.059] | [0.129] |
| S_Middle X R_Middle | -0.012 | -0.038 | -0.009 | -0.016 | -0.039 | -0.064 |
| | [0.073] | [0.083] | [0.158] | [0.078] | [0.085] | [0.198] |
| S_Middle X R_Top | -0.027 | -0.033 | -0.085 | -0.038 | -0.052 | -0.136 |
| | [0.071] | [0.084] | [0.151] | [0.076] | [0.085] | [0.189] |
| S_Top X R_Middle | 0.129 | 0.105 | -0.033 | 0.104 | 0.096 | -0.087 |
| | [0.082] | [0.090] | [0.240] | [0.089] | [0.095] | [0.269] |
| S_Top X R_Top | 0.082 | 0.107 | -0.177 | 0.074 | 0.107 | -0.207 |
| | [0.080] | [0.089] | [0.233] | [0.088] | [0.095] | [0.262] |
| No. of proposals | 1,902 | 1,245 | 657 | 1,615 | 1,153 | 462 |
| Pseudo R-sq | 0.280 | 0.300 | 0.220 | 0.280 | 0.310 | 0.250 |

Note: Other control variables: constant, recipient and sender's characteristics -- verification status (minimum, medium, full), age, living in Seoul or Kyunggi, squared difference of age between a sender and a recipient, a dummy indicating whether the two are in the same location

**Table 8 Determinants of Using No-Response**

| | Yes vs. No<br>(1) | Yes vs. NR<br>(2) | No vs. NR<br>(3) |
|---|---|---|---|
| Rose | 0.010 | 0.037** | -0.006 |
| | [0.031] | [0.016] | [0.010] |
| S_Middle | 0.119*** | 0.015 | 0.003 |
| | [0.038] | [0.020] | [0.012] |
| S_Top | 0.342*** | 0.110*** | -0.026** |
| | [0.042] | [0.021] | [0.013] |
| S_age | -0.020** | -0.007* | 0.007** |
| | [0.008] | [0.004] | [0.003] |
| S_Seoul | 0.041 | 0.082 | -0.012 |
| | [0.063] | [0.054] | [0.029] |
| S_fullproof | 0.097 | 0.051 | -0.003 |
| | [0.110] | [0.065] | [0.038] |
| S_mediumproof | 0.130 | 0.027 | -0.018 |
| | [0.111] | [0.067] | [0.038] |
| locasame | 0.000 | -0.073 | -0.013 |
| | [0.061] | [0.054] | [0.028] |
| agediffsq | 0.001 | 0.000 | 0.000 |
| | [0.001] | [0.000] | [0.000] |
| Constant | 0.713*** | 0.324** | 0.106 |
| | [0.269] | [0.139] | [0.087] |
| No. of Observations | 737 | 1,473 | 1,626 |
| No. of recipients | 227 | 331 | 346 |
| R-sq | 0.150 | 0.050 | 0.020 |

**Table 9 Difference in Fraction of Accepted Proposals**

**Between Proposals with a Rose and Proposals without a Rose**

Unit: percentage points

| | S_Bottom | S_Middle | S_Top | All |
|---|---|---|---|---|
| R_Bottom | -3.189 | -6.208 | 10.753 | -1.230 |
| R_Middle | 4.811 | 0.503 | 8.369 | 5.654 |
| R_Top | -4.614 | 1.685 | -5.016 | -1.957 |
| All | -0.673 | 0.772 | 0.781 | 0.879 |

