2019

Love at First Byte: An Economic Analysis of the Internet Dating Apocalypse

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LOVE AT FIRST BYTE: AN ECONOMIC ANALYSIS OF THE INTERNET DATING APOCALYPSE

submitted to

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by

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for

Senior Thesis

Spring 2019

April 29, 2019

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I. ACKNOWLEDGEMENTS

How does one talk about Tinder and the Nobel-laureate Gary S. Becker in the same sentence? This thesis is my attempt at doing that, and I would like to express my appreciation for my mentor and friend, Professor Eric Helland, for indulging me with these peculiar conversations. Thank you for your hard-won "looks good" at 5 in the morning – as you were starting your day (and I was ending mine!) The process of writing a thesis was made more enjoyable because of your good humor.

I would also like to express my gratitude to Professor Janet Smith, who kept me on track with deadlines, sent resources my way, and showed great enthusiasm for my research.

I would like to thank my sister, Aishwarya, for encouraging me to choose this topic. I have now theorized online dating enough to be completely turned off by it, but I am grateful for the inspiration nevertheless.

I want to thank my father, Srikanth, for reminding me to take care of myself and supporting my education, and Anugraha – whose delightful company and Trader Joe's snack cravings kept me sane this semester.

Lastly, I'd like to acknowledge the true 'hero' of this thesis – the creaky door at Stark Lab. I became a more productive worker because I wanted to get away from its annoying noises as soon as possible.

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III. INTRODUCTION

We're often warned that the internet will hasten the dating apocalypse. Many of us reminisce about the days when partner selection happened the old-fashioned way — in the local church, through set up from friends, or on the first day of ECON 101. The internet (it is posited) is depriving us of that elusive in-person magic (Turkle, 2011; 2015), and modern courtship is now little more than love at first *byte*.

There remains uncertainty, however, about what the independent impact of the internet on the dating market has been. Similar to the internet, the telephone also changed the way we communicate, but its effect on the dating market was mostly complementary to the 'traditional' ways of meeting – i.e. calling your school crush at home. So the question remains: Is the effect of the internet on the dating market *complementary* (adding your school crush on Facebook) or *substitutionary* (matching with a stranger on Tinder)? Is the internet any better than the telephone?

Rosenfeld and Thomas (2012) was the first to study this question of how couples meet in the internet era – and reports that the effect is that of displacement. Rosenfeld and Thomas (2012)'s claim may well be true, but I identify four shortcomings of their model which renders the evidence inadequate. In this paper, I present three methodological advances to Rosenfeld and Thomas (2012), from the perspective of dependent variable selection, empirical strategy, and economic theory to explain the dating behavior of individuals who inhabit "thin" markets (such as LGBTQ).

I code my dependent variable "met online" such that it only includes couples who met as strangers through the internet – thus removing any complementary effect of social circle. Then, I estimate the relative probability that a couple met online as opposed to

through their social circle, by employing a multinomial logistic regression model on a nationally-representative sample of 3,054 American couples.

If all that was known about a random couple is that they met after 2015, I find that there is a 1 in 3 chance that the couple met as strangers online. Lesbian couples who met after 2015 have a 1 in 2 chance of meeting online, whereas gay male couples have a 63% probability of meeting online as strangers. This increased likelihood of same-sex couples meeting online (as opposed to heterosexual couples) confirms the thin-market hypothesis.

The key value proposition of the internet is that it reduces search frictions in the dating market – effectively making it easier for individuals to seek out their optimal matching. I find that the internet is primarily displacing only 'social circles' as a dating venue – the probability of meeting partners in public or at institutions (like college) is unchanged. In other words – individuals are essentially replacing their friends with Wi-Fi when it comes to mate search.

In Section 4, I examine the economic understanding of mate selection and contextualize the theory of dating markets having "search frictions." In Section 5, I review Rosenfeld and Thomas (2012), identify methodological shortcomings, and motivate my own multinomial logistic regression model. Sections 6-8 discuss the data, the model, replicated results using the original model, and show the displacement effect of the internet. Sections 9 and 10 perform robustness checks and test the difference in match quality between dating venues. Sections 11 and 12 present a discussion of the results as well as illustrative exhibits.

IV. ECONOMIC MODEL OF MATE SELECTION

The Understudied Problem of Mate Search

The first to bring the cryptic world of romance into the field of economics was Gary S. Becker in 1973 with his article titled *A Theory of Marriage*. Becker (1973) likens mate selection to the process of selecting a consumer good, which is designed to increase an individual's happiness. This model has its foundations in two principles: First, that marriage is practically always a voluntary transaction between the individuals, such that mate selection reveals preferences and raises individual utility levels. Second, that there exists a market mechanism in marriage, since men and women vie for their mates. The corollary is that individuals pursuing their own selfish interests in the marriage market are "led by the invisible hand of competition" to maximize aggregate output (Becker, 1991, p.112).

Becker (1973, 1974, 1991) inspired a series of sophisticated models from the perspective of the three economic problems: *allocation* (assortative matching and optimal sorting into couples), *production* of marital output, and *distribution* of resources and labor within the marriage (Grossbard, 2006). But the subject that remains understudied precedes the economic problem of allocation — the actual search for viable mates in different market 'venues' such as social circles, church, and bars. Previous attempts to address this deficiency either use data that predate the rise of the internet (Bozon and Heran, 1989; Kalmijn and Flap, 2001) or present methods and perspectives from the field of sociology (Thomas, 2011; Rosenfeld & Thomas, 2012). The theory of economics has left the problem of mate search through different market 'venues' unaddressed.

In this paper, I advance the economic understanding on mate search: How do couples meet, and how is this changing in the Internet Era? To put it plainly — In which sea are the proverbial "plenty of fish" swimming?

The Dating Market Isn't Efficient

In Gale and Shapley (1962)'s seminal matching algorithm, as well in the Becker (1973, 1974, 1991) marriage model, there is an assumption that the dating market is perfectly competitive. The Walrasian matching model presumes that there are a large number of participants, distributed randomly, with free mobility of potential partners. Individuals can thus observe all potential mates in a costless manner, input characteristics into their respective utility functions, and accordingly enter a "stable matching" with the most compatible partner (Gale and Shapley, 1962). The assumption of a 'frictionless' market is a necessary one, because it enables models to claim that mate sorting is optimal, and that couples have maximized (not marginally improved) upon their utility (Becker, 1991).

Why dating venues matter. The reality of mate search, however, is the tale of costly coordination. These search frictions arise because the distribution of potential partners in the dating market is not random — a Christian hoping to mate with another Christian won't find much success at an Atheist convention. For this reason, we should expect that different dating 'venues' offer different rates of success for individuals — depending on what and whom they are seeking as mates.

I use the word 'venue' to imply not just physical spaces but also different social foci — the various settings and ways in which people meet and develop social relationships with one another (Feld, 1981). This includes friends, family, and other

intermediaries, who create an environment conducive to meeting and getting introduced to potential partners.

Search frictions in thin dating markets. These search frictions are particularly present in 'thin' dating markets — notably: individuals who self-identify as lesbian, gay, bisexual or transgender (LGBTQ), queer, or not-heterosexual. The queer dating market can be described as "thin" because only 4.5% of American adults identify as LGBTQ. Even at its highest concentration, Gallup reports[1] that only 6.2% of the adult population in the San Francisco metropolitan area identifies as LGBTQ. In the economic framework, I expect that thin dating markets are associated with higher search costs; the odds are unfavorable for accurately locating and ascertaining compatibility with partners in a sparsely-distributed market.

Search frictions also manifest as: queer-phobia which necessitates signaling ambiguity, discrimination that creates a barrier to market entry (coming out), imperfect information, and imperfect mobility (not everyone can live in San Francisco!) Similar frictions apply to dating markets consisting of middle-aged and previously-married singles. The very qualities that make traditional methods of finding love appealing to our sensibilities — the chase, the guessing game, and the network familiarity — are often obstacles in partner selection for these subgroups: Is that person also queer? Are they single, or do they just not wear their wedding ring?

All else being equal, I expect that higher search friction unfavorably changes an agent's trade-offs in mate selection (see also: Chade, Eeckhout, and Smith, 2015). Agents

[1] https://news.gallup.com/poll/182051/san-francisco-metro-area-ranks-highest-lgbt-percentage.aspx

in thin dating markets are more likely to settle for non-optimal pairings, since the marginal cost of continuing the search is higher than the marginal utility of seeking the Pareto-optimal, Gale-Shaley-predicted “stable matching.” Given that individuals are utility-maximizers — I expect that individuals will switch to or adopt those dating venues that lower their search costs.

