# Did Craigslist's Erotic Services Reduce Female Homicide and Rape?*

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## Abstract

Sex workers have historically faced harm from clients. However, sex workers have claimed that Internet platforms, such as Craigslist erotic services (ERS), reduced that violence. Using the staggered rollout of ERS for identification, we find that it is likely that ERS reduced female homicides by between 12 and 18 percent and (reported) female rape offenses by between 7 and 9 percent. We hypothesize that this was due to more transactions occurring indoors, better screening efforts, and more efficient matching. Our results suggest that some Internet platforms may mitigate the historical risks sex workers have faced.

*Keywords*: Public health and safety, two-sided matching, black markets, platforms, gender, sex work.

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# I Introduction

Illegal sex work has historically been dangerous in the United States because of the frequency of violence from clients. While it is challenging to establish the exact number of sex workers in the United States, a common claim is that the number of yearly full-time female sex workers is 23 per 100,000 (Potterat et al. 1990). Potterat et al. (2004) estimate that the workplace homicide rate for female sex workers is 204 per 100,000 person-years.[1] Outdoor solicitation (i.e., street sex work) has historically been considered the most dangerous market segment for sex work with a death by homicide rate over 13 times higher than the general population (Lowman and Fraser 1995; Church et al. 2001; Potterat et al. 2004).[2]

The emergence of the Internet, coupled with the 1996 Communications Decency Act (CDA), set into motion a series of events that altered illicit sex services markets (Leary 2018). The Internet impacted most markets by allowing the creation of a myriad of institutions and technology-mediated practices that reduced search costs and facilitated more efficient matching (Brynjolfsson and Smith 2000; Brynjolfsson, Hu and Simester 2011). In the United States, these platforms were protected by the CDA against liability for content posted by those who used the platform. Of particular importance was the emergence of centralized online clearinghouses for classified advertising (e.g., Craigslist) and searchable review databases (e.g., Yelp). Because the CDA protected all internet platforms, some sites (such as Backpage, Craigslist, and The Erotic Review) emerged to coordinate the transactions for illegal sex work (Cunningham and Kendall 2011a, 2016). The use of these platforms for coordinating sex work transactions led to considerable debate and controversy. Some observers claimed the use of these platforms made the underground market safer (Bass 2015a,b), while others argued the opposite (Hughes 2004). Until this study, little evidence has been available about the causal effects of these platforms on illicit sex markets.

In general, labor market clearinghouses improve markets through market thickening, reduced search costs, and safer market participation (Roth 2008). Assuming that sex markets react similarly to legal markets,[3] and due to the high level of historical violence in sex markets, a thickening of the market would increase the number of transactions and, hence, increase potential violence. However, this might not be the case if additional structural reorganization accompanies the thickening. In the context of sex work, online clearinghouses have the potential to improve safety by redirecting exchange through the clearinghouse and replacing more risky outdoor face-to-face transactions with indoor, direct transactions, and an associated reduction in the use of other intermediaries (e.g., pimps) (Bass 2015a,b).[4] Matching online through a clearinghouse enables both sides of the market to more easily discern the quality of the match *ex-ante.* This occurs via activities such as better screening, for instance, by sex workers circulating black and white lists, or a client accessing online reviews (Cunningham and Kendall 2011b; Grant 2009).[5] This may provide the ability for sex workers to identify and screen out violent clients, law enforcement, and scammers. We seek to better understand this complex phenomenon by investigating the research question: *What were the impacts of online clearinghouses on female safety through the reshaping of illegal sex work markets?*

We investigate the impact of the introduction of an online clearinghouse on female safety using the staggered rollout of ERS around the US using a difference-in-differences (DD) design as well as matrix completion. Legal sex workers, such as private dancers, were the first users of ERS, which was open from 2002 to 2010, but advertisements by illegal sex workers openly soliciting clients quickly became the nearly exclusive content. ERS was not an original feature of Craigslist, but was added to the platform later as one of a bundle of 14 unrelated "services" sections of the website (e.g., legal, events, lessons, financial, real estate). The ERS rollout was geographically

staggered over time. We use the date of inclusion of ERS on the Craigslist front page for each geographical area to identify the causal effect of ERS on violence against females.

We provide some evidence that the introduction of the Craigslist ERS thickened the internet-mediated market. Specifically, reviews at The Erotic Review (the dominant platform for sex worker reviews) increased by 51 percent after the introduction of ERS. In addition to increasing the size of the online market, the introduction of ERS caused additional structural changes, evidenced by an increase in the use of Craigslist emails and a shift in the composition of the online market channel from predominantly agency-based, intermediary transactions to independent, direct transactions. Most importantly, we find evidence that ERS significantly reduced female homicide rates by as much as 11 to 17 percent and reported rape rates by 6 to 7 percent. We do not find evidence that this was driven by a more general reduction in crime, as ERS is unrelated to male murders, manslaughters, and violent property crimes like burglary. This strengthens our assessment that it is likely that ERS-driven changes in sex markets were the primary driver of the reduction in female murders and reported forcible female rape offenses.

We propose three mechanisms that may help to explain our results. First, because matches occur online and at arm's length, ERS may have enabled sex workers to perform more screening, such as using references or background checks when seeing new clients. Increased screening means that new clients should be of lower risk vis-a-vis new clients pre-ERS. Additionally, online screening creates a digital trail that could deter some violent clients. Therefore, additional safety provided by screening might lead to switching from high- to low-risk new client matches. Second, and in contrast, it is possible that as the size of the market expands, providers might develop cohorts of regular clients that are lower risk and provide sufficient income. The establishment of a cohort of known, safe clients would lead to a rise in repeat business and a corresponding reduction

in the need to add new, unknown clients. Third, the introduction of ERS may have allowed for a greater proportion of sex workers to utilize the safer, indoor channel rather than the more dangerous outdoor street-based channel. If so, then we would expect the composition of online sex workers to shift towards the marginal sex worker who would more likely be a former street sex worker. Our results indicate that the decline in female murders can be at least partially explained by more efficient matching, growth in repeat business, and a higher proportion of indoor sex work transactions compared with outdoor sex work transactions, all of which may be buoyed by improved screening technologies.

We organize the remainder of this article as follows. In sections two and three, we discuss CDA, Craigslist's ERS, opposition to the introduction and presence of ERS, as well as our theoretical basis for causal effects. In section four, we describe the four unique data sets used in this study. In section five, we present evidence for the influence of ERS on providers reviewed at The Erotic Review. In section six, we offer evidence of the proposed mechanism that might link ERS to reductions in female homicide and reported rape. In section seven, we report a series of robustness analyses supporting our hypothesis that ERS reduced female homicide and reported rape. In section eight, we explore the mechanisms that might have caused the decline in female homicide and reported rape. Finally, in section nine, we conclude and discuss the implications of our study for market participants and law enforcement in the sex services space.

## II CDA, Craigslist, and Associated Opposition

### A 1996 Communications Decency Act §230

In 1996, Congress passed the Communications Decency Act (CDA), which significantly altered telecommunication law. While Congress' stated goal when enacting the CDA was to create more competitive markets in the telecommunications arena, the impact of the bill was far more

sweeping due to its regulation of internet speech that assigned criminal liability to any person who knowingly used a website or any other form of digital communication to send any communication to a legal minor that depicted or described sexual or excretory activities (Kuzma 2013).

However, in 1997 the Supreme Court *(Reno v. ACLU*) struck down the anti-obscenity portions of the CDA on 1$^{st}$ Amendment grounds. More important to our investigation, §230(c) of the CDA included two relevant subsections. The first stated that "No provider or user of an interactive computer service shall be treated as the publisher or speaker of any information provided by another information content provider." The second point referenced civil liability and stated that "No provider or user of an interactive computer service shall be held liable on account of" content published on the website by third parties.

The implications of §230(c) were far-reaching because, through repeated decisions, courts found that it provided nearly complete civil immunity for websites (Kuzma 2013). Section 230 and its subsequent interpretation clarified that a website, such as Craigslist, that allowed for user-created content was itself neither the publisher nor the speaker with respect to information posted by others on the site. Therefore, it could not be held liable as an editor of the content of third-party specific postings under libel laws or other torts that may be committed by those who post on the site. This protection was an important legal precedent because it resolved considerable uncertainty regarding liabilities. The immunity from liability led to the explosive growth of Internet platforms that allowed for user-created content.

## B Craigslist and ERS

Craigslist (http://www.craigslist.org) is one of the most commonly visited websites in the world.[6] Craigslist is a generic classified-advertising website that facilitates multiple matching markets on a single, consolidated platform. Matching market interactions on the Craigslist

platform include job and resume postings, real estate/rental markets, general goods and services transactions, and dating/personal ads. Craigslist was founded in 1995 in San Francisco, began expansion in 2000, and then accelerated growth across the US between 2004-2010 (Wolf 2009). Craigslist's expansion focused initially on large cities, but by 2010 covered most US cities and, as of 2017, the platform had a presence in over 700 locations, including multiple markets outside of the US.[7]

The impact of Craigslist on markets, both online and offline, was significant. For example, Craigslist's market entry was associated with reduced classified advertising rates, increased subscription prices, and reduced circulation for print newspapers (Seamans and Zhu 2014). Craigslist's entry also led to reduced online traffic and posting fees for multiple job posting websites (Brenčič 2016), reduced real estate vacancy rates (Kroft and Pope 2014), reduced solid waste added to landfills (Fremstad 2017), and increased price dispersion of secondary concert ticket markets (Bennett, Seamans and Zhu 2015). Concerning public health, Craigslist's entry has been associated with increased HIV incidence rates (Chan and Ghose 2014; Greenwood and Agarwal 2016), and an increase in online sex work trends (Chan, Mojumder and Ghose 2019).[8] But the effects of ERS have not been as extensively studied; what little we do know suggests that observed effects of ERS were distinct from the entry of the Craigslist platform. For example, while Craigslist entry is positively associated with HIV incidence, one study found that ERS negatively affected HIV incidence (Chan and Ghose 2014).

Craigslist continuously updated its site after the initial launch, each time without any advertising or announcement forecasting users about the imminent changes. Most of these updates took the form of changes to its front page, including adding new links to augment the professional services section.[9]

The additional services section expanded over time to include 14 services, one of which was ERS. ERS was initially intended to be an advertising channel for legal erotic services, such as private dancing. But almost immediately, illicit sex workers captured ERS to advertise illegal sex services openly. Craigslist continued to provide this controversial service in part because §230 of the CDA protected it from liability.[10]

Although Craigslist does not provide reasons for its decision regarding market entry, many of the characteristics of the markets they entered do not differ on observables. In Appendix Table A.1, we present a simple comparison of socioeconomic covariates for treated versus untreated locations at the monthly level. Specifically, we conduct a monthly-level analysis with a number of observable socioeconomic covariates as outcome variables on a binary treatment variable including Originating Reporting Agency Identifier (ORI)[11] and year fixed effects. The overwhelming majority of the covariates are not statistically different in treated versus control locations. The only statistical differences that we observe are that treatment locations have a population that is approximately 6200 persons larger (approximately 2% of the average population) than control locations. Additionally, treatment locations have 0.6% (0.9% of the mean) lower employment rates, 0.6% (2.3% of the mean) higher high school graduation rates, and 0.4% (1.8% of the mean) lower likelihood of having completed some college. While these are statistically significant differences in socioeconomic covariates, they are not economically meaningful, as the differences are small.[12] This suggests that Craigslist's openings of ERS do not select on observable characteristics except population and distance to San Francisco.

But as the site continued its growth and usage by illicit sex workers, multiple advocacy groups brought pressure on Craigslist to shut it down, using three primary arguments. First, critics argued that Craigslist both facilitated sex work transactions through ERS (Delateur 2016), and made

enforcement more difficult.[13] Second, critics argued that the use of ERS was dangerous for the individuals involved. Several infamous cases in which serial killers and murderers targeted sex workers on Craigslist were used as justification for this assertion.[14] The final argument was based on the widespread belief that online platforms were utilized by human traffickers. Therefore, the growth and importance of online platforms supported the infrastructure of human trafficking networks (Delateur 2016). Craigslist ultimately shut down ERS amid mounting legal pressure from federal and state government agencies (Miller 2010).

However, both law enforcement and sex workers dispute the validity of these points. Law enforcement officials have suggested that shutting down online ERS made law enforcement more, not less, difficult by dispersing trafficking through more clandestine channels (Mehta 2017; Press 2017).[15] Also, some sex workers and journalists have argued that ERS shutdowns made sex work more dangerous (Bass 2014, 2015a).