**Table 10 Effect of Roses**

| | | All | | Only active | OLS | FE logit |
|---|---|---|---|---|---|---|
| Recipient's gender | All | Men | Women | All | All | All |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| No. of proposals | 1918 | 657 | 1261 | 1169 | 1902 | 812 |
| No. of recipients | 394 | 168 | 226 | 227 | 393 | 104 |
| ***Model A*** | | | | | | |
| Rose: All recipients | 0.033** | 0.053 | 0.027 | 0.055** | 0.030* | 0.462** |
| | [0.016] | [0.033] | [0.018] | [0.025] | [0.018] | [0.200] |
| S_Middle | 0.046** | 0.067* | 0.029 | 0.074** | 0.074*** | 0.768*** |
| | [0.019] | [0.037] | [0.022] | [0.030] | [0.020] | [0.297] |
| S_Top | 0.179*** | 0.178*** | 0.178*** | 0.293*** | 0.191*** | 2.281*** |
| | [0.020] | [0.040] | [0.023] | [0.032] | [0.021] | [0.311] |
| R-sq (log Likelihood) | 0.08 | 0.06 | 0.1 | 0.12 | 0.13 | -246.31 |
| ***Model B*** | | | | | | |
| Rose: R_Bottom | 0.056 | 0.273 | 0.038 | 0.089 | 0.003 | 0.998* |
| | [0.047] | [0.218] | [0.046] | [0.070] | [0.047] | [0.604] |
| Rose: R_Middle | 0.077*** | 0.104 | 0.073*** | 0.097** | 0.082*** | 0.684** |
| | [0.027] | [0.076] | [0.027] | [0.040] | [0.029] | [0.318] |
| Rose: R_Top | -0.001 | 0.035 | -0.023 | 0.013 | 0.003 | 0.132 |
| | [0.022] | [0.037] | [0.027] | [0.035] | [0.024] | [0.292] |
| S_Middle | 0.045** | 0.067* | 0.027 | 0.074** | 0.072*** | 0.776*** |
| | [0.019] | [0.037] | [0.022] | [0.030] | [0.020] | [0.298] |
| S_Top | 0.178*** | 0.177*** | 0.176*** | 0.291*** | 0.189*** | 2.282*** |
| | [0.020] | [0.041] | [0.023] | [0.032] | [0.021] | [0.312] |
| R-sq (log Likelihood) | 0.08 | 0.06 | 0.11 | 0.13 | 0.13 | -245.17 |
| ***Model C*** | | | | | | |
| ***R_Bottom*** | | | | | | |
| Rose from S_Bottom | -0.045 | 0.166 | -0.054 | -0.064 | -0.024 | -1.200 |
| | [0.064] | [0.311] | [0.062] | [0.095] | [0.063] | [1.345] |
| Rose from S_Middle | 0.125* | 0.496 | 0.104 | 0.189* | -0.001 | 1.900** |
| | [0.070] | [0.311] | [0.068] | [0.107] | [0.068] | [0.967] |
| Rose from S_Top | 0.155* | 0.079 | 0.130 | 0.265* | 0.072 | 2.847* |
| | [0.084] | [0.453] | [0.081] | [0.136] | [0.087] | [1.470] |
| ***R_Middle*** | | | | | | |
| Rose from S_Bottom | 0.107** | 0.208 | 0.091* | 0.150* | 0.076 | 1.272* |
| | [0.049] | [0.151] | [0.050] | [0.078] | [0.050] | [0.662] |
| Rose from S_Middle | 0.022 | -0.068 | 0.043 | 0.022 | 0.065 | 0.294 |
| | [0.039] | [0.118] | [0.040] | [0.059] | [0.041] | [0.464] |
| Rose from S_Top | 0.119*** | 0.209* | 0.095** | 0.145** | 0.108** | 0.861* |
| | [0.040] | [0.112] | [0.042] | [0.060] | [0.045] | [0.464] |

[Cont.]