V. LOVE AT FIRST BYTE: INTERNET AS A DATING VENUE

Is the Internet any Different from the Telephone?

The internet is disrupting the way that firms advertise to buyers, platforms aggregate information, and old people pass their time. It is thus no surprise that the internet has also penetrated into the dating market. However, it is unclear what its independent impact on the dating market has been.

Similar to the internet, the adoption of the telephone also made communication significantly more efficient. Yet, its primary function in the dating market was only to reinforce existing social networks and connections (Fischer, 1994) — the ability to call your school crush at home. On the other hand, the internet actually has the ability to not just reinforce existing networks, but also create new connections and expand one's market for potential mates. If the effect of the internet on the dating market is mostly the former, then it is but a slight improvement on the telephone.

Thus, the question remains on whether the internet's impact on the dating market is *complementary* (adding your school crush on Facebook instead of a phone call) or *substitutionary* (matching with a stranger on Tinder). Only the latter would imply that the internet has a displacement effect on 'traditional' dating venues.

Rosenfeld and Thomas (2012)

The frequently cited sociological paper, "Searching for a Mate: The Rise of the Internet as a Social Intermediary" was the first to study how 'ways of meeting' have changed over time and which subgroups were more likely to meet online (Rosenfeld & Thomas, 2012). It analyzes the popularity of different dating venues by plotting them on a graph where: the y-axis is 'percentage of couples who met this way' and x-axis is 'year

couple met.' Rosenfeld and Thomas (2012) finds that traditional venues have been in steady decline since the dawn of the internet era, whereas "the Internet was the third most likely way of meeting" for heterosexual couples who met in 2009. Extrapolating from these two results, Rosenfeld and Thomas (2012) makes the claim that "the Internet is displacing rather than simply complementing the traditional ways of meeting a partner" (p.531, p.532).

The study also proposes that the alleged displacement is particularly true for "individuals who face a thin market for potential partners," such as same-sex couples or middle-aged heterosexuals (Rosenfeld & Thomas, 2012, p521). Through an adjusted odds ratio model, it finds that a) same-sex couples were less likely to have met through family intermediation when compared to heterosexual couples, and b) same-sex couples were 2.93 times more likely to have met online when compared to heterosexual couples.

Shortcomings of Rosenfeld and Thomas (2012)

The claims made in Rosenfeld and Thomas (2012) may well be true, but the evidence is inadequate for four reasons. The first shortcoming is from the perspective of the dependent variable: 'ways of meeting' were not coded to be mutually exclusive. In the dataset, a respondent who met their partner through family and then developed a more intimate relationship online would be double-counted as "Met through Family" and "Met Online." This is also why the percentages for 'couples who met this way' did not add up to 100 percent — more than one category/dating venue could apply for any given individual. Exhibit 1 illustrates how Rosenfeld and Thomas (2012)'s coding scheme includes the effect of existing social circles in its dependent variable "Met Online." [See Exhibit 1A and 1B for more information on venue type].

The second shortcoming is from the perspective of the model: the adjusted odds ratio model derives its probabilities from *separate* logistic regressions with a simple yes/no value. Thus, the result does not provide evidence for either/or displacement of traditional ways of meeting. Instead, Rosenfeld and Thomas (2012) are capturing the power of the internet to reinforce and complement existing connections — similar to the effect of the telephone.

The third and fourth shortcomings reference the finding about same-sex couples. Third, the relative probability of 'meeting online' for same-sex couples is reported in comparison to *heterosexual couples*, but Rosenfeld and Thomas (2012) incorrectly derives conclusions about the probability in comparison to *traditional ways of meeting.* In this paper, I report the relative probability of 'meeting online' for same-sex couples in comparison to heterosexual couples and *also* in comparison to traditional ways of meeting.

Fourth, the only 'traditional' way of meeting for which relative probabilities are reported is "Met through Family." However, research shows that there has been a general decline in parental influence over young adults from 1940s to the present (Rosenfeld, 2007), and this is merely reflected in the diminishing role of family as a dating intermediary (Rosenfeld & Thomas, 2012). Thus, choosing 'family' (and not friends or college) to represent the 'traditional' ways of meeting misrepresents the actual impact that the internet has had on mate search for same-sex couples.

In this paper, I include couples that met through twenty-five different 'traditional' venues — including friends, bars, military, coworkers — that are more representative and comprehensive of the ways that modern couples meet (Exhibit 1B). I also report relative

probabilities of meeting online for same-sex couples — not just in comparison to heterosexual couples but also in comparison to traditional ways of meeting.

Empirical Strategy

This paper presents three methodological advances to Rosenfeld and Thomas (2012). First, I correct for the 'dependent variable' problem by generating the variable "How Couple Met," where the outcomes are coded to be mutually exclusive: Met in Public (as strangers), Met at Institution (as strangers), Met through Social Circle, and Met Online (as strangers). Second, I correct for the 'model' problem by employing a multinomial logistic regression, where the probability of meeting online is measured *relative* to that of meeting through social circle. Both these specifications ensure that only the substitutionary or displacement effect of the internet is reported. Third, I examine Rosenfeld and Thomas (2012)'s claim that individuals in a thin dating market (such as LGBTQ) are especially likely to meet partners online. I explain this finding by contextualizing it into the economic theory of search frictions, and I present the role of the internet in optimizing dating markets.

VI. THE DATA

Source: HCMST 2017

This study uses the dataset "How Couples Meet and Stay Together 2017 fresh sample" (HCMST 2017) collected by principal investigators Rosenfeld, Thomas, and Hausen, at Stanford University[2]. It features cross-sectional data from 3,510 survey respondents i.e. English-literate individuals and couples in the United States. The data includes subjects with current partners (N=2862), unpartnered subjects with only past partners (N=541), and subjects who have never had a partner (N=107).

The data is described by the principal investigators as "nationally representative," since the online survey company (GfK) recruited subjects by phone and by Address Based Sampling method. Subjects without internet access at home were provided internet access to complete the survey. One caveat is that self-identified Lesbian, Gay, and Bisexual respondents were oversampled — approximately 17% of subjects did not identify as heterosexual or straight. However, it is helpful in providing additional observations and improving statistical significance for the purpose of this study.

The HCMST 2017 subjects were asked to respond to the question: "Please write the story of how you and [Partner_Name] first met and got to know one another and be sure to describe "how" and "where" you first met."[3] Since this paper examines how couples meet, irrelevant data points from the original survey dataset are excluded from analysis. This includes participants who have never had a partner (N=107), refused to respond how they met their partner (N=70), or failed to provide sufficient information so

[2] Survey instrument and codebook are publicly available at: https://data.stanford.edu/hcmst2017
[3] Q24 [O], page 14 of How Couples Meet 2017 Pretest 310.209.01361.1

their response could not be accurately coded for how (N=228) or at what age (N=33) they met their partner. In total, 3,056 American couples were considered in the model.

Exhibit 2 shows that of these 3,056 couples, 5% are gay male couples and 4% are lesbian couples. These percentages approximately track the metric that 4.5% of American adults identify as queer. Of these same-sex couples (N=275), 18.5% are married. This differs significantly from the profile of heterosexual couples in the same sample – 66% were married. The disparity is unsurprising since gay marriage had only been legalized for 2 years, at the time the survey was conducted (2017).

85% of the respondents in the sample are currently partnered (N=2600) and 15% of the respondents had a past partner. The latter group responded to the survey questions with respect to their most previous relationship, and provided year of meeting and relationship dissolution to create context. Since this study focuses on *how* couples met, the story from both groups was sufficient to model outcomes.

Dependent Variable

I generated the dependent variable "How Couple Met" such that it takes four mutually-exclusive outcomes. The original survey dataset recorded responses into twenty-six codes including: met through friends, party, church, college, et cetera. However, these were not mutually exclusive; a single respondent could be coded "yes" for multiple 'ways of meeting.' Exhibit 1B shows that I divided these twenty-six ways of meeting into four basic "venue types:" random, institution, social circle, and online. These venue types are also not mutually exclusive – they were further recoded into the four outcomes that generate my dependent variable: "How Couple Met." [See Exhibit 1A

for a visual illustration of my coding scheme]. The four mutually- exclusive outcomes for "How Couple Met" are as follows:

Met in Public (as strangers): Includes couples that met purely by chance. There is no overlap of institution, social circles, or any online interaction. This also excludes institutions like college or church that would add a degree of familiarity. These individuals had to have met as strangers in a public venue, such that their encounter was random. Example: Met at a bar, on vacation, on a business trip.

