Internet's Dirty Secret:
Assessing the Impact of Technology Shocks on the
Outbreaks of Sexually Transmitted Diseases[*]

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Abstract

This study investigates the impact of online platform's entry on the prevalence of sexually transmitted diseases (STD) in the United States. In particular, we examine how the expansion of Craigslist into different U.S. states over 8 years affects the incidence of AIDS and Syphilis. As an electronic intermediary, Craigslist's personal ads facilitate the search process for casual sex partners, thereby increasing the number of casual hook-ups and STD rate. Using a difference-in-difference approach that exploits the variation across states and time, we identified the effects of Craigslist's entry on STD trends through a natural experiment setup. After controlling for extraneous factors, results showed that Craigslist's entry give rise to 14 and 18.8 percent increase in rate of AIDS and Syphilis cases, respectively. Not only do these increases in STD cases represent serious health concerns on the population, they also imply heavy economic toils on the U.S. healthcare system. For instance, the increase in new AIDS cases resulting from Craigslist's entry imposes a hefty treatment cost of over $94 million annually. Through our subsample analysis, we find that the increase in AIDS cases is largely driven by the volume of "Men Seeking Men" ads posted while the increase in Syphilis cases is affected by the number of "Men Seeking Women" and "Women Seeking Men" ads. We discuss implications of our paper for policies and regulations to curb the impact of Craigslist on STD trends.

1. Introduction

Sexually transmitted diseases (STDs) are major public health concerns that can impose both physical strains and psychological stigmatization on infected patients. Apart from these consequences, STDs impose heavy economic tolls: it costs the U.S. healthcare system $16.4 billion to treat 19 million new STD infections each year.[1] On top of these costs, expenses are also incurred in the prevention and awareness programs (e.g. Red Ribbon Project and Syphilis Elimination Effort). Yet, external shocks via the Internet can disrupt the control over STD proliferation and undermine the effectiveness of prevention programs. In particular, online classified advertising, personal and hook-up sites make it easier for individuals to find casual sex partners, thereby increasing the incidence of casual sex and STDs. This study aims to investigate whether the entry of a major classified personal ad site, Craigslist, increases STD rates.

The entry of Craigslist produces a transformative shift in people's casual sex seeking behavior. The ease of seeking sex partners through Craigslist's personal ad listings have brought a culture of sexual openness to the younger generation not seen since the seventies. Interviews reveal that not only do users search for strangers online to have no-strings attached relationships; they also post ads to solicit more diverse sexual experiences.[2] For instance, a 32-year old newspaper editor posted an ad in which she declared December 2002 to be a moral free zone, where she would have sex with whoever she wants with minimum self restrain. Her ad received responses from 70 men of which she met up with ten. Craigslist personal ads are also being used by individuals to look for extramarital affairs as exemplified by the recent case of the married Congressman, Christopher Lee. The Congressman sent emails and his shirtless photo to a woman found on Craigslist's personals section. Lee made an abrupt

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[1] Figures reported by Center for Disease Control and Prevention (http://www.cdc.gov/std/stats09/trends2009.pdf)
[2] Report available at http://nymag.com/nymetro/news/features/n_8227.

resignation from his Upstate New York seat when news of his correspondence was reported online.[3] In addition to transforming people's sex seeking behavior, Craigslist has created a market infrastructure that has served to channel a large and growing share of the commercial sex market off the street. As a result, less than 20 percent of transactions in the United States were conducted in the traditional outdoor environment in recent years (Cunningham and Kendall, 2010). Craigslist was also named as the 'single largest source of prostitution in the nation' by the law enforcement office.[4] Finally, the sizable revenue of $45 million yielded from Craigslist's adult service alone in 2010 indicates that there is a non-trivial usage of Craigslist as a platform for commercial sex purposes.

The biggest risk faced from having casual sex with online strangers is the possibility of contracting sexually transmitted diseases (STDs). No matter how carefully one tries to vet one's partners, it would be difficult to accurately know their entire STD history. Many people are not even aware of their own STD status; an online stranger's assurances that he or she is "STD-free" are dubious at best. Thus, it should not come as a big surprise that the period of Craigslist expansion witnessed an increase in STD cases in the United States. Before the start of Craigslist's expansion efforts in 2000, the number of new AIDS cases was declining in the late 1990s. This decreasing trend was disrupted upon the onset of Craigslist's expansion in the United States (see Figure 1). AIDS is not the only STD that has experienced a shift in trends during the period of Craigslist expansion. The number of new Syphilis cases was decreasing steadily in 1990s and met an all time low in 2001. An outbreak occurred after 2001 and persisted over the next 5 years along with the expansion of Craigslist in the United States (see Figure 2), producing an average increase of 11% of primary and secondary Syphilis cases each year.[5]

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[3] Report available at http://www.washingtonpost.com/wp-dyn/content/article/2011/02/10/AR2011021003020.html
[4] Report available at http://archive.chicagobreakingnews.com/2009/03/sheriffs-lawsuit-says-craiglist-largest-source-of-prostitution.html.
[5] Figures calculated and provided by CDC. See http://www.cdc.gov/std/stats/default.htm.