**Table 10** [continued]

| | | | | | | |
|---|---|---|---|---|---|---|
| ***R_Top*** | | | | | | |
| Rose from S_Bottom | -0.002 | -0.031 | 0.009 | 0.000 | 0.010 | -0.682 |
| | [0.044] | [0.081] | [0.052] | [0.070] | [0.046] | [0.922] |
| Rose from S_Middle | 0.036 | 0.058 | 0.025 | 0.063 | 0.026 | 0.61 |
| | [0.032] | [0.054] | [0.040] | [0.051] | [0.035] | [0.426] |
| Rose from S_Top | -0.037 | 0.040 | -0.077** | -0.036 | -0.025 | -0.091 |
| | [0.032] | [0.058] | [0.037] | [0.053] | [0.035] | [0.394] |
| ***S_Middle*** | 0.038* | 0.057 | 0.020 | 0.066* | 0.069*** | 0.629* |
| | [0.023] | [0.043] | [0.028] | [0.037] | [0.024] | [0.366] |
| ***S_Top*** | 0.175*** | 0.160*** | 0.181*** | 0.284*** | 0.188*** | 2.198*** |
| | [0.024] | [0.046] | [0.028] | [0.039] | [0.026] | [0.367] |
| R-sq (log Likelihood) | 0.09 | 0.08 | 0.12 | 0.14 | 0.13 | -239.25 |

Note: All except column 5: other control variables – sender's age, attractiveness group, legal verification level, residential location, squared age difference, indicator of whether the recipient and the sender live in the same location. Other controls in column 5: all control variables included in other columns plus recipients' characteristics - no of proposals that a recipient made, no of roses that a recipient sent, no of proposals that a recipient received, dummy of whether a recipient received at least one rose, and no of roses that a recipient received, and the recipient's characteristics corresponding to those of senders in other columns.

**Table 11 Treatment Effects**

| | Group 1 (1) | Group 2 [b] (2) | Group 3 [c] (3) |
|---|---|---|---|
| **Treatment Status** | | | |
| - Number of roses | 2 | 2 | 8 |
| - Perception or Empowerment | No | Yes | Yes |
| ***Male participants*** [a] | | | |
| Likelihood of having at least one date | 0.477 | 0.429 | 0.615*** [b] |
| No of all first dates | 1.034 | 0.893 | 1.513*** |
| No of first dates initiated by the participant | 0.602 | 0.482 | 0.897*** |
| No of first dates initiated by others | 0.432 | 0.411 | 0.615 |
| Likelihood of having at least one date\|proposal | 0.563 | 0.436 | 0.511 |
| No of first dates initiated by the participant\|propose | 1.000 | 0.872 | 0.978 |
| ***Female participants*** | | | |
| Likelihood of having at least one date | 0.340 | 0.389 | 0.393 |
| No of all first dates | 0.804 | 1.052 | 1.180 |
| No of first dates initiated by the participant | 0.353 | 0.421 | 0.705*** |
| No of first dates initiated by others | 0.451 | 0.632 | 0.475 |
| Likelihood of having at least one date\|proposal | 0.558 | 0.694* | 0.769 |
| No of first dates initiated by the participant\|propose | 1.038 | 1.111 | 1.654*** |

Note: a) male participants include only men who live in Seoul and Kyunggi and provided full level of legal documentation. b) *, **, and *** indicate that the p-value of testing the value in a cell in column 2 is different from the corresponding value in column 1 (i.e., two-sided test): less than 10 percent, 5 percent, and 1 percent, respectively. *, **, and *** indicate that the p-value of testing the value in a cell in column 2 is larger(smaller) than the corresponding value in column 1 (i.e., one-sided test): less than 10 percent, 5 percent, and 1 percent, respectively. c) We compare the value of each cell in column 3 with the corresponding value in column 2 and report the p-value of the two-sided test (with a black asterisk) and p-value of the one-sided test (with a red asterisk). The definition of each asterisk is the same as in b).