Met at Institution (as strangers): Includes couples that had no previous overlap of social circles or any online interaction. These couples met as strangers with no intermediation from venues such as friends and the internet. While these couples are strangers, they met at an institution such as school, temple, or the military, which provides a degree of familiarity and are not purely random.

Met through Social Circle: Includes couples that were connected through their social circle. If the couple connected on an online dating site but had mutual friends in common, they were included in this category. If the couple met in college and had no friends in common, they were excluded from this category. This outcome captures all those couples that were intermediated through social circles. Example: Met through church friends, dating the boy next door, or matched with your crush on Tinder.

Met Online (as strangers): Includes couples that met purely online, with no previous overlap of social circles. This category was coded with the most scrutiny – if a couple had any social networks or connections in common before they met, then they were excluded from this category. Example: Met on online dating site such as Match.com and had no previous mutual friends.

A high level of rigor was selected for "Met Online" to overcome the shortcomings of Rosenfeld and Thomas (2012). The goal is to avoid capturing the power of the internet to complement existing connections. If all that the internet did was reinforce social circles, then its impact on the dating market would be no different than that of the telephone. I code the dependent variable such that only the displacement effect of the internet is reported.

Exhibit 3 shows that social circle is the most popular dating venue for heterosexual and lesbian couples – with 60% and 51% of couples meeting this way. However, an equally popular method for gay male couples is the online venue – with one in three gay male couples having met this way.

Independent Variables

Exhibit 4 shows that 46% of couples met before 1996. This is useful in analysis because there is a near 50-50 split between couples who met before, and couples who met during, the internet era. Thus, comparisons between the two groups have improved statistical significance. The independent variable – "Year When Met" is manually coded into categories that reflect inflection points in the history of internet dating. 1996: dawn of the internet era, 2005: de-stigmatization of online dating and launch of the dating site OKCupid[4], 2009: launch of the gay dating-app Grindr, 2012: launch of the most popular dating-app Tinder, 2015: legalization of same-sex marriage in the U.S.

Exhibit 5 shows that 50% of couples met for the first time when they were college-aged (18-22 years) or in their twenties (23-29 years). It is striking that while 21%

[4] The first time Pew Research Center studied online dating habits was in 2005. They found that 44% of U.S. adults agreed that "Online Dating is a good way to meet people." Article found here: https://www.pewresearch.org/fact-tank/2016/02/29/5-facts-about-online-dating/

of heterosexual couples had already met before the age of 18 years, only 4% of gay male couples and 8% of lesbian couples had met. Same-sex couples met much later in life. One-third of the gay male couples met after 40 years, compared to only 13% of heterosexual couples who met after this age.

In the original survey HCMST 2017, subjects were asked "How often do you attend religious services?" I coded responses as "frequent religious attendance" if subjects indicated that they attended services at least "once or twice a month." I expect that frequent religious attendance creates a conducive environment for mate search – individuals are surrounded by people with similar values and beliefs. Churches, temples, and mosques, are the original match-making institutions. Exhibit 6 shows that over one-third of heterosexual couples attend religious services frequently. It is unsurprising that 88% of gay male couples and around 82% of lesbian couples report either absence or infrequent attendance.

Exhibit 14 reports the independent variables included in the model. In addition to those already listed, I also run the model with interaction controls, acknowledging the fact that variables such as religious attendance, education, age when couple met, and race, have different effects depending on Couple Type – heterosexual couple, gay male couple, lesbian couple. The fact that nearly 90% of gay males do not attend religious services frequently is further proof of that. Notes to Exhibit 14 shows the interaction effects that I controlled for in my multinomial logistic model.

VII. THE MODEL

Multinomial logistic regression fits maximum likelihood models (MLM) with a dependent variable that takes on more than two outcomes (i.e. it is discrete) and when the outcomes have no natural ordering. The 'unordered' categorical property distinguishes multinomial logistic regression from ordinary least squares (OLS) regression, ordered logistic regression, and logistic regression.[5]

In this model, the dependent variable How Couple Met takes four outcomes that are mutually exclusive. The outcomes are not preferential, so outcome 1 (Met in Public) is not less than outcome 4 (Met Online). Individual probabilities cannot be known, so the probability of membership in other categories is compared to the probability of membership in the reference category. Met through Social Circle has the highest frequency, with approximately 58% of the couples meeting this way. Hence, it is selected as the reference category and I set the coefficient $\beta^{(3)} = 0$.

$$\Pr(Met\ through\ Social\ Circle) = \frac{1}{1 + e^{XB^{(1)}} + e^{XB^{(2)}} + e^{XB^{(4)}}}$$

In the multinomial logistic model, I estimate a set of coefficients $\beta^{(1)}$, $\beta^{(2)}$, and $\beta^{(4)}$ corresponding to the outcomes Met in Public, Met at Institution, and Met Online.

$$\Pr(Met\ in\ Public) = \frac{e^{XB^{(1)}}}{1 + e^{XB^{(1)}} + e^{XB^{(2)}} + e^{XB^{(4)}}}$$

[5] A good explanation of multinomial logistic regression as well as interpretation of estimates is available in the Stata manuals available here: https://www.stata.com/manuals13/rmlogit.pdf

$$\Pr(Met\ at\ Institution) = \frac{e^{XB^{(2)}}}{1 + e^{XB^{(1)}} + e^{XB^{(2)}} + e^{XB^{(4)}}}$$

$$\Pr(Met\ Online) = \frac{e^{XB^{(4)}}}{1 + e^{XB^{(1)}} + e^{XB^{(2)}} + e^{XB^{(4)}}}$$

I report probabilities that a couple Met in Public, Met at Institution, or Met Online, *relative* to the probability of Met through Social Circle (base outcome).

$$Relative\ \Pr(Met\ Online) = \frac{\Pr(Met\ Online)}{\Pr(Met\ through\ Social\ Circle)} = e^{XB^{(4)}}$$

Risk is measured as the risk of the outcome relative to the base outcome. If this risk-relative-ratio (rrr) for outcome 4 (Met Online) is *greater* than one, it implies that a couple is *more likely* to have met online, as opposed to through their social circle. Conversely, if the risk-relative-ratio (rrr) is less than one, it implies that a couple is more likely to meet through social circle. As such, all probabilities reported are relative to the base outcome (Met through Social Circle) and assume all other factors are held constant (ceteris paribus).

VIII. RESULTS

Replicated Results: Rosenfeld and Thomas (2012)

Exhibit 7 shows the preliminary results replicating the original study in Rosenfeld and Thomas (2012). I use the new dataset HCMST 2017 (N=3,510) and employ the two separate logistic regression models from Rosenfeld and Thomas (2012). Met through Family and Met Online are not mutually exclusive and overlap (N=12). I only consider respondents above age 19 years and control for the same variables as in the original models in Rosenfeld and Thomas (2012).

The Rosenfeld and Thomas's (2012) model estimates that same-sex couples are 2.8 times more likely than heterosexual couples to meet online. This is slightly lower than the adjusted odds ratio 2.93x from the original study. The odds of meeting through family are 0.5 times as high for same sex couples compared to heterosexual couples. This is higher than the adjusted odds ratio 0.19x from the original study. In the next section, I report my results with reference to these replicated results from Rosenfeld and Thomas (2012). Any differences between the two results are thus driven by different econometric methods — not difference in datasets or changes with time.

The Replacement of Friends with Wi-Fi

The results confirm the intuitive belief that the internet has penetrated into the dating market. Exhibit 8 plots the absolute probabilities for the four outcomes, as a function of the year that the couple met.[6] It shows that the probability of meeting online

[6] Absolute probabilities are estimated through the multinomial logistic regression model. Predictive margins and contrasted predicted margins are quantified for the relevant independent variables.

has been on a monotonic incline since the dawn of the internet era (1996). If no information was known about a random couple "RC," *except* that they met after the year 2015, there is a 33% chance that the couple met online. Couples were coded as "Met Online" only if they had absolutely no overlap of social circles: they were not college friends who matched on Tinder or coworkers who started chatting on Facebook. There is a 1 in 3 chance that couples formed after 2015 met as strangers online.

Exhibit 9 plots the difference between the absolute probabilities predicted for each time period and the predicted probabilities for couples who met before the internet era (1996). Since the probability of meeting online before 1996 was 0%, Exhibit 9 shows a 33% point increase in absolute probability for couples who met after 2015. The striking result is that couples who met after 2015 are 25% points less likely to have met through social circle, compared to couples who met before the internet era.