In this study, we investigate the impact of Craigslist's entry on STD trends via a natural experiment setting. Craigslist's expansion in the United States took place from 2000 to 2005 during which the website was made available in certain cities at each time. Our identification strategy relies on a difference-in-difference approach that assesses Craigslist's post-entry impact by detecting changes in the rate of AIDS and Syphilis cases based on the variations in Craigslist's presence across states and time periods. In operationalizing the difference-in-difference model, we ran panel regressions with state and year-quarter fixed effects and included multiple controls for demographic, socioeconomic and internet penetration variables. Results of the panel regressions are found to be consistent with that derived from count data model specifications. We further show that this set of results is robust when the number of posted personals ads is used as an alternative measure of entry, in which we are effectively using a more precise measurement of the activity level of Craigslist's personals section.

Our empirical analyses revealed that the entry of Craigslist leads to 14 percent increase in the rate of new AIDS cases, which is equivalent to 6658 new AIDS infections in the United States for each year.[6] This number of new AIDS cases translates to over $94 million in annual treatment costs. Craigslist's entry has a similar upward impact on the outbreaks of Syphilis. The entry of Craigslist is found to create an 18.8 percent increase in the rate of new Syphilis cases. This leads to annual treatment costs of over $0.84 million for these newly infected individuals. To ensure that the positive relation between Craigslist's entry and STD trends is not subjected to any endogeneity bias, we perform a series of empirical tests to scrutinize the exogeneity assumption of Craigslist's entry. We find the entry of Craigslist is exogeneous with respect to STD trends. Furthermore, there is no evidence to suggest the presence of a pre-trend leading to an increase in STD trends. Our subsample analyses show that specific types of personal ads on Craigslist are responsible for causing the increase in different types of STDs. More specifically, the

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[6] Calculated using 2005 figures.

increase in AIDS rate is driven by the number of "Men Seeking Men" ads, while increase in Syphilis rate is influenced by both the number of "Men Seeking Women" and "Women Seeking Men" ads.

The contribution of this study is three-folds. *First*, our findings contribute to previous research in economics that has investigated how information technologies can affect health outcomes and health-related behaviors. Examples include Miller and Tucker (2011) on electronic medical records improving neonatal outcomes, Lee (2008) on Internet usage increasing the demand for health professional contact and Athey and Stern (2002) on technology adoption enhancing emergency health outcomes. While extant work in this realm report the positive impacts of technology, our work represents the one of the first research effort that examines the unintended negative consequences of technology to society.

Second, our work contributes to a health policy literature that examines issues related to STD transmission. Previous studies have largely focused on examining the demographical effects on STD outbreaks (e.g. Chesson et al. 2010; Heffelfinger et al. 2007) while ignoring the relationship between the technology introduction and STD trends. Extant works that studied the link between technology and STD outbreaks were however limited in that they do not identify the specific source nor are they able to establish the causal relationship between technology and STD trends (e.g. Kent et al. 2003; Klausner et al. 2000; McFarlane et al. 2000). By utilizing a natural experiment setup, we are able to overcome the limitations faced in prior work while addressing the question of what kind of technology shocks affect STD trends. Our findings provide crucial inputs towards federal and state policy formulations aimed at cracking down and mitigating STDs. Currently, authorities assert little governance over Craigslist's operations while the site owners provide less than adequate effort in warning users against the risk of contracting STDs from strangers met on the site. Our results suggest that new policies should be considered given that the unrestricted operation and use of Craigslist leads to more AIDS and Syphilis

cases. Policy implications provided by the study are not limited to Craigslist but are also pertinent to other websites that facilitate hook-ups for casual sex (e.g. eros.com, eduhookups.com).

Third, by attempting to understand and quantify how STD trends change with the introduction of technology shocks, our study results contribute to the literature that investigates the interconnectedness between the Internet and offline world. For instance, Forman et al. (2008) explored the change in online behavior that results from the entry and existence of competing offline retailers. Seamans and Zhu (2011) studied the relation between the Internet and offline world by quantifying the impact of Internet shocks on advertisers' pricing strategies. In addition, Freund and Weinhold (2002) looked at how Internet penetration affects international trade. Our current study provides additional empirical evidence to illustrate the dependency between the Internet and offline phenomena.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data used in the study. Section 4 delineates the empirical methodology and Section 5 reports the results. The paper concludes with a discussion of policy implications and future work.