## III ERS and Market Participant Safety

Illegal sex workers had faced multiple sources of risk, including the risk of arrest, violence from clients and serial killers, and general environmental violence.[16] This high level of risk has led to the emergence of an extensive set of mechanisms (primarily related to screening, the location of solicitation, and the coordination of assignation) that market participants use to increase safety. There are multiple segments in sex work markets, ranging from the primarily higher-priced independent "call girl" to escort agency workers to streetwalking sex workers (Reynolds 1986; Weitzer 2011).[17] Segments differ regarding levels of risk, as well as numerous dimensions such as the quality of the workers, prices charged, services rendered, and the location where services are performed.

Before ERS, sex workers had few ways to identify, screen, and transact with potential clients. An independent worker could advertise in alternative local print publications (e.g., *The Providence Phoenix*), develop their reputation through online "review" websites, such as The Erotic Review[18], or utilize paid online advertising. As an alternative to working independently, escort agencies provided advertising, screening, and matching services at a monetary cost to the worker. Independent and agency-affiliated workers screen potential customers before agreeing to meet. In contrast, a street walker has significantly less opportunity to screen before contracting. This lack of screening ability may lead to a street walker becoming entangled with other illegal intermediaries, such as pimps or drivers. For this reason, so-called "indoor" sex work is typically considered to be less risky than streetwalking (Church et al. 2001; Weitzer 2011).

## IV Description of Data

We investigate the effects of ERS on market participant safety using four datasets. First, we collected the date on which ERS was rolled out in each geographic location using the *Wayback Machine.*[19] Then, by accessing each dedicated geographic area of the Craigslist website, we searched through its history for the first appearance of ERS. The first month in which ERS appeared was considered the first month in which ERS entered a market. Figure 1 shows the number of cities in our dataset around each relative event time.

Our second dataset utilizes reviews from The Erotic Review (TER), which is a reputation website (similar to Yelp.com). TER is one of the largest websites devoted to sex work in the United States (Cunningham and Kendall 2016). Clients use TER to share detailed reviews of sex workers.[20] We use these data to measure whether a sex worker identified themselves as working for an agency vs. working independently, whether the sex worker provided incall services[21], the average hourly price[22], ratings on performance and appearance, and unstructured textual data

provided by reviewers. We collected 344,561 unique reviews of 68,450 unique sex workers reviewed between 1998-2009 from across the United States.[23] Our data contains information on reviews of sex workers from 185 cities in the United States.[24]

Our third dataset is the FBI's Supplemental Homicide Reports (SHR) for 1995-2009. These data contain information on the number of homicides, the gender of the victim and the murderer, the circumstances of the murder, the weapon used, and the relationship between the victim and the murderer (Fox and Swatt 2014).[25] However, Brewer et al. (2006) note that sex worker homicides are grossly under ascertained in the SHR.[26] This appears to be a by-product of how information about the homicide is reported in the SHR. The monthly reporting schedule for participating agencies "requires agencies to report homicides in the month that they are *discovered,* even if that is not the month in which they occurred or if the social context of the homicide is not yet known. Sex worker homicides often go undetected for weeks, months, or years, so the SHR procedures have a built-in bias toward under ascertainment of many sex worker homicides" (Brewer et al. 2006, emphasis added).[27] Thus, we focus on total female homicides for most of our analysis to avoid this biased under ascertainment problem. Our proxy for female safety is the number of female victim homicides per 100,000 population.[28] We also measure three other non-female violent crimes – male homicides, manslaughters, and burglaries – as a falsification exercise. Our final dataset uses a total of 304 cities with a population of at least 100,000 persons.

Finally, we measure reported forcible rape offenses against females, as well as the number of manslaughters and burglaries from the FBI's Summary Uniform Crime Reports Part I files using jurisdiction-level files provided by Chalfin and McCrary (2018). After sample selection decisions based on minimum population levels are made, these data contain information on 286 ORIs. Summary statistics for our data are shown in Table 1.[29]

## V Did Craigslist Affect the Structure of Sex Services Market?

We examine the effect that ERS had on the structure of the sex services market by investigating changes in intermediary composition. We do not observe the universe of sex services because a representative survey or census of sex workers in the United States does not exist. Review websites have been used in previous studies as a proxy (Cunningham and Shah 2018). Therefore, we examine the influence of Craigslist ERS on the structure of the sex services market by examining its effect on reviews posted at The Erotic Review. We have two measures of firm intermediary in The Erotic Review: whether a provider self-identifies as working through an agency vs. identifying that they are independent (e.g., self-employed).

Our identification strategy uses the staggered introduction of ERS in different cities across the US. For some cities, ERS was present on the day Craigslist entered the market, persons cases, 45% were adults. Of those adult missing while in other cities, ERS opened months or even years later. Our approach is similar to the one taken by Kroft and Pope (2014), Seamans and Zhu (2014) and Greenwood and Agarwal (2016), though in each they use the Craigslist platform entry for identification; in contrast, we look at the opening of ERS, similar to Chan, Mojumder and Ghose (2019). Critical to our identification strategy is that both Craigslist's entry into markets, as well as the entry of its ERS section, was *ex-ante* unannounced. Under a variance weighted parallel trends assumption with time-invariant treatment effects, we can identify the variance weighted average treatment on the treated of ERS using "twoway fixed effects" (TWFE) (Goodman-Bacon 2021).[30]

However, although we observe when Craigslist introduced ERS in a market, this does not indicate whether sex workers used the platform for advertising and solicitation. As such, our treatment estimates may simply be intent-to-treat measurements. To investigate whether sex workers used the ERS platform, we examined variation in email addresses of sex workers reviewed

at The Erotic Review. When posting an advertisement, Craigslist creates a temporary pseudonymized Craigslist-specific email address for the poster (e.g., jdst7-5899208383@sale.craigslist.org). If sex workers initiated contact with clients on the Craigslist platform, then it is plausible that clients would record the temporary Craigslist email in their review. The pseudonymized email address provides an additional level of identity protection for the worker at the point of solicitation. Investigation of the TER data shows that there were 129 unique providers whose profile contained a Craigslist email address.[31] We plot the relationship between ERS opening in a market and the use of temporary Craigslist email addresses graphically in the upper left panel of Figure 2.[32] The probability a sex worker had a Craigslist email before the introduction of ERS was zero but increased substantially afterward. Specifically, the use of Craigslist emails on The Erotic Review became more prevalent approximately ten months after the introduction of ERS.

Given the 10 month lag between the introduction of ERS and the use of Craigslist emails on TER, we empirically investigated the impact of ERS using the following linear regression model:

$$(1) Y_{mt} = \delta_1 D_{<10,mt} + \delta_2 D_{\geq 10,mt} + \alpha_m + \alpha_t + \varepsilon_{mt}$$

where $Y$ is the outcome of interest, expressed as a count per 100,000 by market $m$ and month $t$, $D_{<10}$ is a dummy indicating 0-9 months after ERS opened in the market, and $D_{\geq 10}$ is a dummy indicating 10+ months post-entry. Market, ($\alpha_m$) and month-by-year fixed effects (e.g., January 2001 dummy) ($\alpha_t$) are included as controls. The error term is represented with $\varepsilon_{mt}$. All standard errors are clustered at the market level to account for within-market serial correlation. Our model attempts to capture effects for both pre- and post-10-month periods through the inclusion of two staggered treatment indicators.

Results are presented in Table 2. The effect of ERS opening on the probability of a Craigslist email (Table 2, column 1) is statistically significant at the 1-5 percent level. After the $10^{th}$ month, the probability a review contained a Craigslist email had quadrupled over the immediate effect.[33]

We find robust evidence that ERS led to a change in the makeup of the market channels of sex workers reviewed at The Erotic Review. In the first ten months, the probability that a sex worker's profile identified the worker as independent (Table 2, column 2) rose 6.5 percentage points, which is 12 percent of the mean. This effect persisted in the post- 10-month period, as evidenced by the positive and statistically significant 10+ month coefficient. This increase in the probability of a sex worker identifying themselves as an independent worker is associated with a declining probability of agency employment (Table 2, column 3).[34] We suspect that this reversal comes both from agency workers becoming independent and also through the additional benefit of online matching in that it allows women unaffiliated with agencies to more easily work indoors rather than having to match on the street. One can see this change in channel composition in Figure 2. The introduction of ERS into markets had a significant negative effect on the likelihood that sex workers reported being associated with an agency, suggesting that ERS reduced transaction costs (Williamson 2002) or simply led to an introduction of sex workers who were unaffiliated with agencies.[35]

In addition to the variation in the proportions of intermediaries, we investigated changes in the size of the internet-mediated market, specifically the effect that ERS had on total reviews and the total number of providers. These are both aggregate market-level outcomes. To calculate the aggregate number of unique reviews, we summed all reviews at the city/month/year level. To calculate the aggregate number of unique provider profiles, we did the same. As there is often more than one review per provider profile, the count of the number of reviews is larger than provider profiles. Columns 1 and 2 of Table 2 report the results from estimating equation 1. In the first ten

months, we find that the number of unique reviews increased 25 percent over the mean and 51 percent over the mean after ten months. We also find that the number of unique providers increased by 9 percent (by market/month) in the first ten months, but this is not statistically significant. But ERS is associated with a 31% increase in unique provider profiles after ten months.[36]

Insofar as these technologies afforded sex workers the ability to meet clients indoors, then it stands to reason that streetwalker arrests would decline. Cunningham and Kendall (2011a) found that the advent of Internet-mediated sex work caused street sex work arrests to fall using an IV strategy with broadband as an instrument for the growth in online sex work. We conduct a similar type of analysis by regressing male and female arrests onto our two policy dummies. While we cannot say that these arrests correspond to street arrests, Cunningham and Kendall (2011a) note that the vast majority of individuals arrested for sex work in the NIBRS data had been arrested at a "street" location, such as an alley, garage, parking lot, or a literal street corner. Thus, it stands to reason that men and women arrested for sex work are likely arrested at a street location. Table 3 shows results of these regressions. Although all coefficients are negative, only the coefficients on male arrests (column 1) are statistically significant. This suggests Craigslist's introduction of ERS was most strongly felt in the shifting of arrests away from male clients engaged in street solicitation, perhaps because they began substituting towards online solicitation.

These findings illustrate that the introduction of ERS likely changed the illicit sex markets in at least two ways. First, we find suggestive evidence that the online intermediary structure shifted transactions toward independent work and away from intermediaries such as agency work. Second, ERS appeared to thicken the market, resulting in significantly more reviews which may reflect increased transactions initiated online with clients. These two changes could potentially have offsetting effects on female safety, as more transactions increase the number of opportunities for

violence to occur, while the movement online and away from agencies indicates a greater ability of providers to screen and avoid violent clients. Therefore, the impact of ERS on violence is ambiguous, so we investigate this question in the next section.

## VI Did Craigslist Increase Market Participant Safety?

As noted above, sex workers have claimed that their safety increased after ERS opened in their markets (see Bass (2014, 2015a)), but this claim is sometimes disputed (see Delateur (2016)). Knowing whether ERS negatively or positively affected female safety is, therefore, an empirical question. In this section, we examine the effect of ERS on female homicide rates and reported forcible female rape offense rates.[37] Since female homicides and reported female forcible rape offenses are infrequent at the ORI/date level, we estimate equation 1 using both OLS with date and ORI fixed effects (TWFE) and a Poisson two-way fixed effects specification. In Table 4, we show the results of our equation estimate 1 using the TWFE specification (columns 1-3) and using the Poisson specification (columns 4-6). In our OLS model, we estimate the effect of ERS on female murder and reported female rape events per 100,000. Thus, the interpretation of our coefficient is as a marginal effect on the rate, which we have converted into a semi-elasticity, to make it comparable with our Poisson estimates, which we present as semi-elasticities.

### A Impact on Female Homicide and Rape

ERS would have increased violence against women if ERS use was either more dangerous than the alternative, or the growth in the market size resulted in an increase in the incidence of violence. Theoretically, the fact that sex workers voluntarily selected into the Craigslist platform suggests that there was some perceived reduction in cost that potentially included safety (Grant 2009). However, herding could also be a possibility (Banerjee 1992). It is also possible that by thickening

the matching markets themselves, sex work grows in new areas, which may impact various matching markets.[38]

In panel 1, column 1 of Table 4, we report our TWFE results controlling for ORI fixed effects and month-year fixed effects (e.g., August 2000, September 2000, etc.). We find that ERS is associated with a post-10-month reduction of 0.019 female homicides per 100,000. In panel 1, column 2, we include controls for state-year fixed effects (e.g., California in 2000), which forces the estimation to compare treated ORIs to untreated ORIs in the same state-year (Cheng and Hoekstra 2013). This causes the post-10-month coefficient to fall to -0.015 but remains significant at the 5 percent level.