Exhibit 9 also shows that the probability a couple Met in Public or Met at Institution has remained low and stable. Couples who met after 2015 are only a modest 5% points and 2.5% points less likely to have met in these ways, when compared to couples who met before the internet era. These minor fluctuations across the years are not noteworthy and estimates do not suggest any trends.

Popularity of Online Dating with Same-Sex Couples

If no information was known about a random couple "RC," *except* that they met after the year 2015, results showed that there is a 1 in 3 chance they met online. If it is known that the same couple RC is a lesbian couple, there is now a 50% chance that the couple met online (Exhibit 10). If that same couple RC is instead a gay male couple, there is a striking 63% chance that the couple met online (Exhibit 12). Exhibits 10 and 12 plot

the absolute probabilities as a function of the year that couples met, for lesbian and gay male couples respectively.

Exhibits 11 and 13 show that the drop in popularity of social circles as dating venue is even more pronounced for same-sex couples. They plot the difference between the absolute probabilities predicted for each time period, and the predicted probabilities for couples who met before the internet era (1996), for lesbian and gay male couples respectively. Both lesbian and gay male couples who met after 2015 are 35% points less likely to have met through social circle, as compared to their counterparts who met before the internet.

Exhibit 14 reports risk-relative-ratios of the three outcomes (Met in Public, Met at Institution, and Met Online). Probabilities are thus interpreted as relative to those for the base outcome (Met through Social Circle). Exhibit 14 shows that gay male couples are 7.8 times more likely and lesbian couples are 3.7 times more likely to have met online as opposed to heterosexual couples.

Both these estimates are higher than the 2.8x that was predicted by the Rosenfeld and Thomas (2012) separate logistic model for all same-sex couples. This is despite removing all instances of overlap between dating venues, such that the four outcomes for How Couple Met were mutually-exclusive. My model is more demanding and removes the complementary effects of the internet; so theoretically, results from my model should be lower than those from the original model. This discrepancy suggests that the higher relative probabilities in my multinomial logistic model are boosted by the decline in the probability of meeting through social circle. I capture the pure displacement effect of the internet — the replacement of social circle with Wi-Fi.

IX. ROBUSTNESS CHECK

The main model in this paper uses multinomial logistic regression, selecting "Met through Social Circle" as the base outcome category. Probabilities for the likelihood of a same-sex couple meeting online were reported relative to the probability of meeting through social circle. To check the robustness of the findings reported in Exhibit 14, I run two other multinomial logistic regressions with "Met in Public" and "Met at Institution" selected as the base outcomes.

Exhibit 15 shows that I did not find evidence to suggest that gay male couples are more likely to meet online as opposed to in public or at an institution. Results show that lesbian couples more 5.3 times more likely to meet online as opposed to meet as strangers in public. This risk-relative-ratio (rrr) is higher than the rrr compared to "met through social circle". Meeting online continues to be the preferred method of meeting for both gay male and lesbian couples.

X. MATCH QUALITY

To test whether the quality of matches differs across dating venues, I ran a difference in means in testing for "Relationship Quality" and "Difference in Educational Attainment." Relationship quality is self-report on a scale of 1-5, with 5 being "excellent." The variable "difference in educational attainment" was calculated as the difference in years of formal schooling between subject and partner. Difference in means are reported by group: couples who met online versus those who did not, and couples who met through social circle compared to those who did not.

Exhibit 16 illustrates that I do not find any evidence for difference in means in both these tests. The mean for relationship quality is lower for couples who met online and significant at the 10% level. However, this difference is very low at only 0.07 quality points. Recent studies have shown that meeting online "predicts faster transitions for heterosexual couples" (Rosenfeld, 2017, p.490) and that couples who met online had a slightly lower probability of breaking up (Cacioppo et al, 2013)

XI. DISCUSSION

The results show that the internet is displacing social circle as a dating venue. The monotonic decline of Met through Social Circle since the internet era almost perfectly mirrors the monotonic rise of Met Online. The striking result is that couples who met after 2015 are 25% points less likely to have met through social circle, compared to couples who met before the internet era. This shows that the increasing popularity of the internet as a dating venue is antithetical to social circles as a dating venue — hence, the internet's impact is substitutionary.

The probability that a couple met as strangers in public or at institution has remained low and stable in the last two decades. There are some minor fluctuations across the years but estimates do not suggest any trends or marked decline. The results suggest that hoping to mate with strangers at random venues is reliably a disappointing and low-probability strategy. Furthermore, it indicates that the rise of internet as a dating intermediary has not displaced these venues. The results from the robust checks confirm this, since I find no conclusive evidence that couples are more likely to have met online as opposed to through these two dating venues.

The model also predicted relative-risk-ratios that were significantly higher than the Rosenfeld and Thomas (2012) ratios – even though this model is more rigorous. This discrepancy suggests that the higher relative probabilities in my multinomial logistic model are boosted by the decline in the probability of meeting through social circle.

In the economic literature analyzing frictional markets (Burdett and Coles, 1997; Adachi, 2003; Chade, Eeckhout, and Smith, 2015), there is a consensus that the efficient Gale-Shapley algorithm becomes an increasingly better predictor for stable matchings as

search frictions approach zero (Adachi, 2003). The corollary is that non-competitive markets (in which the assumptions stated before do not hold) result in sub-optimal matchings. In other words — people settle for "good enough" when it comes to love; some more than others.

However, individuals are utility-maximizers, and will rationally seek out venues that reduce search frictions and other market inefficiencies. Earlier in the text, I expected that individuals will switch to or adopt those dating venues that lower their search costs. This hypothesis is confirmed by my finding that the displacement effect of the internet on social circles is even more pronounced among same-sex couples. Both lesbian and gay male couples who met after 2015 are 35% points less likely to have met through social circle, as compared to counterparts who met before the internet era.

The value proposition of the internet is that it aggregates broad but shallow markets. The dating market for LGBTQ individuals is broad, because gays are sparsely distributed across various social circles – even if they are geographically concentrated in San Francisco. The market is also shallow, because as discussed only 4.5% of American adults identify as queer. Hence, the internet aggregates participants in the market and "thickens" it such that Becker (1991)'s assumption of "large number of participants" holds true. Thus, the appeal of the internet is that it makes the dating market more efficient – which is why the alleged "apocalypse" has already begun.

XII. EXHIBITS

Exhibit 1: Coding Scheme for Dependent Variable: How Couple Met

A. Srikanth (2019) versus Rosenfeld and Thomas (2012)

Dependent Variable Coding	VENUE TYPE			
	Random	**Institution**	**Social Circle**	**Online**
How Couple Met (Srikanth 2019)				
Met in Public (as strangers)	✓	X	X	X
Met at Institution (as strangers)	X	✓	X	X
Met through Social Circle	O	O	✓	O
Met Online (as strangers)	O	O	X	✓
Rosenfeld and Thomas (2012)				
Met Online	O	O	O	✓

✓ Must have met this way
X Must not have met this way
O Could have also met this way

B. Definitions of Venue Type

VENUE TYPE			
Random	**Institution**	**Social Circle**	**Online**
Public	School	Singles Event (Non-internet)	Met Through The Internet
Vacation	College	Set Up On Blind Date	
Bar/Restaurant	Military	Coworkers	
Volunteering Organization	Church	Family *(and intermediaries)*	
Business Trip		Friend *(and intermediaries)*	
Customer-client		Neighbors *(and intermediaries)*	
Party		Respondent or Partner's Past Significant Other	
Worked In The Same Neighborhood		*Intermediaries:* Past Significant Others	

Exhibit 2: Partnership Status by Couple Type

	N	%	Column %	Row %
Heterosexual Couple				
Married	1835	60	66	96
Partnered, not married	567	19	20	82
Unpartnered, has had past partner	379	12	14	83
Total	*2781*	*91*	*100*	*91*
Gay Male Couple				
Married	39	1	23	2
Partnered, not married	72	2	43	10
Unpartnered, has had past partner	55	2	33	12
Total	*166*	*5*	*100*	*5*
Lesbian Couple				
Married	31	1	28	2
Partnered, not married	56	2	51	8
Unpartnered, has had past partner	22	1	20	5
Total	*109*	*4*	*100*	*4*
Total Sample				
Married	1905	62	62	100
Partnered, not married	695	23	23	100
Unpartnered, has had past partner	456	15	15	100
Total	*3056*	*100*	*100*	*100*