**Table 12 Heterogeneous Treatment Effects**

| | All | | Sender | | Recipient | |
|---|---|---|---|---|---|---|
| | At least one date | No. Dates | At least one date | No. Dates | At least one date | No. Dates |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Men –bottom - 8 roses | 0.127 | 0.624 | 0.138 | 0.213 | 0.104 | 0.411 |
| | [0.143] | [0.503] | [0.128] | [0.296] | [0.128] | [0.324] |
| Men –middle - 8 roses | 0.101 | -0.004 | 0.055 | -0.050 | 0.075 | 0.046 |
| | [0.109] | [0.382] | [0.097] | [0.224] | [0.097] | [0.246] |
| Men –top - 8 roses | 0.221* | 0.987** | 0.295*** | 0.688*** | 0.111 | 0.299 |
| | [0.119] | [0.418] | [0.106] | [0.245] | [0.107] | [0.269] |
| Women –bottom - 8 roses | 0.088 | 0.343 | -0.003 | 0.158 | 0.129 | 0.185 |
| | [0.138] | [0.486] | [0.124] | [0.285] | [0.124] | [0.313] |
| Women –middle - 8 roses | -0.009 | 0.361 | 0.106 | 0.499** | -0.126 | -0.139 |
| | [0.109] | [0.383] | [0.097] | [0.225] | [0.098] | [0.246] |
| Women –top – 8 roses | -0.068 | -0.349 | 0.061 | 0.085 | -0.125 | -0.434 |
| | [0.124] | [0.436] | [0.111] | [0.256] | [0.111] | [0.280] |
| Men – Perception | -0.091 | -0.346 | -0.096* | -0.110 | -0.053 | -0.236* |
| | [0.062] | [0.217] | [0.055] | [0.127] | [0.055] | [0.140] |
| Women - Empowerment | 0.037 | 0.198 | 0.060 | 0.033 | 0.046 | 0.166 |
| | [0.063] | [0.222] | [0.056] | [0.130] | [0.057] | [0.143] |
| No. of observation | 611 | 611 | 611 | 611 | 611 | 611 |
| R-sq | 0.050 | 0.070 | 0.070 | 0.070 | 0.040 | 0.050 |

Note: Standard errors are in brackets.We additionally include the following variables: sex, the dummy variable of whether a participant lives in Seoul or Kyunggi, the dummy variable of whether the participant provides the full level of legal documentation, age, whether a participant provides a medium level of legal verification, and dummy variables for a participant's attractiveness group.

**Table 13 Alternative Usage of Roses**

| | Senders | | |
|---|---|---|---|
| | All | Men | Women |
| | (1) | (2) | (3) |
| ***No. accepted proposals*** | | | |
| Panel 1. Actual | | | |
| (i) Data | 1.057 | 0.958 | 1.202 |
| (ii) Model Prediction | 1.047 | 0.958 | 1.175 |
| [pvalue- (ii) vs. (i) ] | [0.856; 0.428] | [1.000;0.500] | [0.796; 0.398] |
| Panel 2. Counterfactuals | | | |
| (iii) Not using roses | 0.962 | 0.881 | 1.079 |
| [pvalue- (iii) vs. (i) ] | [0.094; 0.047] | [0.278; 0.139] | [0.193; 0.096] |
| (iv) Optimal use of roses | 1.179 | 1.055 | 1.357 |
| [ pvalue- (iv) vs. (i) ] | [0.052; 0.026] | [0.181;0.091] | [0.152; 0.076] |
| [ pvalue- (iv) vs. (iii) ] | [0.001;0.000] | [0.018;0.009] | [0.011; 0.006] |
| ***Quality Adjusted No. accepted proposals*** | | | |
| Panel 3. Actual | | | |
| (i) Data | 1.019 | 0.943 | 1.220 |
| (ii) Model Prediction | 1.019 | 0.987 | 1.104 |
| [pvalue- (ii) vs. (i) ] | [1.000; 0.500] | [0.513; 0.256] | [0.297; 0.149] |
| Panel 4. Counterfactuals | | | |
| (iii) Not using roses | 0.940 | 0.915 | 1.005 |
| [pvalue- (iii) vs. (i) ] | [0.151; 0.075] | [0.661; 0.331] | [0.046; 0.023] |
| (iv) Optimal use of roses | 1.173 | 1.144 | 1.247 |
| [ pvalue- (iv) vs. (i) ] | [0.012; 0.006] | [0.005; 0.002] | [0.820; 0.410] |
| [ pvalue- (iv) vs. (iii) ] | [0.000; 0.000] | [0.001; 0.001] | [0.046; 0.023] |