As a robustness check, we also estimate a specification that controls for all aforementioned fixed effects as well as the population associated with a particular ORI. While including additional time-varying controls is standard practice, doing so can introduce biases when estimating with TWFE. Several additional assumptions must hold if we estimate models with time-varying covariates, such as the absence of covariate-specific time trends for the treated group, the absence of covariate-specific trends for the control group, and lastly, homogenous treatment effects (Sant'Anna and Zhao 2020). These are stronger assumptions than we are comfortable making, and since we already control for population by transforming counts into offenses per 100,000 population, our preferred estimates do not control for time-varying controls. But, we present estimates controlling for time varying population in columns 3 and column 6 for the sake of the reader and transparency. Controlling for ORI-level population (panel 1, column 3) reduces the post-10-month coefficient to -0.013, which is significant at the 10 percent level. However, our preferred specification is presented in columns 2 and 5.

In Table 4, panel 1, columns 4-6, we repeat all three specifications using a Poisson fixed effects estimator. These coefficients can be interpreted as semi-elasticities, which is useful for benchmarking our results to the prior literature on the incidence of sex worker homicide among females. We ultimately find effects that are similar in magnitude and precision. We find, using our preferred specification (column 5), the estimated coefficient on the post-10-month lag of ERS is a 13.5% reduction in female homicides.[39] Our 95% confidence interval on our preferred Poisson specification covers -0.004 to -0.266% reduction in female homicides in the 10-months after ERS opens in an area. Including population slightly reduces the magnitude and precision of our estimates. Further, as a robustness check, of our results presented in panel 1, we also estimated our models using vital statistics measures of female homicides. These are presented in Table 5. The signs on the TWFE models are negative but with a p-value of 0.109 for our preferred specification. Poisson models are negative and statistically significant at the 5% level. Magnitudes using Vital Statistics are universally smaller than what is measured using the Supplemental Homicide Report data. Our TWFE model is 5% below the mean, for instance. Our Poisson models show 7.5% marginal effects. While the TWFE model 95% CI covers zero, the Poisson model has a 95% CI from -0.13 to -0.02.

In panel 2 of Table 4, we repeat our analysis to evaluate the effect of ERS on reported forcible female rape offense rates. Three of the six regressions (columns 2, 5, and 6) are statistically significant. The typical effect size is around a 6-7% reduction in female rape offenses. However, as this is not robust across all regression model specifications, we suggest that the result should be considered with a reasonable degree of skepticism.

## B Event Study Analysis

One of the critical identifying assumptions in any DD design is the parallel trends assumption. This assumption is inherently untestable as it requires contrasting the evolution of the treatment group's potential outcomes without the treatment with that of the comparison groups. As we do not observe the treatment group's counterfactual, social scientists often examine the pre-treatment leads in its place. We examine this by estimating the following event study model:

$$(2) Y_{mt} = \sum_{j=-2}^{-6} \gamma_j L_{m,t-j} + \sum_{i=1}^{8} \delta_i D_{m,t+i} + \alpha_t + \alpha_m + \varepsilon_{mt}$$

where $L_{mt}$ is one of five ten-month pre-treatment dummies and one binned pre-50-month dummy, and $D_{mt}$ are seven post-treatment ten-month dummies[40] and one post-70-month dummy.[41] Market, $\alpha_m$, and time, $\alpha_t$, fixed effects are includes as controls.

Sun and Abraham (2021) decompose the population regression coefficients on lead and lag indicators in a dynamic specification when estimated with regression models and show that unless three assumptions hold, the population regression lead and lag coefficients are contaminated by treatment effects from other leads and lags. These necessary identifying assumptions are parallel trends, with no anticipation of the treatment and homogenous treatment profiles. While parallel trends and homogenous treatment effects cannot be directly tested, we do know that no anticipation effects are present in our case because Craigslist did not announce they were refreshing their main page before doing so. This is because Craigslist does no advertising and no communication with markets beforehand. If one can assume parallel trends and homogenous treatment profiles in addition to no anticipation, then the group specific ATT for each lead is equal to zero.

We plot the coefficients on binned relative event time indicators and include 95% confidence intervals in Figures 3 and 4 for easier interpretation given the large number of coefficients. The

effect of ERS on female homicides is a long-term negative effect starting at approximately the tenth month. Importantly, there is no statistical difference between the treatment units and the control units in the pre-treatment period. Coefficient estimates in Figure 3 are nearly zero in three of the five estimates but with relatively large standard errors.[42]

We conducted a similar analysis on reported female rape offenses per 100,000 and also found evidence for a gradual decline. But, unlike homicides, these dynamic treatment effects are less precise, which may explain why the aggregate estimate was imprecise half the time. Coefficient estimates in Figure 4 show slight declines (but insignificant at conventional levels) on the pre-treatment lead indicators, which then fall steeply after treatment as shown in the coefficient on 10 month lags. The effects using our Poisson model are more consistently different from zero, which is also what we found using our primary model with two policy dummies.[43]

Are these magnitudes plausible? It is difficult to answer this question, given that the true incidence of sex worker violence is unknown. Most datasets do not record whether a female victim of a homicide was a sex worker; those that do suffer from severe under ascertainment biases built into the data collection methods. To our knowledge, there is only one study that has attempted to estimate the incidence of sex work homicide as a share of female homicides (Brewer et al. 2006). The authors concluded that 2.7 percent of all female homicides are sex work deaths by clients. But this study has significant limitations. It utilizes limited data only from Chicago, St. Louis, Washington state, North Carolina, the SHR, 33 urban counties for one cross-section, and Colorado Springs. The issue of under ascertainment bias would conceivably hold, and maybe more so, for this select sample. Our confidence interval covers this previous finding, which suggests that this finding is consistent with the limited prior literature.

The data on sex work rapes are even worse, though, due in large part to low levels of reporting. These studies are usually small samples based on convenience-based nonrandom samples which are likely rife with selection bias. But, one study found that 68% of sex workers had been raped while working as a sex worker (Farley and Barkan 1998). This is more likely the case for street-based sex workers than indoor sex workers according to Church et al. (2001). Several studies have found that indoor sex work appeared to cause reductions in rapes (Bisschop, Kastoryano and van der Klaauw 2017; Cunningham and Shah 2018; Ciacci and Sviatschi 2022). To the degree that clients are substituting from street workers, or street workers are substituting indoors, then it is possible rapes may fall, though the mechanism by which this occurs has not yet been established in the literature.



## C Randomization Inference

Under Fisher's sharp null of no unit level treatment effects (Fisher 1935), we can calculate simulated p-values by randomly assigning our treatment profiles repeatedly to units. This hypothesis test provides a reasoned basis for inference without appealing to large sample distributional assumptions, such as normality or asymptotic theorems (Young 2019). Comparative case study approaches to causal inference have also noted the suitability of randomization inference when estimation uncertainty is the result of unknown counter-factuals as opposed to sampling uncertainty (Abadie, Diamond and Hainmueller 2010; Buchmueller, DiNardo and Valletta 2011). This is particularly relevant in our context because our data are all reported homicides by police jurisdictions choosing to submit to the UCR, not merely a sample. For these reasons we implement randomization inference in our analysis.[44]

Our randomization is as follows. Using the exact number of treatment groups, we randomly assign our existing treatment dates to ORIs. By doing this, we are essentially randomizing

*treatment profiles* across panel units. We then estimate the effect of ERS on female homicide rates and forcible reported female rape offense rates conditional on ORI, month-year fixed effects, and state-year fixed effects. We repeat this exercise 1,000 times and save the coefficients on short and long-term exposure to ERS from each regression. We then merge all 1,000 coefficients with the true effect creating a sample of 1,001 observations where each observation is a regression coefficient for short-term exposure and long-term exposure. We find that the estimated effect of -0.015 from a mean of 0.13 female homicides per city-month (11.5 percent reduction) is statistically significant with an approximate p-value of 0.06. This simulated p-value was calculated by dividing the rank of the true effect by 1,001 placebo treatment assignments. We also find that the estimated true effect for rapes (-0.125 and -0.204 on the short- and long-term effects) is statistically significant at the 6% level. We present our results from this analysis in Appendix Table A.4. This result suggests that the decline in female homicides and forcible reported female rape offenses are uniquely associated with the precise structure of actual treatment dates assigned across cities. Something, in other words, is special about the true treatment profiles.

## VII TWFE Bias, Matrix Completion and Falsifications

The prior analysis estimated equation 1 using both TWFE and Poisson estimators. While a popular form of estimation, these estimators are potentially biased if treatment effects evolve over time. Alternative estimators that do not suffer from the same type of bias are worth using to understand the effect of ERS on our main outcomes of interest. In this section we explain the bias of TWFE, an alternative estimator called matrix completion for panel data (Athey et al. 2021), and several falsification exercises.

## A Bias of TWFE

In a simple DD design with only one treatment group and one untreated group, identification of the ATT requires parallel trends in both group's potential outcomes without treatment. Estimation can be done using either sample averages or TWFE as they are equivalent without covariates. But when treatment timing varies across multiple groups, as is the case here, then TWFE is potentially downward biased (Goodman-Bacon 2021). We explain this problem using a basic building block called the 2x2 DD, which we represent here using sample averages:

$$(3)\hat{\delta}_{kU}^{2x2} = \left(\bar{y}_k^{post(k)} - \bar{y}_k^{pre(k)}\right) - \left(\bar{y}_U^{post(k)} - \bar{y}_U^{pre(k)}\right)$$

where *k* is a group of units that share the same treatment date, *U* is a comparison group, and *pre* and *post* are means of the outcome in periods before and after k's treatment date. There are $K^2$ 2x2s and each group will serve as a treatment group and sometimes as a comparison group depending on the 2x2 under consideration. Now consider the Bacon decomposition:

$$(4)\hat{\delta}^{DD} = \sum_{k \neq U} s_{kU}\hat{\delta}_{kU}^{2x2} + \sum_{k \neq U}\sum_{l > k} s_{kl}\left[\mu_{kl}\hat{\delta}_{kl}^{2x2,k} + (1 - \mu_{kl})\hat{\delta}_{lk}^{2x2,l}\right]$$

where $s_{kU}$ and $s_{kl}$ are all non-negative weights summing to one. The first subscript on these weights references the treatment group and the second subscript references the comparison group. These weights are the product of group size and the variance of treatment and the variance of treatment weighs groups at the center of the panel more heavily than others (Goodman-Bacon 2021).

When a DD design is based on differential timing and treatment effects are dynamic, then strict exogeneity is violated and TWFE is biased. Heterogenous treatment effects under differential timing create correlations between group fixed effects and the error term. The problem is that TWFE uses already-treated groups as comparison groups when calculating $\hat{\delta}_{lk}^{2x2,l}$ which introduces

bias if the early treated groups have dynamic treatment effects. Goodman-Bacon (2018) establishes this by substituting potential outcomes into each 2*x*2 term:

$$(5)\ p\ lim\ \hat{\delta}^{DD}_{n\to\infty} = VW\ ATT + VW\ PT - \Delta ATT$$

where *VW ATT* is a variance weighted *ATT*, *VW PT* is a collection of variance weighted parallel trends, and $\Delta ATT$ is the dynamic treatment effect. This decomposition has two possible implications for our analysis. First, it may mean that our estimates are lower bounds since the bias attenuates the magnitude of our DD coefficient. But, it is also possible, depending on the size of $\Delta ATT$, that the estimated coefficient has the wrong sign. The last bias is caused by the mechanics of TWFE, which calculates numerous 2x2 comparisons, some of which compare later treated groups to earlier treated groups. When treatment effects are dynamic, the late to early 2x2s introduce bias caused by their changing treatment effects.

To check the severity of this problem, we use the Bacon decomposition to examine the weights attached to each 2x2 sub-type. Our decomposition is based on the same specification as equation 1 which controls for ORI (i.e., market) and month-by-year fixed effects. We found modestly sized weights on the late to early DD estimates. Appendix Table A.3 shows that female homicides have a weight of around 0.233 for the late to early groups and 0.235 for reported female rape offenses. Thus, at least some bias is likely when using TWFE.[45] This does not mean our estimated causal effect is the wrong sign, but it does mean that the effect may be larger in absolute value than is calculated using TWFE.