2. Literature Review

Craigslist is a website featuring free online classified ads with sections devoted to jobs, housing, personals, and items/services for sale. It was started in 1995 as an email distribution list of friends in San Francisco Bay area. A web interface was established in 1996, as the service got more popular. Following that, Craigslist was incorporated as a for-profit company in 1999 and began to expand to other locations rapidly. In 2000, Craigslist was launched in Boston, Chicago, New York and 6 other cities. The site expanded into four cities for each of the next two years and continued to expand into 14 cities in 2003. Craigslist expanded steadily over the years and is present in more than 700 local sites in 70 countries in

2011.[7] The staggered entry of Craigslist into different locations provides the main basis for our identification strategy (see Section 4).

Along the beginning of expansion, Craigslist launched its personals section featuring user ads for personal meet ups in the middle of year 2000. A typical personal ad post on Craigslist can consists of 1) an open-ended text requesting for meet up, 2) a telephone number, 3) a randomly generated Craigslist email address, and 4) photographs of the poster. Personal ads are further classified into subcategories that denote the relationship type that users would like to seek (e.g. men seeking men, men seeking women, casual encounters). An examination of the ad content in the personals section revealed that the purpose of some meet ups is to have casual sex. For instance, an ad reads *"Any Girls Looking to get Laid? Email ME – m4w"*. Another ad reads *"I have been single for a while and the tides will change, so I think I'll just settle for a one night stand. Preferably with an older man. –w4m".* The ease of posting feeless ads requesting for casual sex encourages the development of promiscuous behaviors within locations served by Craigslist.

Compared to other online personals sites, including Match.com, eHarmony, and Yahoo personals, Craigslist's personals sites have attracted the highest traffic since its expansion efforts in 2000.[8] Prior to its closure in late 2010, the "Adult Services" section on Craigslist charged $10 per post. The Advanced Interactive Media (AIM) Group, which has tracked Craigslist's revenue since 2003, estimated that revenue from adult services hit $45 million in 2010, more than three times of what it had earned in 2009. AIM also projected that Craigslist generated approximately $122 million in revenue in 2010, up

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[7] http://www.craigslist.org/about/factsheet, accessed August 2011.
[8] See http://www.nytimes.com/2009/04/19/fashion/19craigslist.html.

from $100 million in 2009.[9] These figures jointly suggest that the use of Craigslist to seek casual sex is substantial and proliferating.

The entry of Craigslist into a city can be understood as an emergence of an electronic intermediary that facilitates market transactions. As an electronic intermediary, Craigslist enables the efficient matching of buyers and sellers, making product/service offerings readily available (Bakos 1997). Not only do market participants experience a reduction in search cost, they also benefit from being able to identify products/services that better match their needs, allowing the market to operate more efficiently (Bakos 1997). Economic theory posits that the decline in search cost and heightened fit between services and consumer needs lead to more transactions taking place as the market clears.

Under the current study context, the presence of Craigslist's personals section acts as an intermediary that amasses the local demand and supply for casual sex. Personal ads on Craigslist provide participants in the sex market with key information regarding sexual transactions, including 1) location and time of meet up, 2) physical characteristics of potential partners such as ethnicity, nationality, age, build, sexual orientation, attractiveness, voluptuousness, 3) societal characteristics such as wealth, job, marital status, and 4) specific expectations and requests of intimate exchange. As such, personal ads not only signal sexual availability of individuals but also facilitate the locating of sex partners that have optimal fit with one's preferences. The ability to find well-matched sex partners has paramount importance in the sex market since this market is characterized by heterogeneous tastes and varied physical/service offerings. By fulfilling the dual roles of reducing search costs in locating available individuals and improving the fit between the sex seekers, Craigslist's personal ads soothes out the "friction" in the search process, thereby increasing the prevalence of casual sex within the area served by the site.

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[9] See http://aimgroup.com/blog/2010/09/05/craigslist-adult-services-revenue-soared-new-figures-for-2010-44-4-million.

Craigslist's entry alone does not provide a complete picture in illustrating the incidence of STD cases. Factors leading to risky sexual behavior are often cited in explaining STD trends. Studies revealed that individuals who use the Internet to seek sex partners are more likely to engage in risky sexual behaviors compared to individuals who do not seek sex online: Internet sex seekers have more casual partners, engage in more anal sex, and are more likely to have sex with HIV positive partners (Kim et al. 2001). As such, with more users seeking sex partners via Craigslist after its entry into various locations, the number of STD cases increases.