Exhibit 3: How Couple Met by Couple Type

	N	%	Column %	Row %
Heterosexual Couple				
Met in Public (as strangers)	394	12.89	14.17	86.98
Met at Institution (as strangers)	459	15.02	16.50	97.25
Met through Social Circle	1659	54.29	59.65	93.57
Met Online (as strangers)	269	8.80	9.67	75.14
Total	*2781*	*91*	*100*	*91*
Gay Male Couple				
Met in Public (as strangers)	43	1.41	25.90	9.49
Met at Institution (as strangers)	6	0.20	3.61	1.27
Met through Social Circle	58	1.90	34.94	3.27
Met Online (as strangers)	59	1.93	35.54	16.48
Total	*166*	*5.43*	*100*	*5.43*
Lesbian Couple				
Met in Public (as strangers)	16	0.52	14.68	3.53
Met at Institution (as strangers)	7	0.23	6.42	1.48
Met through Social Circle	56	1.83	51.38	3.16
Met Online (as strangers)	30	0.98	27.52	8.38
Total	*109*	*3.57*	*100*	*3.57*
Total Sample				
Met in Public (as strangers)	453	14.82	14.82	100
Met at Institution (as strangers)	472	15.45	15.45	100
Met through Social Circle	1773	58.02	58.02	100
Met Online (as strangers)	358	11.71	11.71	100
Total	*3056*	*100*	*100*	*100*

Exhibit 4: Year When Met by Couple Type

	N	%	Column %	Row %
Heterosexual Couple				
Before 1996	1353	44	49	95
1996 to 2005	535	18	19	90
2006 to 2009	287	9	10	89
2010 to 2012	204	7	7	86
2013 to 2015	232	8	8	84
After 2015	170	6	6	81
Total	*2781*	*91*	*100*	*91*
Gay Male Couple				
Before 1996	40	1	24	3
1996 to 2005	42	1	25	7
2006 to 2009	18	1	11	6
2010 to 2012	19	1	11	8
2013 to 2015	25	1	15	9
After 2015	22	1	13	11
Total	*166*	*5*	*100*	*5*
Lesbian Couple				
Before 1996	24	1	22	2
1996 to 2005	20	1	18	3
2006 to 2009	16	1	15	5
2010 to 2012	13	0	12	6
2013 to 2015	19	1	17	7
After 2015	17	1	16	8
Total	*109*	*4*	*100*	*4*
Total Sample				
Before 1996	1417	46	46	100
1996 to 2005	597	20	20	100
2006 to 2009	321	11	11	100
2010 to 2012	236	8	8	100
2013 to 2015	276	9	9	100
After 2015	209	7	7	100
Total	*3056*	*100*	*100*	*100*

Exhibit 5: Age When Met by Couple Type

	N	%	Column %	Row %
Heterosexual Couple				
0-17 years	572	19	21	97
18-22 years	790	26	28	95
23-29 years	631	21	23	90
30-39 years	417	14	15	84
Over 40 years	371	12	13	84
Total	*2781*	*91*	*100*	*91*
Gay Male Couple				
0-17 years	6	0	4	1
18-22 years	21	1	13	3
23-29 years	40	1	24	6
30-39 years	46	2	28	9
Over 40 years	53	2	32	12
Total	*166*	*5*	*100*	*5*
Lesbian Couple				
0-17 years	9	0	8	2
18-22 years	24	1	22	3
23-29 years	27	1	25	4
30-39 years	31	1	28	6
Over 40 years	18	1	17	4
Total	*109*	*4*	*100*	*4*
Total Sample				
0-17 years	587	19	19	100
18-22 years	835	27	27	100
23-29 years	698	23	23	100
30-39 years	494	16	16	100
Over 40 years	442	14	14	100
Total	*3056*	*100*	*100*	*100*

Exhibit 6: Religious Attendance by Couple Type

	N	%	Column %	Row %
Heterosexual Couple				
Absent or Infrequent	1750	57.26	62.93	88.16
Frequent	1031	33.74	37.07	96.27
Total	2781	91	100	91
Gay Male Couple				
Absent or Infrequent	146	4.78	87.95	7.36
Frequent	20	0.65	12.05	1.87
Total	166	5.43	100	5.43
Lesbian Couple				
Absent or Infrequent	89	2.91	81.65	4.48
Frequent	20	0.65	18.35	1.87
Total	109	3.57	100	3.57
Total Sample				
Absent or Infrequent	1985	64.95	64.95	100
Frequent	1071	35.05	35.05	100
Total	*3056*	*100*	*100*	*100*

Exhibit 7: Replication Results from Rosenfeld and Thomas (2012)

A. Adjusted Odds Ratio for "Met Online" using Logit Model

Met Online N=1051	**Adjusted Odds Ratio**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
Same-Sex Couple	2.798785***	.5107843	5.64	0.000	1.957147	4.002356
Internet Access at Home	1.048821	.086952	0.57	0.565	.8915235	1.233871
Respondent's Age	1.017819***	.0052589	3.42	0.001	1.007564	1.028179
How Long Ago (within 10 years) the couple first met	.8720479***	.0199386	-5.99	0.000	.8338317	.9120157
Constant	.3262624***	.0729283	-5.01	0.000	.2105236	.5056305

B. Adjusted Odds Ratio for "Met through Family" using Logit Model

Met through Family N=3237	**Adjusted Odds Ratio**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
Same-Sex Couple	.5473251**	.1319845	-2.50	0.012	.3411793	.8780275
Respondent's Age	.9901962*	.0052366	-1.86	0.062	.9799857	1.000513
Year When Couple Met	.9730564***	.0048335	-5.50	0.000	.963629	.9825761
Constant	1.16e+23***	1.18e+24	5.26	0.000	2.91e+14	4.65e+31

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

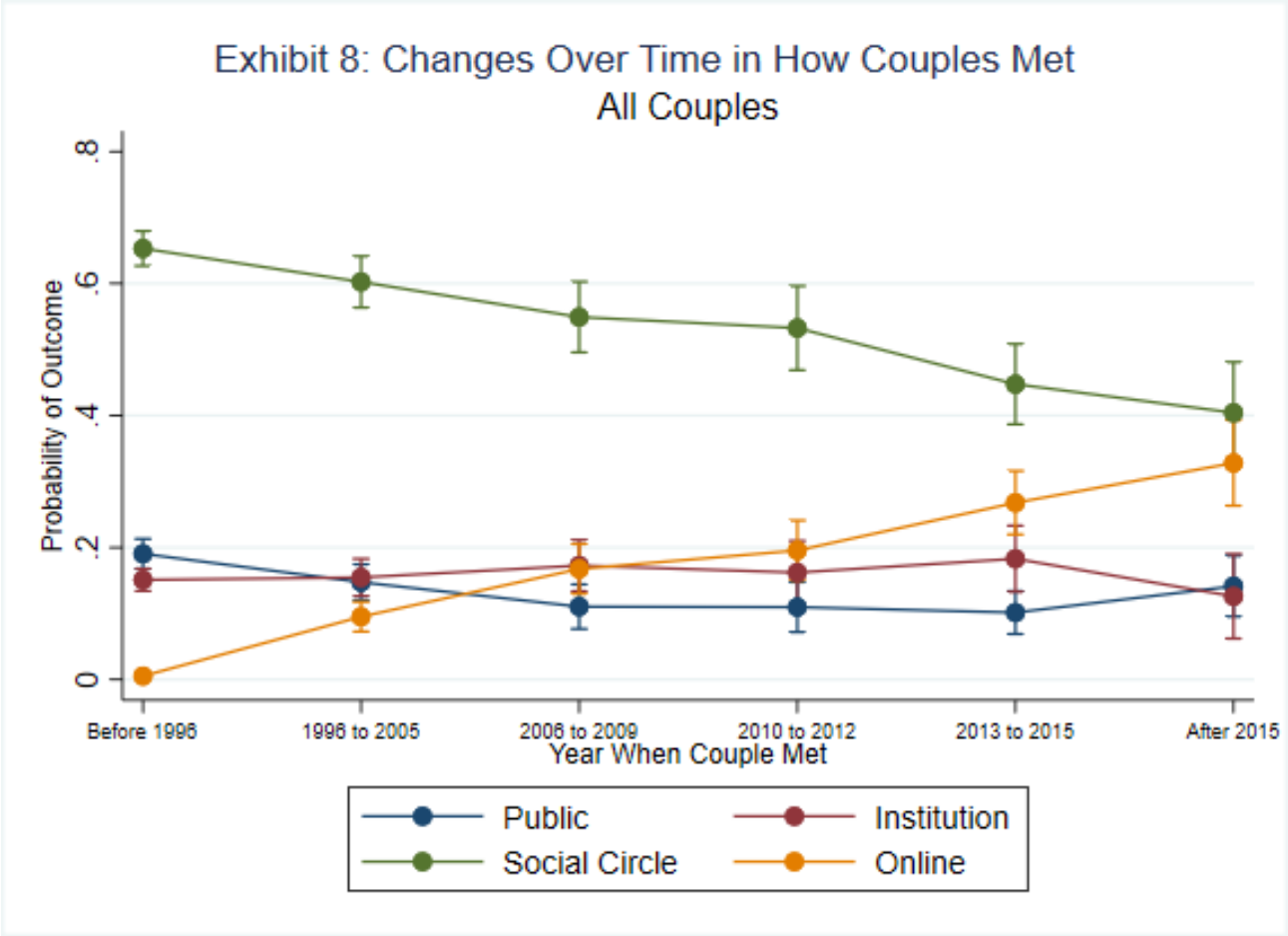
Exhibit 8: Changes Over Time in How Couples Met
All Couples
Probability of Outcome
0
.2
.4
.6
.8
Before 1996
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