## B Matrix Completion for Panel Data

Machine learning approaches to causal inference are rapidly growing, and matrix completion is a recent application created for panel settings (Athey et al. 2021). Matrix completion for panel data has its own set of identifying assumptions and estimating methodology, but none require

treatment effect homogeneity (Sun and Abraham 2020) or variance weighted parallel trends (Goodman-Bacon 2021) like TWFE. Matrix completion for panel data frames the estimation problem as missing data on counterfactuals. In contrast to a weighting method, matrix completion is an imputation method where each observation's missing counterfactual is estimated using comparable units in the cross-section and time-series itself.

We re-examine the question of whether Craigslist impacted female murders and female reported rapes using the matrix completion model for panel data (Athey et al. 2021). Suppose we could create two matrices of potential outcomes: a matrix of $Y^0$ potential outcomes for all panel units over time representing female murder rates and female reported rapes without ERS, and a matrix of $Y^1$ potential outcomes for all panel units over time representing female murder and female reported rape rates with ERS. At any point in time we observe only one of these potential outcomes for an ORI, which creates numerous missing values due to the fundamental problem of causal inference (Holland 1986). Consider the following expression for estimated *ATT*:

$$(6)\hat{\delta}_{ATT} = \frac{1}{N_T}\sum(Y_{it}^1 - L_{it})$$

where $Y^1$ are the observed murder rate outcomes in cities with Craigslist ERS, $L$ are the *imputed* missing elements of the $Y^0$ matrix for the post-treatment period and $N_T$ is the number of treatment units.

The objective in the Athey et al. (2021) matrix completion model is to optimally predict the missing elements of the matrix of potential outcomes by minimizing a convex function of the difference between the observed matrix of $Y^0$ and the unknown complete matrix $L$ using nuclear norm regularization. Letting Ω denote the row and column indices, *(i,j)*, of the observed entries of the outcomes, and the unknown matrix $Z$ to be estimated, the objective function can be written as:

$$(7)\ \hat{L} = arg\,min_L \sum_{(i,j)\in\Omega} \frac{(Y_{it}^0 - L_{it})^2}{|\Omega|} + \Lambda\|L\|$$

where ||L|| is the nuclear norm (sum of singular values of $L$). The regularization parameter $\Lambda$ is chosen using 10-fold cross-validation. Athey et al. (2021) show that solving for the missing counterfactuals using this matrix completion method exploits richer patterns in the data and using extensive simulations show that the method outperforms other methods in terms of root mean squared prediction error.[46]

Matrix completion with nuclear norm regularization unites the unconfoundedness literature and the synthetic control literature in that all have the same objective function. But whereas unconfoundedness and synthetic control depend on restrictions for identification, Athey et al. (2021) depends on nuclear norm regularization. Partly for this reason, the underlying identifying assumptions between the procedures are the same. For matrix completion to estimate the ATT, two identifying assumptions must be satisfied:

$$(8)(Y_{it}^0, Y_{it}^1) \perp\!\!\!\perp D_{it} \,|\, L_{it}, X_{it}$$

The first assumption is the conditional independence assumption.[47] This assumption ensures that the treatment variable, $D_{it,}$ is independent of any error determining the outcomes. The second assumption concerns the staggered rollout itself.[48] In the event that units are treated at different points in time, then we assume that, conditional on $L^*$, the adoption the adoption dates $t_i$ are independent of each other and of the unobserved determinants of $Y_{it}$ itself.[49] Standards errors are calculated using bootstrapping.

We report the results from this analysis in Table 6[50]. The estimated ATT on female homicides per 100,000 is -0.023, which is equivalent to a 17.6 percent decrease in female homicides. We experimented with a dozen different seeds for our bootstrapping, and the p-values were

consistently very small, ranging from 0.008 to 0.028 with a median p-value of 0.015. The effect on reported female rape offenses is similarly large at -0.296, which is 10.1% of the mean.

### C Falsifications

To assess the believability of these estimated causal effects, we implement a falsification exercise using non-female violent crimes. We examine the effect of ERS on non-female violence measures because our ERS hypothesis is not relevant to non-female offenses. These falsification outcomes are male homicides, manslaughters, and burglaries.[51] As none of these outcomes are directly associated with sex markets or mechanisms originating from sex markets, there should be no impact of ERS on these outcomes. We present results in Table 7. The estimated effect of male homicides is -0.023, which is 4.6% of the mean, however this result is not statistically significant at conventional levels. The estimated effect on manslaughters is precisely zero. The point estimate on burglaries is large but is not statistically different from zero at conventional levels. Thus, for all violent offenses in the UCR Summary Part I data, we do not find clear evidence that ERS openings are associated with statistically significant declines except for reported female rape offenses and female homicides.[52]

## VIII What Might Be the Mechanism Linking ERS to Reduced Female Violence?

Given the robustness of our female homicide and reported rape results, we investigated the effect of ERS on sex worker reviews using data from the popular sex worker review website called The Erotic Review (Cunningham and Kendall 2017). We focus on several measures that we believe can help shed light on our results.

Before we present our results, we discuss the layout of Table 8. Panel A uses the same specification in equation 1. These estimates all represent changes in mean values associated with entry. In Panel B, we estimate the effect of ERS on entrants only.[53] Entrants were defined as

providers whose first review was 0-10 months post-ERS opening in their city, 10-20 months, and so on. To estimate the marginal effect of ERS on entrants, we estimated the following two equations:

$$(9) Y_{i,m,t} = \delta_1 D_{t<10,m} + \delta_2 D_{t\geq 10,m} + \beta X_{mt} + \varepsilon_{i,m,t}$$

$$(10) Y_{i,m,t} = \sum_{\tau=1}^{6} \delta_{t+\tau} D_{m,t+\tau} + \beta X_{mt} + \varepsilon_{i,m,t}$$

where $D$ refers to our treatment variable, $X$ are sex worker $i$ controls, $\varepsilon$ is a structural error term and each indicator in Equation 10 refers to a 10-month band. We present estimates of Equation 9 in Table 8, panel A, and estimates of Equation 10 in panel B.

We propose two mechanisms that link ERS to declining violence. One possible mechanism is that ERS leads to greater market efficiency, which leads to more repeat business. This may be because screening of new clients allows sex workers to identify safer clients with whom they form longer-term relationships. We call this the "efficiency effect." The second possible mechanism is that the sex worker's work environment is becoming safer due to clients and sex workers using online solicitation to arrange indoor transactions rather than meeting on the street. This also may be facilitated by the ease of screening clients online than outdoors.[54] We call this the "composition effect." The composition effect speaks to the extensive margin changes for clients, sex workers, or both. In contrast, the efficiency effect speaks to the intensive margin caused by changes in the matching technology linking sex workers with clients.

All of our TER data are reviews by clients who had successfully passed a screening test. As such, we cannot examine the effect of ERS on mentions of screening because it selects on the dependent variable. A valid test of the screening hypothesis requires data from the provider side and would include both clients rejected as a result of screening as well as clients who passed the

screen. These data, to our knowledge, are presently unavailable, as it would require confidential data held by sex workers, and such workers may be understandably unwilling to maintain such records for fear it would create legal jeopardy for them if arrested. Thus indirect tests are needed to evaluate the credibility of this potential mechanism.

### A Efficiency Effect

The efficiency effect is simply a result of declining search costs and otherwise more effective matching through the availability of rich information about both sides of the market facilitated by screening and improved matching. Insofar as sex workers can screen clients ex-ante, they can sort into repeat working relationships with low-risk clients. If this happens, then the propensity to experience victimization may fall if the sex worker screens out the higher-risk clients. On the other hand, the effect may move in the opposite direction if declining search costs scale the market up to the point that, despite declining probabilities of violence, the absolute effect is positive.[55]

To evaluate the efficiency hypothesis, we searched client reviews and classified a review as referring to "repeat" business if it contained the words "repeat" or "regular". Such reviews described approximately 15 percent of the sample. Indeed, the introduction of ERS is associated with a higher probability that a review contains this sort of language — by 2 percent in the first ten months, and 2.7 percent thereafter (Table 8, Column 1, "Repeat"). Examining the effect that ERS had on entrants, we find very weak evidence that their repeat behavior was noticeably different from incumbents. This suggests that ERS affected incumbents and entrants equally with regards to forming repeat liaisons with clients. Also, this suggests that the *need* to screen may be falling simply as an artifact of improved matching in a market with considerably lower search costs and better matching functions.[56]

## B Composition Effect

Evidence for market participants transitioning indoors and online is not possible because we do not observe whether a woman was previously a street sex worker or whether a client primarily frequented street sex workers. We only can determine that she appears in the TER database and at what point her first review occurred. It is important to note that while the first review date does not change over time, changes in a worker's profile data (including indicators of channel, etc.) can change, and the platform does not preserve previous versions of the profile. But we reason that if there was an increase in the preponderance of indoor sex work vis a vis street sex work, then we would expect the composition of TER reviews to present evidence of negative selection. This is because street sex workers are believed to fall on a lower rung of the informal sex market ladder and may be less attractive.[57]

There are several potential reasons we may see this association. For instance, perceptions of worker type may change due to ERS simply because ERS lowered search costs to clients, allowing them to find workers experiencing difficult life circumstances more easily (Scott 2002). Another reason may be that by reducing the fixed and variable costs associated with supplying labor, the zero-profit condition at the margin of the market changes, and new workers may enter the market, some of whom may be workers experiencing difficult life circumstances.[58] All of these explanations from the TER reviews indicate that the composition of reviews is being altered by ERS. Still, not all of them imply a compositional change in the population of workers themselves.

We look for evidence of the compositional shift along several quality dimensions. First, we examine the effect that ERS had on appearance and performance ratings. Reviewers rated each worker on a scale of 1 to 10, with 10 being the highest level of satisfaction. For looks (Table 8, Column 2, "Looks"), we find that ERS reduced the mean score slightly by 0.053 in the first ten

months and 0.131 after ten months. This effect became even more pronounced over time when we focus only on the entrants. After the rollout of ERS, entrant appearance worsened relative to incumbents, suggesting that the marginal sex worker was drawn from a less professionalized pool of women. We also evaluated the impact it had on performance ratings. The introduction of ERS reduced client ratings of performance at the mean, but particularly for new entrants (Table 8, Column 3, "Performance").

Customer satisfaction can also be measured using a question that asked clients to state whether the experience was "as promised." This kind of *ex-post* satisfaction measure is indicative of having one's expectations met. Here we find no effect on the population as a whole, but we find large, negative effects among the entrants. We examine a myriad of quality measures (see Table 8), such as performance and meeting expectations, and they all indicate that the marginal entrant is significantly worse than the existing population of sex service providers.

While we cannot measure street sex work experience directly, we can measure whether the word "street" appeared in a review. Over 6,000 reviews contained the word "street," and while not all of these appear to describe a street sex worker, a large number do. Such examples include a description that a woman appeared to be "street-like". We find that the introduction of ERS is associated with a negative occurrence of street mentions in a review (Table 8, Column 4, "Street"). This suggests that the incidence of reviews with street mentions was reduced post-ERS. But an interesting pattern emerges when we examine the effect of ERS on the characteristics of entrants. All of the coefficients on the entrant variables are positive. Two are significant, suggesting that while ERS is associated with a negative mention of streets in reviews, entrants receive these mentions more often. This provides further evidence that the entrants were street sex workers.

Changes in market composition could also show up as a change in the location that sex workers meet with clients. We examine this by using a field where clients stipulated whether a meeting place occurred at a location of the client's choosing (outcalls) or the service provider's choosing (incall). Outcalls have the potential for risk because the sex worker is in a foreign and unknown situation with a potentially unknown client (Bass 2015a). As ERS has the potential to improve worker safety, it could increase the number of outcalls made because of the reduction in risk. But we find economically large and statistically significant effects of ERS on the likelihood a reviewed sex worker provided incall services (Table 8, Column 5, "Incall"). Incalls increased by 4.9 percent in the first ten months and 8.7 percent after that.

But interestingly, this positive effect does not hold for the entrants. Entrant incall probabilities fall slightly after about the $41^{st}$ month relative to incumbents. Although technically this represents a mechanical shift in the share of reviews towards incalls, it is consistent with the notion that the marginal transaction focuses on the indoor sex worker, as opposed to a street-based worker.