On top of STD risk factors related to Craigslist, demographic factors should also be considered so that their effects can be properly controlled for in the analysis. Among the sexually experienced population, individuals from the adolescent, twenties and thirties age segments are most sexually active (Herbenick et al. 2010; Reece et al., 2010). The proportion of sexually active individuals constitutes towards the population that is at greatest risk of contracting STD infections. For instance, out of 18.9 million new STD cases reported in 2000, 48 percent were attributed to the adolescent segment, a major constituent of the sexually active population (Weinstock et al. 2004). Another demographic factor which affects STD trends comes from the ethnic make-up of a location. With a higher STD prevalence in the African American communities than in others, individuals within these communities face a greater chance of infection even if they have only one sex partner (Laumann et al. 1999). High rates of incarceration among the African American males resulted in disproportionate sex ratio, which destabilizes the community and disrupted its sexual network (Thomas and Torrone 2006). Consequently, poverty rates remain high in these communities, leading to risky sexual behaviors and inducing higher prevalence of STD cases among the African Americans (Hogben and Leichliter 2008).

STD transmission is also affected by socioeconomic factors such as education attainment and income level. Within a society, subpopulations marked with higher level of education attainment and incomes

have better access to health care and information needed to avoid STD infection (Bindman et al. 1995; Wasserheit and Aral 1996). The educated and rich subpopulation are also more motivated to implement preventive measures given that they are aware of the dangers and consequences of contracting STDs and have the capacity to do so. In contrast, areas with poor socioeconomic indicators are plagued with higher occurrence of substance abuse and prostitution activities (Edlund and Korn 2002). Addictions could lead individuals to offer sexual services in exchange of drugs, thereby increasing the STD trends. Prostitution serves as a lucrative source of income to the low-skilled women in poor and lowly educated communities (Edin and Lein 1997), which in turn leads to higher incidence of STDs.

Finally, differing Internet penetration rates across locations can influence the local prevalence of STDs. Internet diffusion improves the efficiency of communicating information to populations (Chinn and Fairlie 2006). Individuals can equip themselves with an unprecedented amount of health information from the Internet so that they become more aware and knowledgeable about the various diseases and infections (Hesse et al. 2005). Going by this argument, Internet penetration is deemed as a factor that dampens the spread of STDs. However, as a double edged sword, Internet could also serve to provide more chances for people to solicit casual sex. With greater Internet penetration, more individuals are using Internet as an avenue to make contacts with other people.[10] The increase usage in Internet has led to a multitude of casual hook-up sites, including Yahoo Personals, AshleyMadison.com, and AdultFriendFinder.com. By including the Internet penetration in our analysis, we would be able to account for the effects on STD trends from other personal sites.

At a broad level, this paper is related to a stream of literature that examines the interconnectedness between the Internet and offline world. In this spirit, our work is related to prior research that has explored the change in online behavior that results from the entry and existence of competing offline

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[10] http://www.economist.com/node/17797424.

retailers (Forman et al. 2008), the impact of Internet shocks on advertisers' pricing strategies (Seamans and Zhu 2011) and the positive relation between Internet penetration and international trade (Freund and Weinhold (2002). Among these works, our research context bears close similarity to that of Seamans and Zhu (2011), which investigates the impact of Craigslist's entry on stakeholders of the local newspapers. Through their empirical study, it is found that newspaper owners dropped their pricing rates for classified ads and raised the subscription prices upon Craigslist's entry into the local market. In turn, consumers reacted to the new pricing strategy, resulting in a decline in circulation share. Though Seamans and Zhu's work and our paper share the similarity of examining the impact of Craigslist on the offline behaviors of the local community, both works have studied disparate sections within Craigslist (personal ads versus classified ads for housing, jobs, sales/services), examined different outcome variables (STD rates versus ad pricing rates), and have distinct implications that appealed to different audiences (policy makers in healthcare and IT sectors versus newspaper and advertising managers). As such, contributions from our current work are unique and disparate from that of Seamans and Zhu.

Another stream of literature that is pertinent to our current work lies in the realm of online dating. Hitsch et al. (2010) examines the economic mechanisms that underlie match formation and mate selection on online dating sites. Their empirical analysis showed that in the absence of search frictions, mate preferences explain much of the sorting along physical and societal characteristics (e.g. looks, height, weight, income, marriage status, education level). Findings in Hitsch et al.'s work also revealed that online dating sites facilitate efficient matching of market participants based on individual preferences. This empirical result is congruent with the theory that was brought forth earlier which suggests that the intermediary function of Craigslist would ease the search process for suitable casual partners in the market, thus raising the incidence of casual sex in the area.

3. Data

To fulfill the goal of investigating the role of Craigslist's entry on STD trends, we constructed a nationwide panel data, which consist of the rates of new STD cases in 50 states and D.C. over a period of 8 years, from 1998 to 2005. The number of STD cases over these 32 quarters is obtained from the National Notifiable Disease Surveillance System (NNDSS) maintained by the Center of Disease Control and Prevention (CDC). The NNDSS tracks weekly information on notifiable diseases at local, state and national levels as an effort to prevent the introduction and spread of diseases in United States. Health departments from the 50 states, 5 territories, New York City and the District of Columbia are mandated to report nationally notifiable diseases to CDC for this purpose.