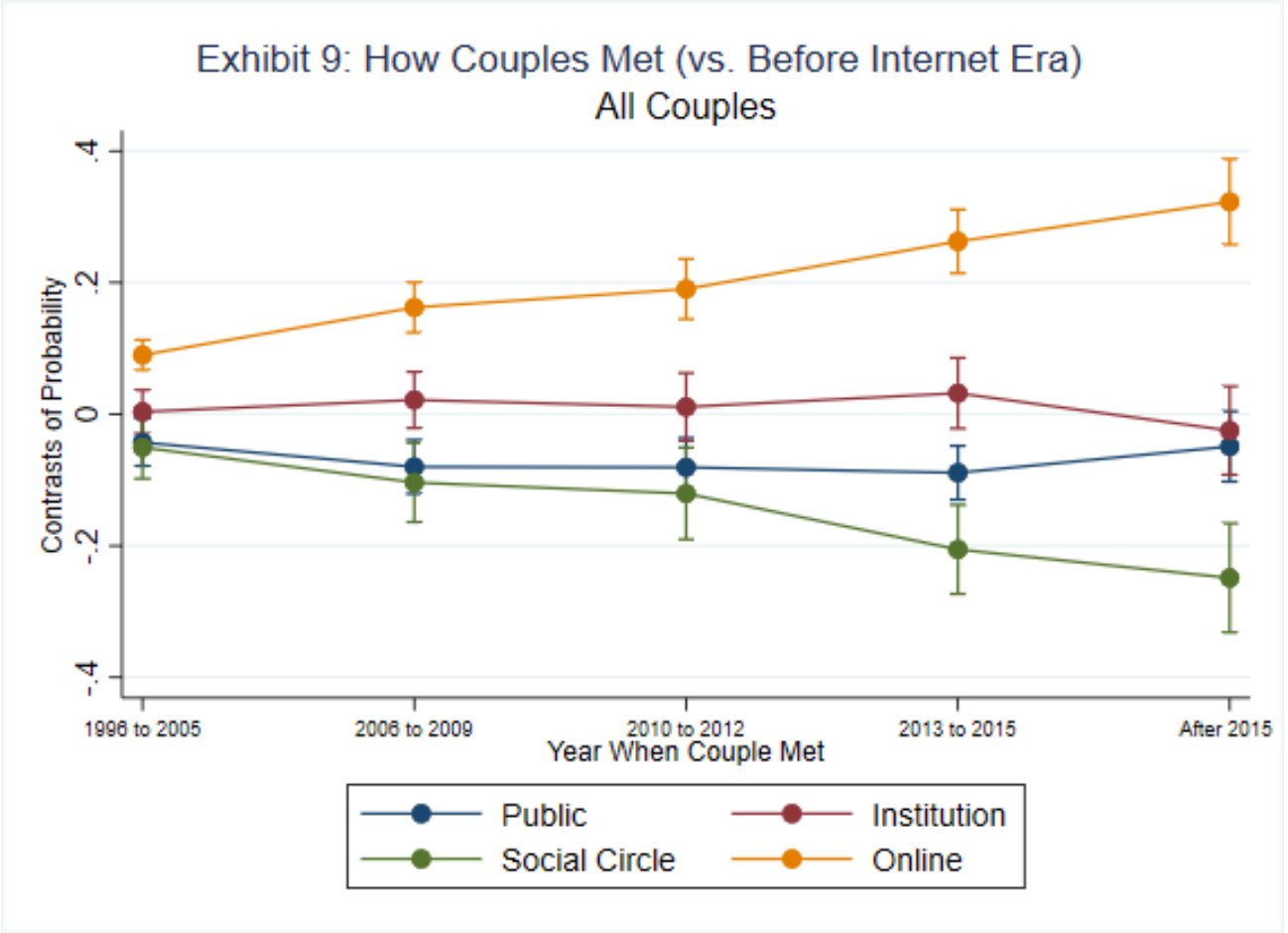
Exhibit 9: How Couples Met (vs. Before Internet Era)
All Couples
Contrasts of Probability
.4
.2
0
-.2
-.4
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

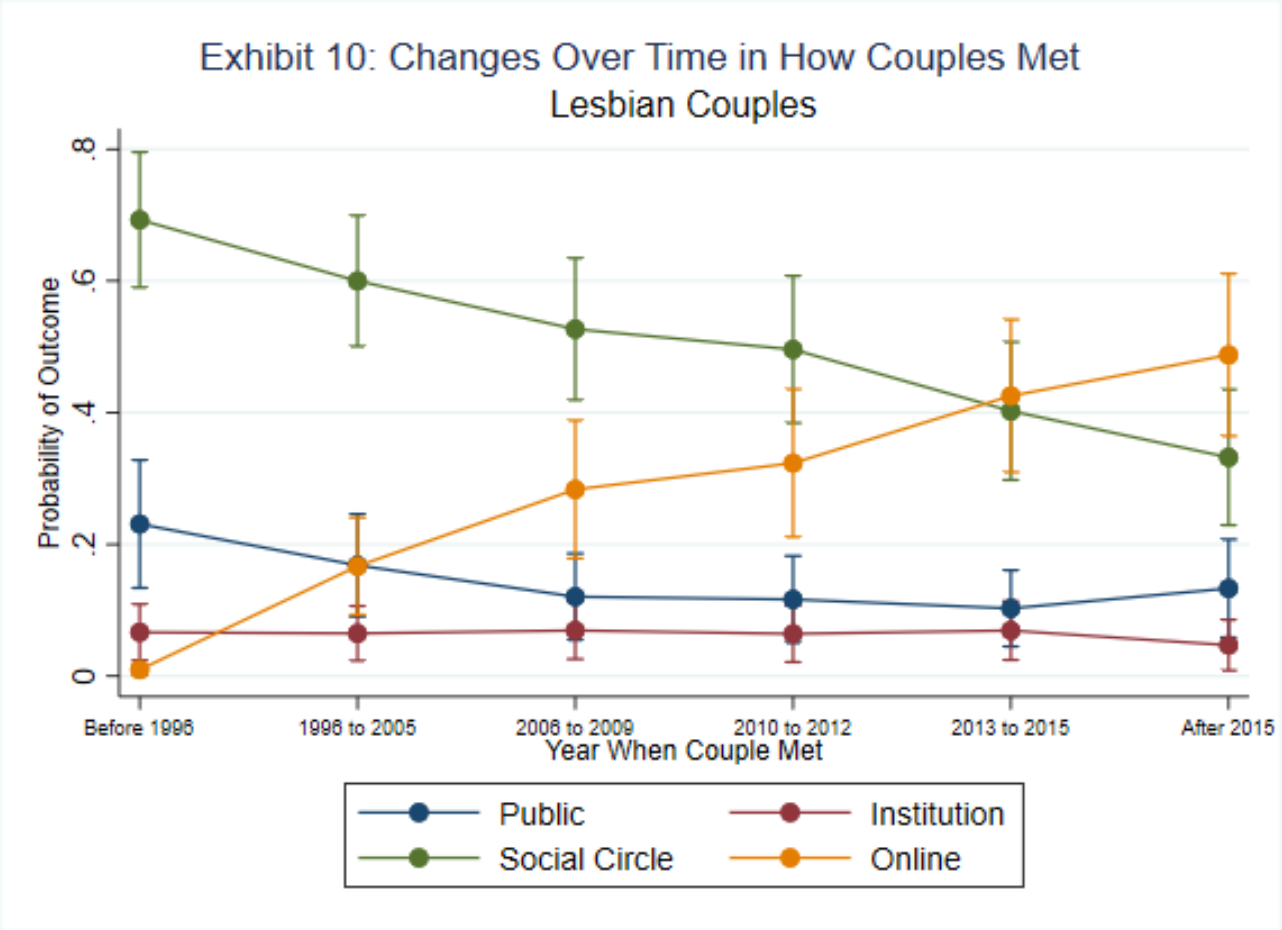
Exhibit 10: Changes Over Time in How Couples Met
Lesbian Couples
Probability of Outcome
0
.2
.4
.6
.8
Before 1996
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