Evidence for negative selection into the Internet-mediated market may also show up in lower prices. Lower prices could reflect supply and demand shifts, but it is also a reflection of the Internet drawing in women from the streets where prices are substantially lower. We examined this by investigating the impact of ERS on the sex worker's hourly adjusted price. We find strong, significant, and economically meaningful declines in average prices per hour associated with ERS (Table 8, Column 6, "Hourly Price"). The average hourly price fell by $6.62 in the first ten months and then by $14.82 after that. This effect is more pronounced among the entrants, though, whose prices are lower within 11-20 months after ERS opened. The drop in price that we find appears to be much higher for entrants than for incumbents.

While intermediaries such as pimps are not direct measures of screening, the value of a pimp in sex work may be that these individuals perform *de facto* screening on behalf of the sex workers. We examined this by searching for the word "pimp" in TER reviews. Clients often write extensive reviews about each provider they visited, and these reviews sometimes contain references to whether these transactions involved a pimp. While the overall effect of ERS on the appearance of the word pimp is zero (Table 8, Column 7, "Pimp"), the marginal entrants do appear to have reviews mentioning this word. But, we caution the reader from over-interpreting this result as the overall incidence of the term "pimp" in reviews is very small.

## IX Discussion and Conclusion

In this study, we find that the rollout of Craigslist ERS was likely a significant contributor to declines in female homicide rates. We also find evidence that it was associated with a reduction in reported forcible female rape offenses, though this effect is somewhat less robust across specifications. The effect of ERS on rapes is consistent with Cunningham and Shah (2018) who found greater liberalization of indoor sex work was associated with a 30% reduction in forcible female rape offenses. This effect is echoed in other studies, such as Bisschop, Kastoryano and van der Klaauw (2017) and Ciacci and Sviatschi (2022). We speculate that enhanced female safety is driven by increased screening caused by shifting solicitation indoors. This, in turn, led to improved efficiency in the market, more repeat customers with lower risk clients, and an overall shift away from street solicitations towards online platforms that have fewer environmental hazards (Cunningham and Kendall 2011a).

Our findings suggest that online platforms may have large benefits to society and particularly sex workers. Policymakers should proceed by acknowledging the costs and benefits of enforcement weighed against the potential for unintended consequences of platform disruption

itself. We suspect that policy considerations are likely to require more nuance and sensitivity than has previously been the case, even if declining violence is a consequence of sex worker platforms. To the degree the ongoing debate is shaped by moral traditions that prohibit sex work as well as repugnance-based judgments, discussions about optimal policies may be challenging since economic studies have found liberalization increases the size of the market (Cunningham and Shah 2018).

ERS disrupted the illicit market for commercial sex in the United States despite its prohibition of sex work. ERS appears to have changed many dimensions of risk, which may have caused the market to grow while simultaneously reducing the incidence of violence associated with the market. Overall, though, there is still a great deal of research required in this area. For instance, other important issues relating to the relationship between technology and sex markets have not been analyzed. Thus, one opportunity for future research is the relationship between ERS and the incidence of human trafficking. Unfortunately, the data does not presently exist that would enable us to answer this question.

While we have focused narrowly on Craigslist's impact on the structure of sex markets and associated impacts on female safety, we believe that our findings have broader implications in understanding the effects of two-sided platform markets. Previous research has focused on the adverse impacts of two-sided platforms on public health, such as increased HIV infection (Chan and Ghose 2014; Greenwood and Agarwal 2016). Because two-sided markets lead to more numerous transactions, they provide aggregation of supply and demand, lower prices, and better matching of buyers and sellers. Therefore, one might assume that two-sided markets simply amplify ex-ante external effects of a particular market. However, our results indicate that this is

not always the case. Although Craigslist led to more transactions occurring in sex work markets, instead of increasing the incidence of violence, it seems to have reduced it.

Further research is required to understand why these externalities emerge. Our findings suggest that higher-order impacts of two-sided platforms can emerge from shifts in the existing characteristics of a market that occur when the market moves to the platform. When existing characteristics of the market do not change (e.g., the platform simply makes an existing market more efficient), higher-order externalities are unlikely to emerge.

However, when shifts in existing characteristics do occur, significant non-economic externalities are likely. Research is required into what properties of the environment, market, transactions, and actors are likely to lead to externalities, both positive and negative.

In summary, we find support for sex workers' claims that the introduction of ERS likely made them significantly safer. We estimate that ERS likely led to an 11 to 17 percent reduction in female homicides and a 7 to 9 percent decrease in reported forcible female rape offenses. The effects on these measures of female violence are consistent with both the high incidence of violence among street-based sex workers as well as theoretical predictions made by Logan and Shah (2012) and Persson and Lee (2016), suggesting that Internet platforms like Craigslist's ERS improved market (and potentially non-market) participant safety. While opposition may persist despite these gains due to "distaste for certain kinds of transactions" (Roth 2007; Gu, Roth and Wu 2022), or because sex work is viewed as equivalent with sex trafficking, the potential improvements in female safety illustrated by our results suggest that it is vital for policymakers to design policies that might improve the lives of trafficked victims without simultaneously harming others.

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**Table 1**
*Summary Statistics for the Craigslist sample (1995-2009)*

| Variables | Mean | Std. Dev | N |
|---|---|---|---|
| Female homicides per 100,000 | 0.13 | 0.39 | 54,424 |
| Male prostitution arrests per 100,000 | 1.00 | 3.72 | 68,513 |
| Female prostitution arrests per 100,000 | 1.79 | 5.22 | 68,513 |
| Female rape offenses per 100,000 | 2.93 | 4.02 | 47,904 |
| Burglary offenses per 100,000 | 87.25 | 110.63 | 47,904 |
| | | | |
| Total reviews | 42.47 | 92.78 | 8,113 |
| Total providers | 8.44 | 16.77 | 8,113 |
| Craigslist email | 0.002 | 0.04 | 68,450 |
| Independent | 0.56 | 0.50 | 68,450 |
| Agency | 0.34 | 0.47 | 68,450 |
| Incall | 0.84 | 0.36 | 68,450 |
| Hourly price | $294.33 | 173.51 | 344,399 |
| Screening | 0.05 | 0.22 | 344,561 |
| Repeat | 0.15 | 0.37 | 344,561 |
| Looks rating | 7.46 | 0.98 | 344,561 |
| Performance rating | 7.32 | 1.42 | 344,561 |
| Street | 0.02 | 0.14 | 344,561 |
| | | | |
| Female homicides from acquaintance killer per 100,000 | 0.03 | 0.13 | 54,272 |
| Male homicides per 100,000 | 0.50 | 0.83 | 54,272 |
| Manslaughters per 100,000 | 0.01 | 0.14 | 51,168 |

All variables are measured at the ORI-month level for crime variables and market-month for TER variables.

**Table 2**
*The effect of Craigslist's erotic services openings on production and intermediary characteristics*

| Dep var: | **Craigslist** | **Independent** | **Agency** | **Reviews** | **Providers** |
|---|---|---|---|---|---|
| ERS (first 10 months) | 0.001** | 0.065*** | -0.069** | 10.640* | 0.777 |
| | (0.000) | (0.024) | (0.031) | (6.176) | (0.926) |
| ERS (post-10-months) | 0.004*** | 0.058* | -0.073* | 21.548** | 2.652* |
| | (0.002) | (0.033) | (0.039) | (9.935) | (1.551) |
| N | 68,450 | 68,450 | 68,450 | 8,113 | 8,113 |
| Mean of dependent variable | 0.00 | 0.56 | 0.34 | 42.47 | 8.44 |

Outcomes are binary variables equaling one if the vendor had the ascribed characteristic. Column 1 is an indicator of whether a review identified a provider with a Craigslist pseudonymized email. Column 2 indicates that a unique provider worked alone. Column 3 indicates a unique provider worked with an agency. Column 4 refers to the total number of unique client reviews. Column 5 refers to the total number of unique providers that appeared in a market for a given month. Models control for city and date fixed effects. Robust standard errors clustered within city in parenthesis. * p<0.10, ** p<0.05, *** p<0.01

**Table 3**
Estimates of the effect of erotic services openings on prostitution arrests per 100,000

| Dep var: | **Male arrests** | | **Female arrests** | |
|---|---|---|---|---|
| ERS (first 10 months) | -0.143** | -0.098 | -0.185 | -0.084 |
| | (0.061) | (0.081) | (0.115) | (0.075) |
| ERS (post-10-months) | -0.288*** | -0.171 | -0.200 | -0.036 |
| | (0.094) | (0.110) | (0.155) | (0.107) |
| Model | OLS | Poisson | OLS | Poisson |
| N | 68,513 | 68,513 | 68,513 | 68,513 |
| Mean of dependent variable | 1.00 | 1.00 | 1.79 | 1.79 |

Male arrests refers to males arrested for prostitution offenses in the Uniform Crime Report Part II arrest database. Female arrests refers to females arrested for prostitution offenses in the same data base. Models control for ORI, year, and month fixed effects. State-year interactions fixed effects were dropped due to a failure to converge. Robust standard errors clustered within ORI are displayed within parentheses. * p<0.10, ** p<0.05, *** p<0.01

**Table 4**

*TWFE and Poisson estimates of the effect of erotic services openings on female murders and forcible female rape offenses per 100,000*

| Dep var: | **Panel A: Female Murders** | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| ERS (first 10 months) | -0.007 | -0.007 | -0.006 | -0.075 | -0.064 | -0.059 |
| ERS (post-10-months) | (0.008) | (0.008) | (0.008) | (0.064) | (0.068) | (0.068) |
| | -0.019** | -0.015** | -0.013* | -0.191*** | -0.135** | -0.124* |
| | (0.008) | (0.007) | (0.007) | (0.070) | (0.067) | (0.067) |
| N | 54,424 | 54,424 | 54,272 | 54,424 | 54,424 | 54,272 |
| Mean of dependent variable | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| Semi-elasticity | -0.143 | -0.112 | -0.10 | -0.191 | -0.135 | -0.124 |
| | [-0.258,-0.028] | [-0.222,-0.001] | [-0.210,0.010] | [-0.327,-0.054] | [-0.266,-0.004] | [-0.255,0.006] |
| Dep var: | **Panel B: Female Rapes** | | | | | |
| ERS (first 10 months) -0.076 | -0.125 | -0.113 | -0.024 | -0.042 | -0.038 | |
| | (0.090) | (0.090) | (0.090) | (0.031) | (0.031) | (0.031) |
| ERS (post-10-months) | -0.135 | -0.205* | -0.183 | -0.055 | -0.081** | -0.073* |
| | (0.123) | (0.118) | (0.117) | (0.044) | (0.041) | (0.041) |
| N | 47,904 | 47,904 | 47,904 | 47,904 | 47,904 | 47,904 |
| Mean of dependent variable | 2.93 | 2.93 | 2.93 | 2.93 | 2.93 | 2.93 |
| Semi-elasticity | -0.046 | -0.07 | -0.063 | -0.055 | -0.081 | -0.073 |
| | [-0.129,0.036] | [-0.149,0.009] | [-0.141,0.016] | [-0.140,0.030] | [-0.162,0.001] | [-0.154,0.008] |
| Estimation method | OLS | OLS | OLS | Poisson | Poisson | Poisson |
| ORI FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| State-Year FE | No | Yes | Yes | No | Yes | Yes |
| Population | No | No | Yes | No | No | Yes |

Female murders refers to female homicides recorded in the Supplemental Homicide Report. Female rapes are reported female forcible rape offenses as defined by the Uniform Crime Reports Summary Part I offenses. Each column represents a separate regression model specification. Cluster robust by ORI standard errors are shown in parenthesis. Semi-elasticities divide the coefficient on the 10 month lag by the mean of the sample. 95% confidence intervals are presented in brackets for all semi-elasticities. * p<0.10, ** p<0.05, *** p<0.01

**Table 5**

*TWFE and Poisson estimates of the effect of ERS openings on female homicides per 100,000 from the Vital Statistics*

| Dep var: | **Female Homicides** | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| ERS (first 10 months) | -0.009 | -0.008 | -0.008 | -0.062 | -0.051 | -0.051 |
| | (0.007) | (0.007) | (0.007) | (0.038) | (0.039) | (0.039) |
| ERS (post-10-months) | -0.009 | -0.010 | -0.010 | -0.078** | -0.075** | -0.075** |
| | (0.007) | (0.007) | (0.007) | (0.031) | (0.030) | (0.030) |
| N | 54,191 | 54,191 | 54,191 | 54,191 | 54,191 | 54,191 |
| Mean of dependent variable | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Estimation method | OLS | OLS | OLS | Poisson | Poisson | Poisson |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| State-Year FE | No | Yes | Yes | No | Yes | Yes |
| Population | No | No | Yes | No | No | Yes |