Among the STDs reported in NNDSS, we focus our analyses on AIDS and Syphilis because the spread of these STDs poses worrying concerns. With more than 550,000 individuals who have already died and an estimated 1.2 million people living with HIV/AIDS in 2007, the Center of Disease Control and Prevention classified AIDS as a national epidemic and took effortful steps to curb the spread of this incurable and lethal STD. Syphilis continues to exhibit uninhibited annual growth despite continuous prevention efforts over the years. The resurgence of Syphilis in 2001 thwarted the 1999 national plan to eradicate the disease by 2005, which imply that heavier burdens would be imposed on the U.S. healthcare system to contain its future growth.

To study the impact of Craigslist's entry, we collected data on the months in which new sites are launched.[11] With this data, we constructed a binary entry indicator for a state at a given quarter. More precisely, this study seeks to understand how the introduction of personals section will affect STD rates. Hence, we need to account for states that had Craigslist sites before the launch of personals section. Upon closer examination, only the state of California is affected and we adjusted its entry variables

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[11] Collected from http://www.craigslist.org/about/expansion, accessed on 18 June 2011.

accordingly.[12] On top of the binary entry variable, we have also constructed a measure of the usage level of Craigslist's personals section after its launch in each state. We collected personal ads data retrospectively through Archive.org, a site which provides digitized snapshots of websites over time. The contents of Craigslist.org were consistently archived from December 1998 to recent years, allowing us to construct quarterly data on number of personal ads posted on each site.

Control variables were collected from several sources. Age, population size and ethnicity data were retrieved from the Surveillance Epidemiology and End Results (SEER) database.[13] The SEER database collects demographic data and uses them for supporting cancer-related research for the population within the United States. The SEER database has extensive breakdown of the age group proportion and ethnicity proportion for all U.S. states over the entire study period (i.e. 1998 to 2005), making it an ideal source for demographic variables for the current study. Data on education attainment and income was obtained from the U.S. Census Bureau, which collects yearly surveys on the proportion of population that has attained high school education and household income by states. Finally, data on the internet penetration was retrieved from the records made by Federal Communication Commission (FCC). The FCC tracks the statistics of subscribership data for high speed Internet access services faster than 200 kbps in at least one direction file twice each year. Table 1 lists the summary statistics of the variables.

4. Empirical Methodology

The expansion of Craigslist into different regions over different time periods creates a natural experiment setting that allows the comparison of the rate of STD cases before and after Craigslist's entry and between cities with Craigslist presence and those without. We exploit the variation across states and year-quarters in the natural experiment setting as the basis for identifying the effect of Craigslist's

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[12] The personals section was started in June 2000. The San Francisco Bay Area was the only location that had Craigslist presence prior to that date.
[13] Provided by the U.S. National Institutes of Health.

entry on STD trends. This identification strategy is implemented via a differences-in-difference approach in our analysis (see Jin and Leslie 2003; Seaman and Zhu, 2010). Two sets of model are tested to ensure that robust results are obtained. The basic specification is of the following form:

$$y_{it} = \beta_0 + \beta_1 CraigslistEntry_{it} + \delta X_{it} + \alpha_i + \gamma_t + \varepsilon_{it},$$

where y_{it} is the dependent variable, which refers to the rate of new AIDS cases or the rate of new Syphilis cases for state i at time t. In the first model specification, $CraigslistEntry_{it}$ is a dummy variable which equals one in the quarters after Craigslist enters the state and zero otherwise. In the second model specification, this variable is replaced with $No.PersonalAds_{it,}$ which captures the number of posted personal ads in a state for each quarter. It is equal to some positive number after Craigslist enters a state and is zero in all the quarters before Craigslist enters. X_{it} is a vector of control variables which includes sexually active proportion (ages 15-35), proportion of African Americans, population proportion with high school attainment, population size, income level, and Internet penetration level. α_i is a state fixed effect and γ_t is a year-quarter fixed effect.

In the above specification, the state level fixed effects controls for time-invariant differences across states and the quarter fixed effects controls for common macroeconomic shocks across time. Despite these fixed effects, unobserved demographical and socioeconomic trends may still drive the rate of STD cases. To account for such effects, several control variables X_{it} are included in the model specification to account for factors that vary within each state over time. Details of these control variables and their effects have been delineated earlier. On top of these control variables, a time trend variable is added to control for general progressions of diseases across time.