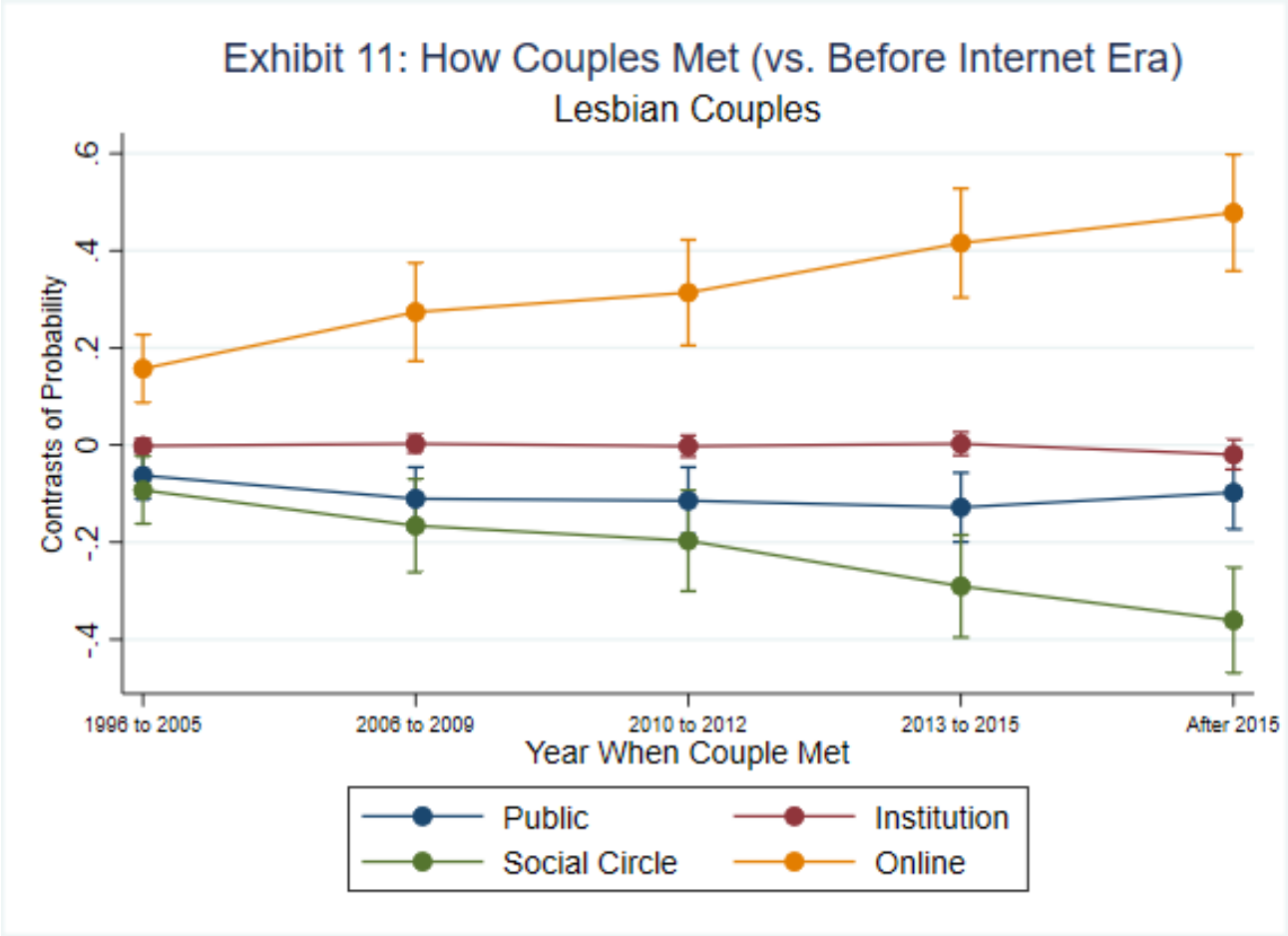
Exhibit 11: How Couples Met (vs. Before Internet Era)
Lesbian Couples
Contrasts of Probability
-.4
-.2
0
.2
.4
.6
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

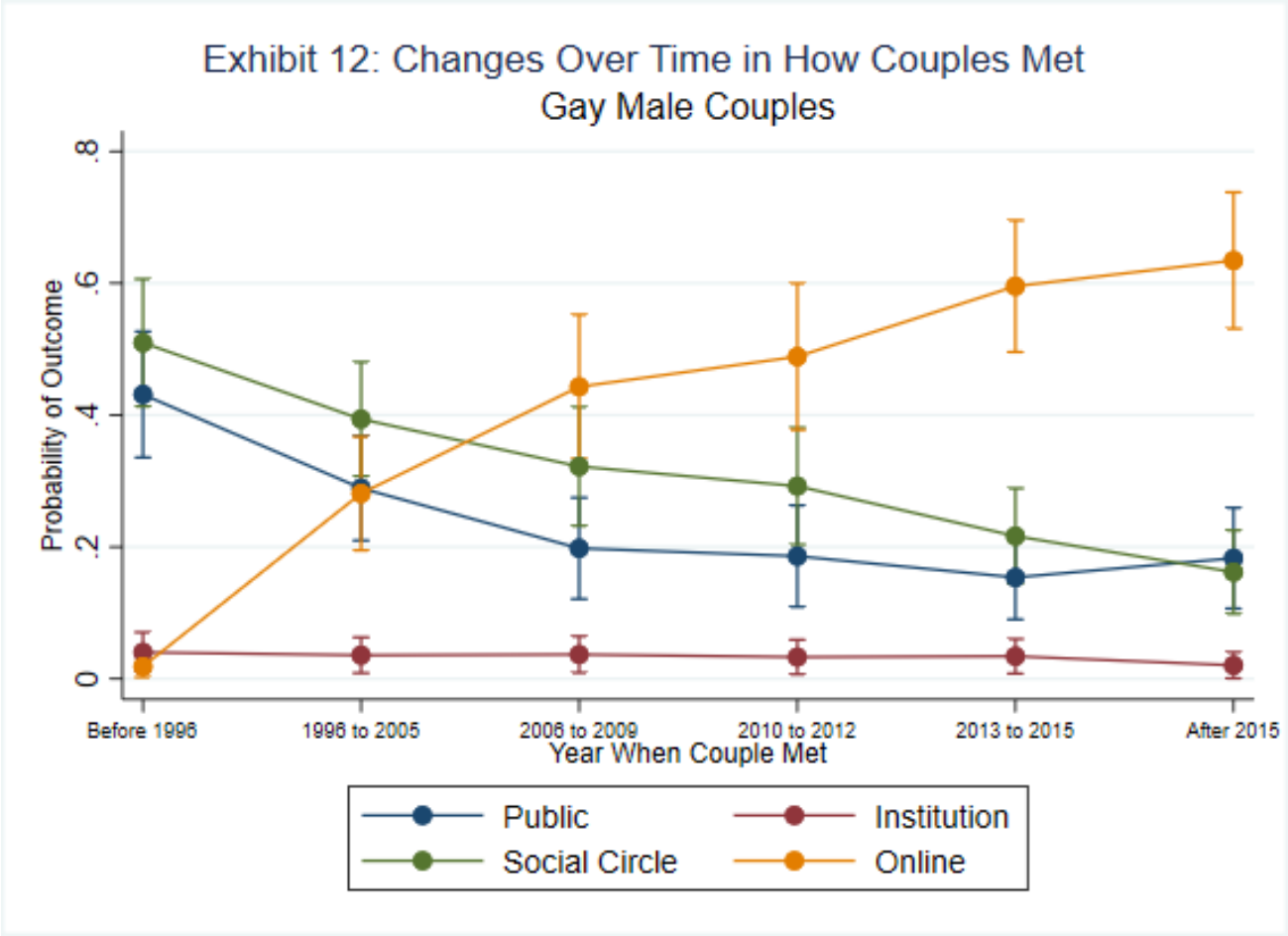
Exhibit 12: Changes Over Time in How Couples Met
Gay Male Couples
Probability of Outcome
0
.2
.4
.6
.8
Before 1996
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