Outcome variable comes from the raw Vital Statistics. Cluster robust standard errors by county are shown in parenthesis. * p<0.10, ** p<0.05, *** p<0.01

**Table 6**

*Matrix completion estimation of ERS on female homicide rates and forcible female rape offenses per 100,000*

| Dependent variable: | Female murders | Female rapes |
|---|---|---|
| ERS (post-10-months) | -0.023** | -0.296** |
| | (0.006) | (0.113) |
| Imputed counterfactuals | 19,127 | 13,224 |
| Mean of dependent variable | 0.13 | 2.93 |

Matrix completion model with 10 folds for cross validation and 1,000 draws for bootstrapped standard errors. Model includes ORI and month-year fixed effects and was estimating used Stata 18 and the -fect- command. Female homicides and female rape offenses are from the Supplemental Homicide Reports and Uniform Crime Reports, respectively. * p<0.10, ** p<0.05, *** p<0.01

**Table 7**
*OLS falsification estimates of the effect of Craigslist erotic services openings on male homicides, manslaughters and burglaries per 100,000*

| Dep var: | **Male Homicides** | **Manslaughter** | **Burglary** |
|---|---|---|---|
| ERS (first 10 months) | -0.022 | -0.000 | -2.780 |
| | (0.016) | (0.003) | (1.745) |
| ERS (post-10-months) | -0.034 | 0.004 | -1.864 |
| | (0.026) | (0.004) | (2.352) |
| N | 54,424 | 47,904 | 47,904 |
| Mean of dependent variable | 0.49 | 0.02 | 87.25 |
| Estimation method | OLS | OLS | OLS |
| ORI FE | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes |
| State-Year FE | Yes | Yes | Yes |

Outcome variable comes from the Supplemental Homicide Reports (column 1), and the UCR Summary Part I offenses (columns 2-3). Cluster robust standard errors by ORI are shown in parenthesis. * p<0.10, ** p<0.05, *** p<0.01

**Table 8**

*The effect of Craigslist's erotic services openings on characteristics of providers*

| Dep var: | **Repeat** | **Looks** | **Performance** | **Street** | **Incall** | **Hourly Price** | **Pimp** |
|---|---|---|---|---|---|---|---|
| | **Panel A: All market participants** | | | | | | |
| ERS (first 10 months) | 0.020** | -0.053* | -0.066* | -0.003* | -10.193** | 0.049*** | 0.001 |
| | (0.009) | (0.030) | (0.034) | (0.001) | (5.034) | (0.013) | (0.001) |
| ERS (post-10-months) | 0.027** | -0.131*** | -0.110* | -0.003* | -22.520*** | 0.087*** | 0.001 |
| | (0.013) | (0.049) | (0.064) | (0.002) | (6.929) | (0.024) | (0.001) |
| | **Panel B: New entrants only** | | | | | | |
| Entrant 0-10mo post ERS | 0.003 | -0.135*** | -0.550*** | 0.003*** | -0.022* | -15.737** | 0.002** |
| | (0.004) | (0.031) | (0.064) | (0.001) | (0.012) | (7.504) | (0.001) |
| Entrant 11-20mo post ERS | 0.011** | -0.102*** | -0.475*** | 0.002 | -0.009 | -13.307* | 0.002*** |
| | (0.005) | (0.032) | (0.052) | (0.001) | (0.012) | (6.772) | (0.000) |
| Entrant 21-30mo post ERS | 0.003 | -0.160*** | -0.501*** | 0.003* | -0.021*** | -21.141*** | 0.002*** |
| | (0.003) | (0.034) | (0.038) | (0.002) | (0.008) | (6.425) | (0.001) |
| Entrant 31-40mo post ERS | -0.000 | -0.160*** | -0.548*** | 0.002 | -0.022* | -16.298*** | 0.002*** |
| | (0.005) | (0.031) | (0.040) | (0.002) | (0.011) | (5.046) | (0.001) |
| Entrant 41-50mo post ERS | -0.001 | -0.222*** | -0.630*** | 0.001 | -0.016 | -17.791*** | 0.003*** |
| | (0.004) | (0.024) | (0.038) | (0.002) | (0.013) | (4.096) | (0.001) |
| Entrant 50mo post ERS | 0.003 | -0.521*** | -1.075*** | 0.005*** | -0.043*** | -10.533* | 0.005*** |
| | (0.003) | (0.018) | (0.049) | (0.001) | (0.006) | (6.064) | (0.001) |
| N | 344,561 | 344,561 | 344,561 | 344,561 | 68,450 | 344,339 | 344,561 |
| Mean of dependent variable | 0.15 | 7.46 | 7.32 | 0.02 | 0.84 | 294.33 | 0.00 |

All data comes from The Erotic Review, a client-based review website. Column 1 is an indicator that a client had seen the provider (e.g., he is a repeat customer). Column 2 measures the provider's appearance according to the client on a scale of 1 to 10. Column 3 measures the subjective experience with the provider on a scale of 1 to 10. Column 4 is an indicator measuring whether the word "street" appeared in a client's review. Column 5 is an indicator measuring whether words associated with the "pimp" concept was used in the review. Column 6 is an indicator stating whether the provider met with clients at the client's location (i.e., an incall). Column 7 is the gross price divided by the length of the session times 60 which yields an hourly price. Coefficients were estimated using OLS controlling for market and date fixed effects. Cluster robust standard errors by market are shown in parenthesis. * p<0.10, ** p<0.05, *** p<0.01

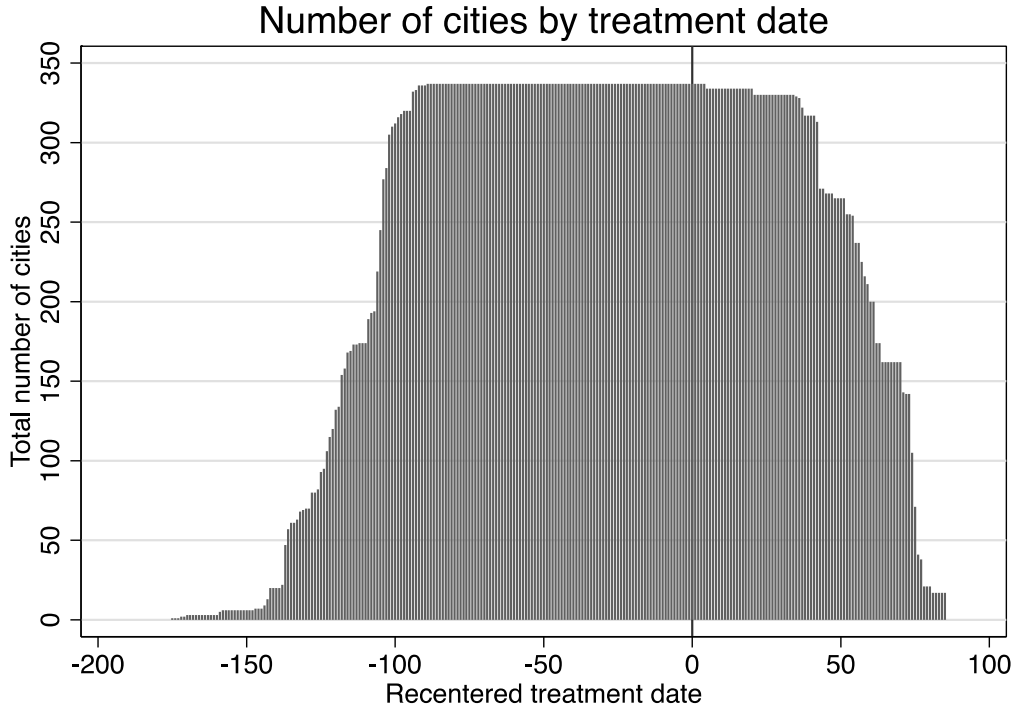
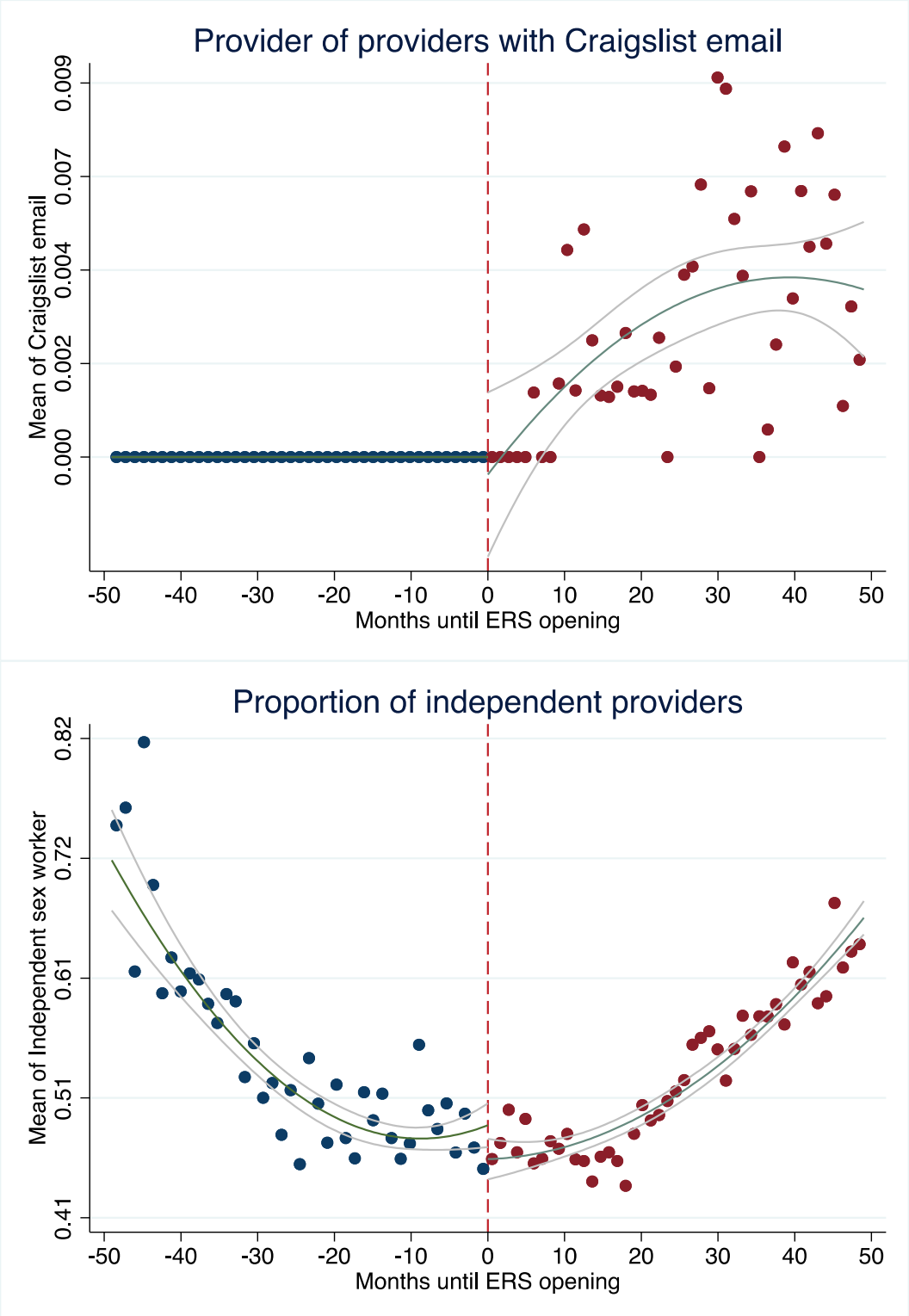



**Figure 1**

*Number of cities represented in our sample relative to the time of treatment. The x-axis depicts the number of months until or after the introduction of ERS. The y-axis presents the number of cities that appear in our panel with the recentered treatment value of the x-axis.*