For all model specifications, the error terms are clustered at the state level to account for autocorrelation in the data across states and over time. By clustering error terms, we prevent the underestimation of standard errors and relax the assumption of independence of error terms of states

that are close to one another (Bertrand et al. 2004). Heterogeneity in population's Internet sex seeking behavior and the ease of access to the Internet would make the use of Craigslist for seeking casual partners more rampant in some areas than others. The analysis using the number of personal posts on Craigslist was used as a robustness check to address this concern. Furthermore, the use of number of personal ads as a regressor directly captures the activity level on Craigslist's personals section, thereby reducing the threat of contemporaneous effects of unobserved factors associated with Craigslist's entry.

However, linear models can have shortcomings when imposed on count data. One may argue that the coefficients would be more accurately estimated using count data models. To further test the robustness of our results, we ran count data models using raw counts of new STD cases as dependent variables on all model specifications. Count data models with fixed effects are known to suffer from the "incidental parameters problem," except for the Poisson model. Therefore, we implemented a Poisson fixed effect model in which the incidental parameter problem is not a problem (Lancaster 2000, Greene 2007).

5. Results

5.1 Main Estimation Results

Table 2 presents the main results for our empirical analysis for AIDS. All models include state and year-quarter fixed effects. We see that the *Craigslist Entry* dummy variable yields a positive and significant coefficient across all models. After controlling for extraneous factors, Model 3 suggests that Craigslist's entry has had an effect of increasing the rate of new AIDS cases by 14 percent. To understand this increase in a more concrete fashion, we translate the coefficient into the number of AIDS cases based on 2005 figures. The average rate of new AIDS cases grows from 13.0 to 18.6 (per million) which meant that 6658 new AIDS infections are introduced on average in the United States each year as a result of Craigslist's entry. Though this coefficient is small compared to that of the sexually active proportion,

Craigslist's entry nevertheless exerts an economically significant impact on the U.S. healthcare costs. The increase in AIDS cases brought by Craigslist's entry leads to over $94 million in annual treatment costs.[14] The fixed effects Poisson regressions (Models 2 and 4) produced positive and significant coefficients for the *Craigslist Entry* variable, thus providing further confidence in the results from Models 1 and 3. In addition, the effect of Craigslist entry does not diminish when more covariates are added to the model.[15]

Across all models in Table 3, the coefficients for the *Craigslist Entry* are positive and significant, suggesting that the launch of Craigslist results in higher incidence of new Syphilis cases in a state. Looking at Models 1 and 3, we see that the coefficient for Craigslist's entry dips in magnitude slightly after extraneous variables are controlled for, but it still remains positive and significant. More specifically, the entry of Craigslist leads to an 18.8 percent increase in the rate of new Syphilis cases (Model 3). In terms of 2005 figures, this positive coefficient implied that approximately 1672 new cases of Syphilis infections in the United States each year arose from the introduction of Craigslist. It is also observed that the sexually active proportion variable has a large and positive coefficient and is deemed to be a major driver of Syphilis trends. Though the Craigslist's entry coefficient is small compared to that of adolescent proportion, the launch of Craigslist translates to annual treatment costs of over $0.84 million for individuals who are newly infected with Syphilis. Count data models show that the Craigslist entry variable is positive and significant, thus providing further rigor in establishing the positive relationship between the Craigslist's entry and Syphilis rate. We observed that the positive impact of Craigslist's entry on Syphilis rate remains even after including additional control variables.[16]

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[14] Figures are calculated based on 1) mean number of new AIDS cases in 2005, 2) population figures from U.S. Census Bureau for 2005, and 3) treatment cost per person from Chesson et al (2004).
[15] The sign and significance for the coefficient on Craigslist's entry stays the same after controlling for homosexual proportion and male-female ratio.
[16] The coefficient for Craigslist's entry is positive and significant after introducing homosexual proportion and male-female ratio into the model.

5.2 Robustness Checks

We performed several robustness checks on our results. First, we used an alternative way of measuring Craigslist's entry. Using the number of personal ads posted on Craigslist, we capture the activity level on Craigslist's personals section in different states, thus accounting for heterogeneity in usage levels and controlling for effects from unobserved factors that vary with Craigslist's entry.

Second, we systematically addressed the endogeneity concern of Craigslist's entry. One may reason that Craigslist's entry decision into a state is endogenous and may be influenced by unobserved time-varying variables that constitute to the real cause for the increase in STD cases. If this argument is valid, the reported results will be undermined as the state and time fixed effects are unable to capture the effects of these unobserved variables. A cursory investigation revealed that Craigslist's entry decisions are driven by user requests[17] and to our best knowledge there is no theoretical and practical reason that suggests that factors related to STD trends play a role in influencing Craigslist's entry. Nevertheless, we provided empirical validation through the use of hazard models and falsification tests to rule out this possibility.