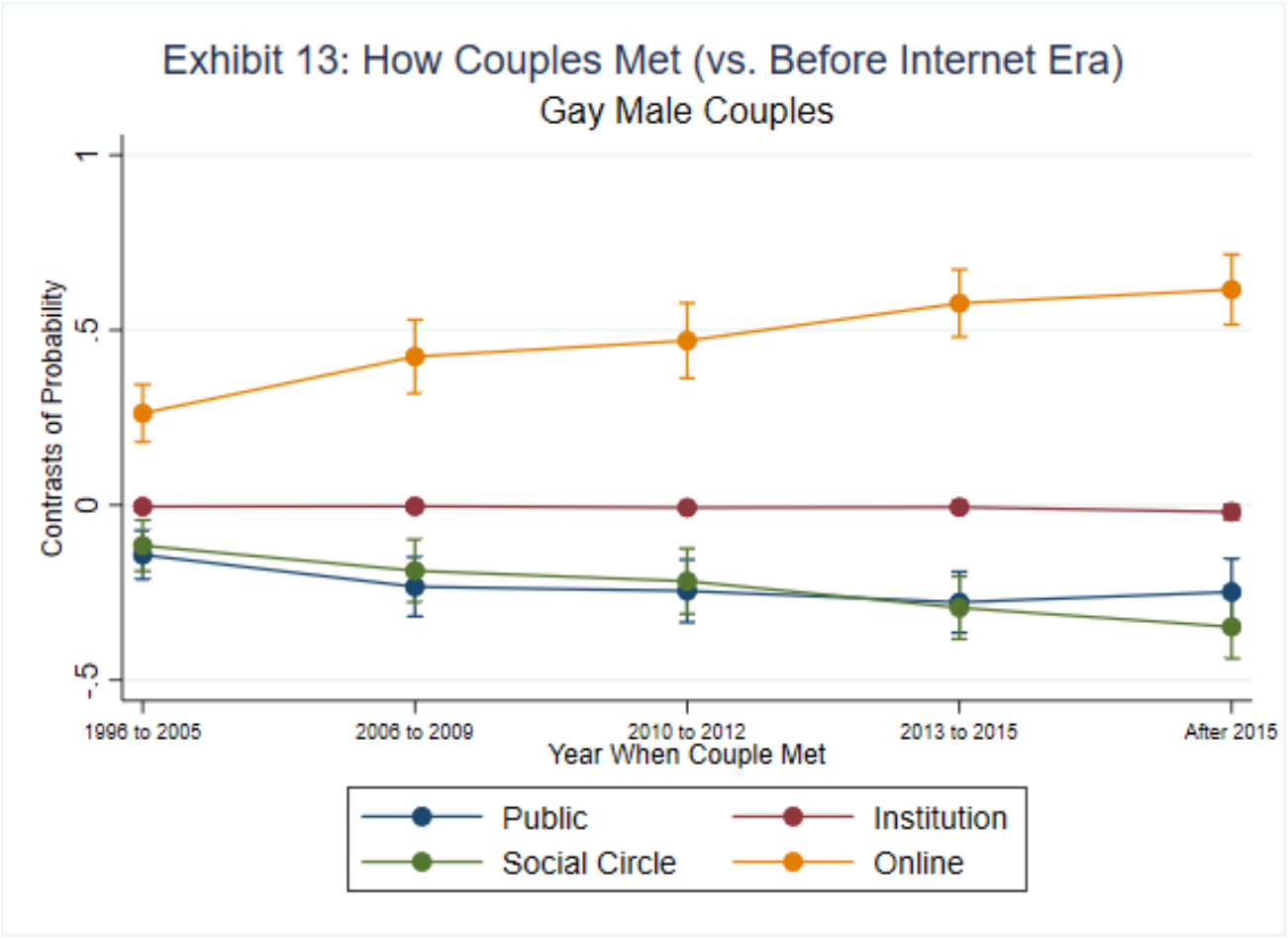
Exhibit 13: How Couples Met (vs. Before Internet Era)
Gay Male Couples
Contrasts of Probability
-.5
0
.5
1
1996 to 2005
2006 to 2009
2010 to 2012
2013 to 2015
After 2015
Year When Couple Met
Public
Institution
Social Circle
Online

Exhibit 14: Risk-Relative-Ratios from Multinomial Logistic Regression

VARIABLES	(1) Met in Public (as strangers)	(2) Met at Institution (as strangers)	(4) Met Online (as strangers)
Same-Sex Couple *(versus heterosexual couple)*			
Gay Male Couple	2.261	2.520	7.788***
	(1.654)	(2.726)	(5.699)
Lesbian Couple	0.696	1.179	3.662*
	(0.593)	(1.499)	(2.838)
Year When Couple Met *(versus before 1996)*			
1996 to 2005	0.852	1.092	20.76***
	(0.127)	(0.165)	(9.116)
2006 to 2009	0.701*	1.342	41.93***
	(0.147)	(0.250)	(18.67)
2010 to 2012	0.729	1.272	51.99***
	(0.171)	(0.296)	(23.48)
2013 to 2015	0.814	1.700**	89.31***
	(0.183)	(0.393)	(39.83)
After 2015	1.345	1.174	132.4***
	(0.329)	(0.433)	(60.93)
Age When Couple Met *(versus 0-17 years)*			
18-22 years	1.556**	0.424***	1.374
	(0.330)	(0.0592)	(0.525)
23-29 years	2.523***	0.184***	2.716***
	(0.533)	(0.0341)	(1.022)
30-39 years	3.572***	0.153***	2.501**
	(0.816)	(0.0384)	(0.977)
Over 40years	6.041***	0.171***	4.596***
	(1.541)	(0.0533)	(1.825)
Respondent's Race: White	0.795	1.160	3.736***
	(0.258)	(0.433)	(1.891)
Household Income	1.007	1.015	0.986
	(0.0139)	(0.0148)	(0.0165)
Respondent's Education	1.015	1.124	1.616***

	(0.115)	(0.134)	(0.255)
Partner's Education	1.009	0.954	1.389***
	(0.0906)	(0.0895)	(0.170)
Daily Internet Use	0.737**	0.786	1.040
	(0.105)	(0.123)	(0.216)
Married More Than Once	4.676***	2.197*	7.492**
	(2.221)	(1.006)	(6.090)
Frequent Religious Attendance	0.903	1.392***	0.741
	(0.125)	(0.168)	(0.137)
Respondent Grew Up In Same City As Partner	0.963	1.391**	0.350***
	(0.143)	(0.178)	(0.103)
Constant	0.220***	0.241***	0.000313***
	(0.0975)	(0.117)	(0.000258)
Observations	3,056	3,056	3,056

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes to Exhibit 14: The multinomial logistic regression model was run with interaction controls, acknowledging that variables such as religious attendance, education, age when met, and race, have different effects depending on Couple Type – heterosexual couple, gay male couple, lesbian couple.

The interaction controls are as follows: Respondent's Education * Partner's Education, Married More Than Once * Age When Met, Married More Than Once * Frequent Religious Attendance, Number Of Marriages * Couple Type, Age When Couple Met * Couple Type, Frequent Religious Attendance * Couple Type, Frequent Religious Attendance * Couple Type * Age When Couple Met, Respondent's Education * Couple Type, Respondent's Education * Respondent's Race, Respondent Grew Up In Same City As Partner * Couple Type.

Exhibit 15: Robustness Check: Risk-relative-ratios for "Met Online" using alternative "Base Outcome" for Multinomial Logistic Model

	Multinomial Logit Model with "Base Outcome" selected as:		*Main Model with Base Outcome:*
VARIABLES	(1) Met in Public (as strangers)	(2) Met at Institution (as strangers)	(3) Met through Social Circle
Same-Sex Couple *(versus heterosexual couple)*			
Gay Male Couple	3.445	3.090	7.788***
	(3.037)	(3.695)	(5.699)
Lesbian Couple	5.259*	3.107	3.662*
	(5.179)	(4.293)	(2.838)
Observations	3,056	3,056	3,056

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Exhibit 16: Match Quality – Difference in Means Testing

	Difference in Mean	t-value
Quality of Relationship		
Other vs. Met Online (as strangers)	.077*	1.70
Other vs. Met through Social Circle	(.002)	(0.09)
Difference in Educational Attainment		
Other vs. Met Online (as strangers)	.062	0.44
Other vs. Met through Social Circle	(.049)	(0.54)

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