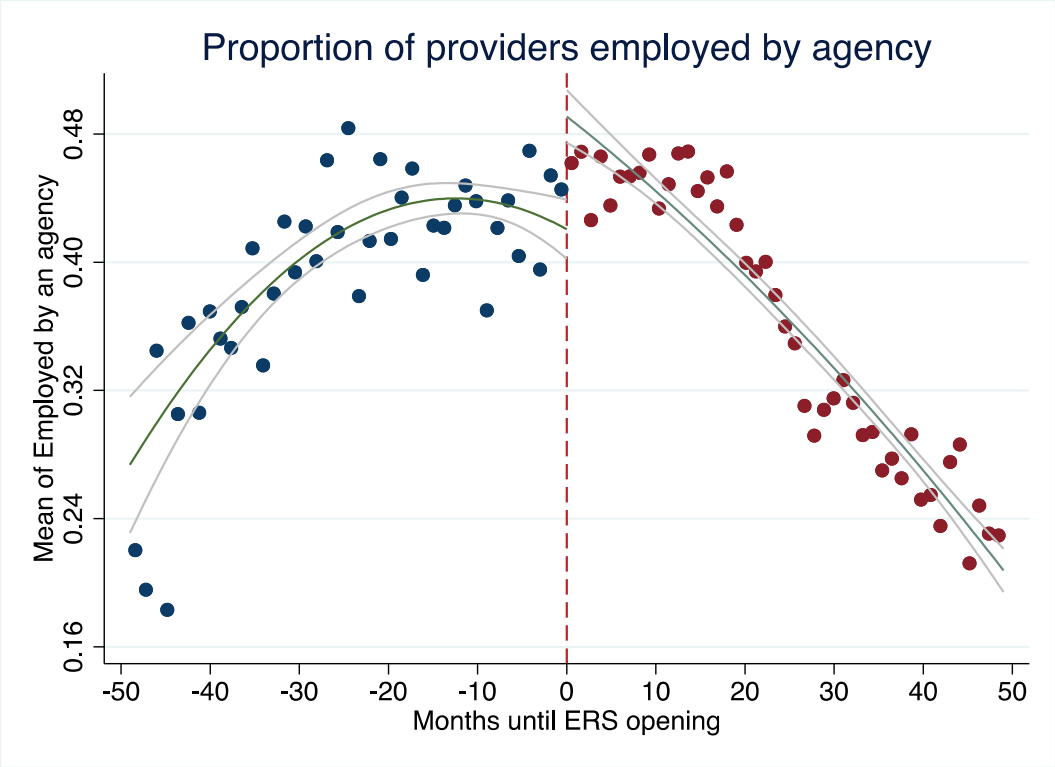



**Figure 2**

*Conditional binned means of characteristics of providers at TER before and after the date where Craigslist refreshed its front page with ERS. Bins are approximately equal to a month; there are 48 bins to the left of the cutoff and 52 to the right.*

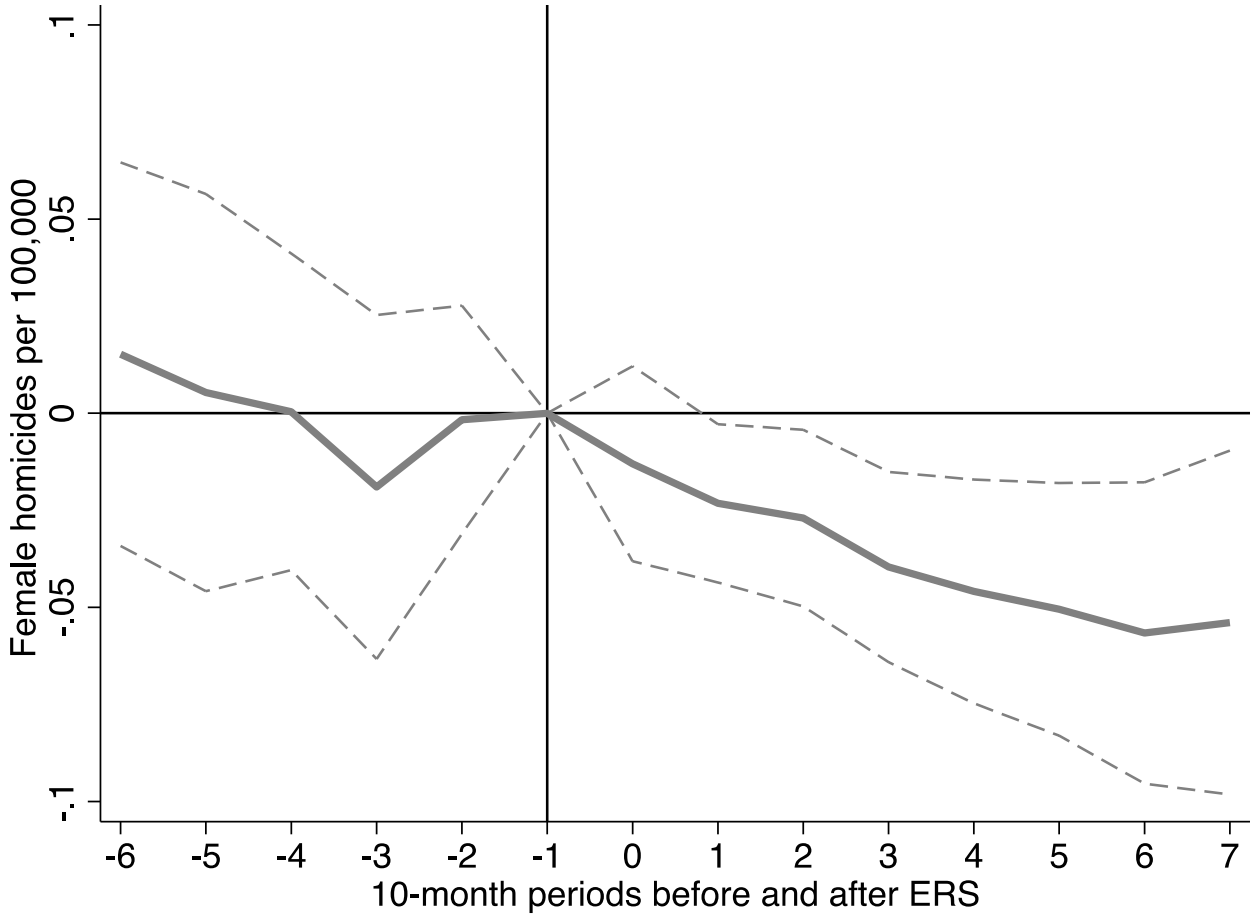



**Figure 3**
*Event study plots from equation 2 for female murders using TWFE*

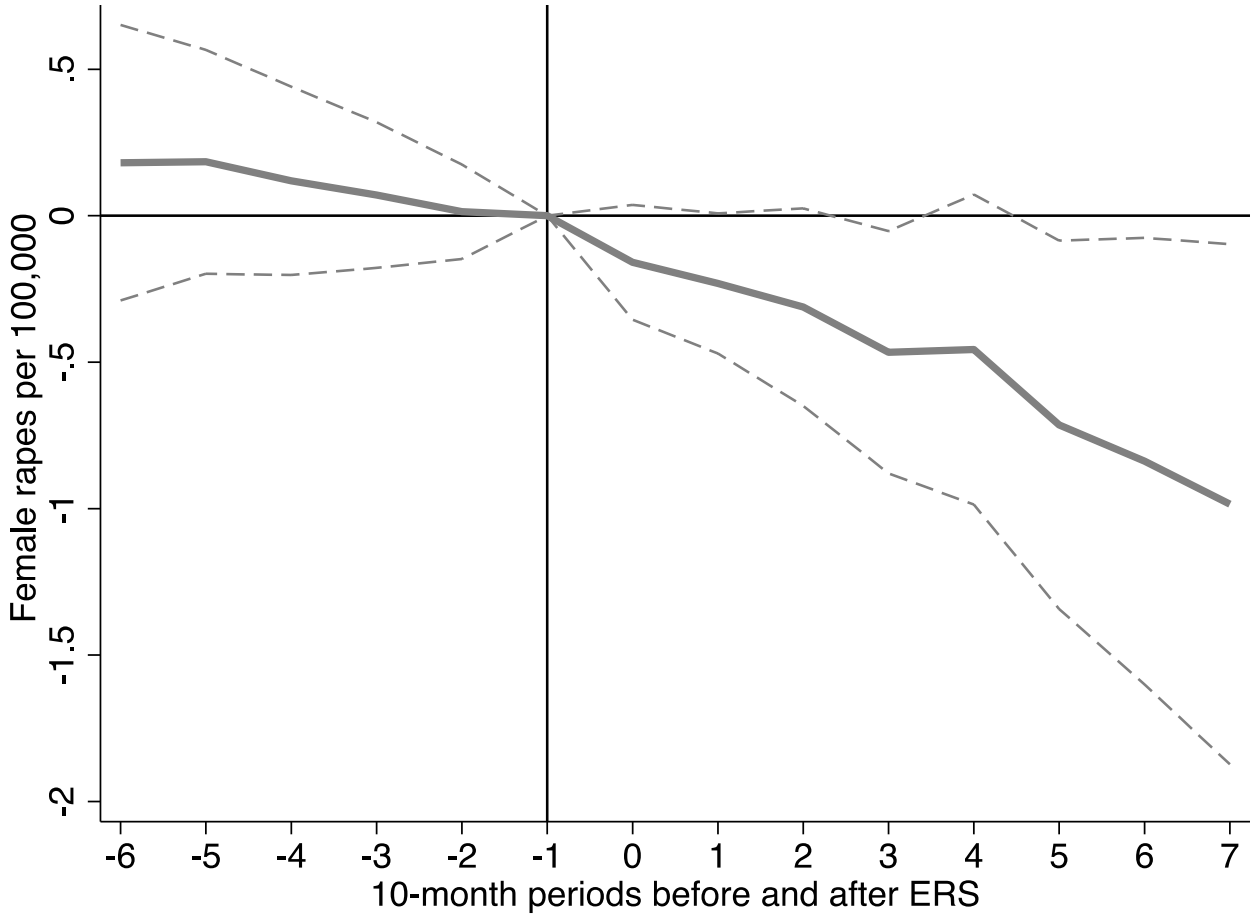



**Figure 4**
*Event study plots from equation 2 for female forcible rape offenses using TWFE*

## Endnotes

1 By comparison, the second most dangerous occupation for females is the liquor store employee, which has a workplace homicide rate of 4 per 100,000 (Castillo and Jenkins 1994).

2 This high level of mortality risk may have initiated economic and structural mechanisms to evolve to manage that risk. Examples include compensating wage differentials (Rao et al. 2003; Gertler, Shah and Bertozzi 2005; DeAngelo et al. 2019) and integrating with intermediaries such as agencies, brothels, and pimps (Reynolds 1986; Levitt and Venkatesh 2007) who provide screening and protection to sex workers in exchange for a percentage of revenue. But, street based sex workers are also oftentimes some of the most vulnerable members of society and engage in such risks due to a lack of alternatives for survival.

3 Duch-Brown et al. (2017) examine the movement of general products to e-commerce and note that when markets move online, they have the potential to divert offline sales, as well as a net market expansion effect.

4 Hagiu and Rothman (2016) find improved safety of general market transactions (i.e., not sex services transactions) on online platforms such as Craigslist.

5 Examples of informal screening include calling a client at his workplace, conducting extensive background checks online, and requiring letters of reference (Cunningham and DeAngelo 2020).

6 Alexa, a commercial web traffic data company owned by Amazon (http://www.alexa.com/siteinfo/craigslist.org), ranks Craigslist the 15th most popular website in the United States.

7 The following link provides the dates and locations of Craigslist expansion: http://www.craigslist.org/about/expansion.

8 Our paper differs substantially from Chan, Mojumder and Ghose (2018). Chan et al. investigate the impact of Craigslist on the size of the sex work market and find that Craigslist is associated with a 17.58% increase in the size of the market. While we also investigate the impact of Craigslist on the size and structure of the sex work market, we focus on these as mechanisms for investigating our primary outcomes of interest - the associated impact on women's safety.

9 Appendix Figure A.1 provides an example of the Craigslist front page before ERS, while Appendix Figure A.2 shows the front page of Craigslist after the introduction of ERS. Note that the updating of the front page included several services added in addition to ERS. Further, Craigslist phased ERS into its front page in different markets over time, as illustrated in Appendix Figures A.3-A.5. The introduction of ERS followed a heterogeneous path, opening on the west coast of the US first and then gradually moving eastward.

10 Craigslist eventually introduced pricing of ERS ads at the recommendation of law enforcement who hoped that it would deter activity. While ads declined under this price increase, Craigslist's revenues from the section increased substantially - potentially by tens of millions of dollars. See Cunningham and Kendall (2010b) for a discussion of the impact of the introduction of pricing on ERS advertising.