Robustness check results in Table 4 showed that the coefficients on number of personal ads are positive and significant across Models 1-4. This means that after accounting for population heterogeneity via personal ads, a positive relationship between Craigslist's presence and the rate of new AIDS cases is still present. In particular, a ten percent increase in the number of personal ads leads to a 0.15 percent increase in AIDS rate (Model 1), which is equivalent to approximately 60.5 new cases of AIDS infections in United States for the year of 2005. For the case of Syphilis, coefficients for number of personal ads are also positive and significant (Models 3 and 4). For instance in Model 3, a ten percent increase in the number of personal ads induces an increase of 0.34 percent in Syphilis rates. This increase maps out to

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[17] Craigslist factsheet reports how sites are chosen. See http://www.craigslist.org/about/factsheet.

26.6 new cases of Syphilis infections in United States in the year of 2005. Poisson fixed effect regressions for both AIDS and Syphilis models revealed that the signs and significance of the personal ads variable are robust under non-linear model specifications. Taken together, the estimates in Table 4 suggest that the sign and significance of entry estimates from the main analyses are robust to other forms of variable operationalization.

Next, we test for the possibility of endogeneity in Craigslist's entry. Using hazard models, we predict the entry of Craigslist into states as a function of demographics, socioeconomic factors, Internet penetration and STD trends. The variables for STD trends were set up to be time varying covariates that interacted with time and the logarithm of time. Table 5 presents the results of the analysis. Model 1 includes only the demographic, socioeconomic and Internet penetration variables. Model 2 and 3 test the impact of STD variables on entry. Internet penetration and age are found to be significant predictors of Craigslist entry. Its impact does not threaten the validity of the results since these factors have been appropriately accounted for through covariates and state fixed effects in all previous specifications. Additionally, Models 2 and 3 showed that the STD variables neither exert significant impacts on Craigslist's entry nor improve model fit.[18]

To further rule out the possibility that STD trends are increasing due to unobserved factors, we performed falsification tests to examine whether STD rates are already increasing prior to Craigslist's entry. A placebo dummy variable which indicates the quarters one year before Craigslist's entry was introduced to the models examined previously. As shown in Table 6, the placebo dummy variable did not pick up any pre-trend effect and the original Craigslist entry coefficients remain positive and statistically significant. This set of results is in favor of the exogeneity of Craigslist's entry, thus giving us greater confidence in the validity of the results.

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[18] Likelihood ratio tests were used to compare Model 1 with 2 and Model 1 with 3. The results showed that the less restrictive models (Models 2 and 3) do not perform significantly better than the restrictive model.

5.3 Analysis based on Personal Ad Type

The analyses thus far have demonstrated that the entry of Craigslist has the effect of increasing the prevalence of AIDS and Syphilis rates. The analysis involving the number of personals ads posted on Craigslist provides us with some evidence that the personals section is responsible for the shift in STD trends seen in the post entry years. To further understand the causal mechanism behind the rise in STD cases after Craigslist's entry, we would examine how different ad types within the personals section impact AIDS and Syphilis rate.

When posting an ad within the personals section, individuals could specify the type of relationship they are seeking for. These relationship types include "Casual Encounters", "Men Seeking Men", "Men Seeking Women", "Women Seeking Men" and "Women Seeking Women". We collected the number of personal ads posted under each category between 2002 and 2003 for 15 states and performed our difference-in-difference analysis using the aggregated number of ads under each category in place of the entry variable.

Table 7 reports the results of our sub sample analysis based on ad types. From Model 1, we observe that the number of "Men Seeking Men" ads has a positive and significant coefficient, which implies that Craigslist's upward impact on AIDS trends is largely driven by the use of "Men Seeking Men" ads within the personals section. This result is in line with real-world data that tracks the progression of AIDS cases over time. Surveillance data shows that men who have sex with men (MSM) have always been the largest group of all AIDS patients since its inception in the United States.[19] In particular, AIDS transmission via MSM contact is disproportionately larger than heterosexual contact. Additionally,

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[19] See http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5127a2.htm, accessed on 13 Nov 2011.

surveillance data revealed that the number of new HIV/AIDS diagnoses among MSM experienced a significant increase from 2001 through 2005.[20]

In the second model that investigates the Syphilis rate, it is interesting to see that the number of "Men Seeking Women" and "Women Seeking Men" posts have positive and significant coefficients. This indicates that the effect of Craigslist on higher incidence of Syphilis is brought about by personal ads that solicit heterosexual sex partners. This finding is aligned with extant literature on transmission mechanism of Syphilis. Unlike AIDS, Syphilis transmission is characterized by heterosexual contact as evidenced in the similarity in timing of peaks and troughs of Syphilis rates for men and women over time (Peterman et al. 2005). Taken together, the results implied by the subsample analysis are strongly matched to STD phenomena in the real world. That is, personal ads posted under relationship types that are related to the increase of AIDS and Syphilis trends parallel the dominant transmission mode for each STD respectively.