11 Every agency that reports to the FBI's Summary Uniform Crime Reports (UCR) is assigned a unique ORI. The majority of ORI codes are associated with police agencies, but, other agencies with law enforcement responsibilities are assigned ORI codes. These may include fire marshals, alcohol and beverage control agencies, regional and special-purpose task forces, Federal agencies, and public and private colleges.

12 One major difference in the rollout of ERS is geographic. Over time, the average distance from the San Francisco bay area grew.

13 Thomas Dart, sheriff of Cook county, sued Craigslist because he estimated that between January and November 2008, his department devoted 3,120 working hours and approximately $105,081.00 to make 156 arrests *(Thomas Dart, Sheriff of Cook County v. Craigslist Inc.,* No. 09 C 1385 [Northern District of Illinois Eastern Division District Court, 2009]).

14 At the time of this writing, there is a still-at-large serial killer of Craigslist sex workers operating out of Long Island, New York (Kolker 2013, 2014). While there appear to be several serial killers currently actively targeting sex workers, it is not clear that all of them used Craigslist or Backpage to target the victims (Henry 2016).

15 This argument has some anecdotal support post-FOSTA implementation, with law enforcement reporting that the shuttering of Backpage has made law enforcement more complicated, with officials reporting that "...it has blinded us. We used to look at Backpage as a trap for human traffickers and pimps." (Fischer 2018)

16 Also, sex workers are easy prey for sadistic individuals (Warren, Hazelwood and Dietz 1996), as more than half of all serial killers' victims have been sex workers (Egger 2003) and fully one-third of all sex worker deaths are due to murder by serial killers (Brewer et al. 2006). The presence of psychopathic homicidal behavior poses a policy problem because these groups of people are not easily deterred.

17 Some sex workers report working simultaneously across these different segments (Moran 2015). See Reynolds (1986) for a detailed taxonomy of the market's historical tiers before the Internet.

18 https://www.theeroticreview.com/

19 The Wayback Machine (https://archive.org) first started archiving in 1996.

20 Generally, clients leave feedback about service providers in two ways. First, through structured dropdown menus, clients can provide items like an appearance score (1-10), performance score (1-10), and various other questions with binary responses. Additionally, clients have the option to leave unstructured, free-text feedback about the services provided. The text is often quite lengthy and typically details how the client contacted the service provider, where the services were performed, and what services were performed. Whenever the client provides this content, we will have this information contained in our data. We can link provided services to sex workers and client reviewers through the structured and unstructured review feedback.

21 Outcalls are instances where the sex worker travels to meet the client. Incalls are instances where the client travels to meet the sex worker.

22 Price is based on a bundle of female characteristics and sex acts. We look only at the aggregate hourly price for simplicity.

23 Upon setting up a TER account, the provider and reviewers must create a unique username (e.g., foxy123). These usernames are utilized by both reviewers and providers to develop a reputation within TER. They are often referenced in sex service advertisements (e.g., www.backpage.com) by sex service providers by providing a link to their TER page so that potential clients can read their reviews. So, although sex services are illegal, service providers often attempt to increase business by establishing a reputation and through specializing in provided services. For our research purposes, these unique identifiers enable us to follow the same provider and reviewer within our data and identify when new providers enter the market.

24 Reviews reflect an individual client's self-reported experience with a specific escort. Reviewers are assumed to be clients who had visited the sex worker and later left a review of her on the website. Reviews remain on the website unless a complaint is made, at which point administrators may remove the offensive review. We utilized the calendar date of each review to determine whether the review was posted before or after ERS existed in the market. As reviews are the self-reported statements by individual clients about a specific escort, they are subject to all caveats, such as hindsight bias.

25 While several previous studies have examined the various crime data sources to examine homicides, the Uniform Crime Reports cover approximately 97 percent of the US population (e.g., Tabarrok, Heaton and Helland (2010)). Although concerns about data quality associated with the UCR have been raised in previous studies (Pepper and Petrie 2003), homicides are the most accurately reported crime. In contrast, other crimes (e.g., rape, assault) are much less accurate (Donziger 1996). Moreover, we further subset our data to only use locations with a population of 100,000 persons or more, which should increase the quality of reporting.

26 For instance, there are only 49 such instances of a murder offense named as a sex work death out of 31,250 observations.

27 Quinet (2007) conducted analyses on homicides using data from 2004. Of the 106,097 active missing person cases, 3,598 (8%) had been missing fewer than 30 days, 2,850 (6%) had been missing from 30 to 60 days, 1,850 (4%) had

been missing 61 to 90 days, 8,743 (18%) had been missing 91 to 364 days, and 30,622 (64%) adults had been missing for one year or more. Thus, the majority of active adult missing persons have been missing for more than one year.

28 In addition, we report additional robustness checks that use the Center for Disease Control's vital statistics data that also records female homicides. These are discussed in our findings below.

29 Summary statistics do not in every instance match event study figures, such as Figure 2, because Figure 2 subsets the data to include on $t$ - 50 and $t$ + 50 relative event time periods, whereas Table 1 uses the entirety of the data for our regression analysis.

30 One may question whether our dataset has sufficient mass for the post-treatment period given the staggered introduction of ERS by market and month. In Figure 4, we report the number of cities by date before and after the treatment. The x-axis depicts the number of months before and after the introduction of ERS, and the y-axis presents the number of cities that appear in our panel with the re-centered treatment value of the x-axis. For example, there are approximately 340 cities in the 75 months leading up to and 50 months after the introduction of ERS. Alternatively, approximately 150-175 months before the introduction of ERS and 70-75 months after the introduction of ERS, there are fewer than 25 cities observed in our data. The lack of observations 150-200 months before the introduction of ERS is due to very few locations being treated later than the bulk of US cities. Similarly, there are few observations 70-75 months after the introduction of ERS because few cities were treated in the early years (2000-2003). We believe that Figure 4 shows a sufficiently large number of observations in the period from 100 months before the introduction of ERS to 50 months after the introduction of ERS for identification in the pre- and post-treatment dates in our estimation.

31 It is worth noting that the use of a craigslist pseudonymized email is an error on the part of the reviewer. These emails are for one-time use, so including this email on TER is not useful for future clients to contact the provider. While reporting a Craigslist email address is a reviewer error, it may have been the only email address that the reviewer had. Thus, insofar as sex workers who advertised through Craigslist provided clients with a real email address, this analysis is a significant lower bound on the use of ERS as a means for connecting with providers. This is also likely why we see few instances of a craigslist email in the TER database.

32 All plots shown in Figure 2 present the mean value of a profile-specific variable against relative time, where relative time is the number of months before and after the introduction of ERS in a market. These figures are, in other words, representations of an interrupted time series style graphics, not difference-indifferences based event study plots.

33 In addition to using typical cluster robust standard errors, we also constructed empirical p-values using randomization inference. We randomly assigned treatment dates using 1,000 permutations and estimated the probability that chance produced our coefficients. The effects were significant at the 5-10% level.

34 This association only represents an increase in reviewed independent sex workers due to ERS, which has several interpretations. One is that ERS causes sex workers to switch from working with a third- party intermediary to working independently. Another explanation is that ERS lowered the costs of entry, which therefore selected on new entrants who were less likely to work with traditional intermediaries. A third explanation is that ERS simply lowered search costs allowing clients to find independent sex workers more efficiently.

35 Before the ERS rollout, TER reviews were increasingly more likely to be escorts associated with an agency. The reasons for this are idiosyncratic to the historical growth in the popularity of TER. The earliest adopters of TER were independent sex workers, but agencies began using it more as the site grew in popularity. But this trend flipped shortly after ERS opened in cities.

36 To calculate percentage changes, we divided each treatment coefficient by the sample mean. For instance, $\frac{0.777}{8.44} = 9\%$.

37 Due to the coding practices required by the FBI's Uniform Crime Reports Summary counts during the sample period, the FBI uses a narrow definition of rape offenses. The UCR counts during this window only reported female rape offenses due to vaginal penetration. Thus, counts of reported rape offenses exclude all male and non-vaginal rape offenses.

38 Alvin Roth writes about the importance of clearinghouses to address market failures in matching markets due to thinness: "Sometimes there is an opportunity to correct the market failures associated with unraveling and exploding

offers by creating clearinghouses that will provide a thick market (for example, Roth (1984)). Clearinghouses are also sometimes employed to fix market failures due to congestion."

39 We also examine the sensitivity of our estimates to other treatment windows. We examine 6-month, 9-month, and 12-month windows and report those analyses in Appendix Table **A.2**. Note that the 10-month window is the most conservative estimate of the windows we examined. All other effects are either the same (6 months) or slightly larger and more significant.

40 We chose 10-month intervals because the Craigslist email results suggest a 10-month lag (see Figure 2). We re-estimated our models using 6-month, 9-month, and 12-month dummies. These are presented in Table 6 and the results are similar both in precision and magnitude.

41 We bin the furthest away leads into the last dummy so that all coefficient plots can be seen on the same graph. The omitted variable is the ten months just prior to treatment.

42 A joint significance test of leads 2, 4, 5, and 6 has a p-value of 0.5, which falls to 0.02 if we include lead 3. Similarly, a joint significance test on lags 2 through 6 has a p-value of 0.053, but once we include lags 7 and 8, the p-value grows to 0.105.

43 The joint significance on all five leads has a p-value of 0.93. The joint significance of the first 6 lags has a p-value of 0.10.

44 The Fisher sharp null assumes that no single unit has a treatment effect, which is a powerful statement and test.

45 Although Goodman-Bacon (2018) does not decompose the Poisson fixed effects estimator, it seems likely that the same problems carry over to Poisson estimators. But the decomposition of a Poisson fixed effects estimator under differential timing is presently unknown.

46 We utilize the *gsynth* package (see https://cran.r-project.org/web/packages/gsynth/index.html for more information about the *R* package) to determine the missing components of the matrix.

47 Recall that Appendix Table **A.1** found considerable support for the notion that the conditional independence assumption is satisfied. See Assumption (1) in Athey et al. (2021) for a more technical discussion of this assumption.

48 Another assumption concerns the construction of the *L* matrix itself, which is that measurement error is independent of L, and that the elements of that measurement error are σ-sub-Gaussian and independent of each other.

49 The primary dependence that we find between treatment dates is population and distance from the Bay Area. We adjust for population by construction population weighted counts as our dependent variable.

50 We include a random, uncorrelated variable to the estimation so that the bootstrapping procedure can generate standard errors and confidence intervals.

51 Though burglaries are typically categorized as property crimes, they are a violent type of property crime since it involves home invasions.

52 Conducting such falsifications for property crime is more complicated, as the introduction of ERS and Craigslist occurred simultaneously in the later years of our data. Of the 304 ORIs in our final sample, 130 (43%) were treated with ERS and Craigslist simultaneously. As the primary use of Craigslist is the exchange of goods and services, Craigslist may have unique effects on property crime. As shown in Hagiu and Rothman (2016), the introduction of online matching platforms enhanced the safety of the exchange of goods, resulting in potentially lower levels of property crimes. But the introduction of Craigslist, for our purposes, should not be relevant to the commission of violence between parties, which is why we favor using violent offenses as a falsification.

53 On average, there are approximately 11 new entrants per market per month, or approximately 2.5% of the market.

54 Bass (2015a) writes: "Having the ability to advertise online allows sex workers to more carefully screen potential customers and work indoors. Research shows that when sex workers can't advertise online and screen clients, they are often forced onto the street, where it is more difficult to screen out violent clients and negotiate safe sex (i.e., sex with condoms). They are also more likely to have to depend on exploitative pimps to find customers for them."

55 Consider an analogy involving automobile safety and aggregate traffic fatalities. As cars have gotten safer and more affordable, more people buy them, and more accidents occur, even though the probability of an accident has fallen, even accounting for any potential moral hazard raised by other authors (Peltzman 1975).

56 As matches improve, higher ratings on performance and appearance are practically guaranteed if for no other reason than that they have matched with a more preferred worker.

57 Scott (2002) notes that "street sex workers have lower status than sex workers who work indoors. They are often in some state of trauma and deterioration (e.g., running away from abusive situations, becoming drug-dependent, deteriorating psychologically, or *getting less physically attractive*)" (emphasis added).
58 This may also hold for intensive margin shifts in clients if new clients frequenting indoor sex workers rate female workers lower on average.