6. Discussion and Conclusion

Though there have been a fair amount of anecdotal evidence in the trade press that suggest that the introduction of the Internet brings about greater incidence of STDs, there is no existing empirical work that establishes its causal impact. This study represents the first empirical effort that quantifies the causal impact of Craigslist's entry on increasing AIDS and Syphilis rates in the United States. By utilizing Craigslist's varying entry time into different cities, we are able to identify the causal effect of its personal ads on STD trends.

Our study results demonstrate that a minimally regulated online intermediary with no advertising cost increases the number of transactions taking place among market participants, including transactions

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[20] CDC. *HIV/AIDS Surveillance Report, 2005*. Vol. 17. Rev ed. Atlanta: US Department of Health and Human Services, CDC; 2007:1-46.

that have undesirable consequences. The case of Craigslist's entry leading to more STD outbreaks serves to show that market participants exert little regulation over their casual sex behavior despite the known risks involved. Not only would this result in more STD infections within the society, the nation would also need to bear a heavier economic burden as more resources would be needed to treat the infected population. The societal damages brought about by Craigslist raise crucial questions for policy makers and information systems practitioners: Can we really allow the Internet to be fully unregulated and available to anyone? Whose responsibility is it to regulate sites: site owners or the central authority?

Craigslist takes on a minimal censorship stance towards its user posts and relies on its user community to moderate its content. The "hands-free" approach taken by Craigslist's owners in moderating the site has led to increased opportunities for users to engage in risky behaviors of seeking casual sex partners online. Last year, Craigslist came under attack by a number of state Attorney Generals over its "adult services" ads on the basis of its adult ads were adding to the rising concerns on the spread of STDs. The AGs and other law makers called on the site to take down the category. Craigslist's intent of creating the "adult services" category in the first place was to limit adult-related ads from being posted in a broad range of non-adult categories. Over 50 million new ads are posted every month and it is virtually impossible for Craigslist to monitor and remove adult ads that show up in the different categories across the site. Furthermore, under U.S. law, Craigslist is not obligated to do so. To clean up the site, Craigslist decided to push all such ads into one category, thereby keeping them out of the non-adult categories. However, with the disabling of the adult services category at the behest of the AGs, there are increasing concerns and anecdotal evidence showing that the adult-related ads are now being posted in the non-adult categories in Craigslist.[21] This may have grave unintended societal consequences as it potentially exposes even minors to such ads.

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[21] See http://online.wsj.com/article/SB10001424052748704392104575475972114109814.html.

Hence, we believe that law makers should be more careful before executing such blanket ban campaigns. To reduce adverse health outcomes from online institutions, authorities should probably consider setting operating guidelines over Craigslist-like sites instead of a complete blanket bans for such ads. A possible guideline would be requiring Craigslist to put up explicit and strong warnings to inform users that finding sex partners on the site could put oneself in danger of contracting STDs. A concrete implementation of this could be the use of visual warnings to deter users from having undesirable behaviors, a technique that was shown to be effective in making smokers contemplate about quitting.[22] Another guideline is to have stronger enforcement of the age limit to restrict access to the personal ads so as to protect the risk-prone adolescent population. To do so, authorities and policy makers in IT governance may consider looking into the development of technical solutions which are capable of verifying the users' age and offer the free use of this technology on personals sites.[23]

Our paper has a few limitations: some of which can pave the way for future research in this area. We do not have data on the content of the ads. Future research could use linguistic analyses and text mining techniques to include the information in those ads in the empirical analyses to provide further insights on how personal ads affect STD trends. Our analyses are constrained to AIDS and Syphilis as a result of data limitations. Currently, the CDC does not track of the number of certain STD infections because these diseases are not classified as nationally notifiable and/or not properly accounted for by local health institutes. The examination of other STDs would serve to complement findings from our study. In addition, future work should examine the impact of personal ad sites on teen pregnancies and divorce rates, which have important societal and health implications too. The robustness of current study results can be further improved upon the controlling for effects from federal education programs and incentives on condom use. Notwithstanding these limitations, this work represents the first attempt in

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[22] See http://www.huffingtonpost.com/2011/06/20/cigarette-warnings-labels-photos-fda_n_880885.html.
[23] Similar technologies (e.g. adult online pass) have already been developed by the private sector and are offered for use over subscription fees.

quantifying the causal relation between Craigslist's entry and STD trends via with a set of robust empirical tests performed through a natural experiment setting. Through this work, we hope to bring about greater awareness on how unregulated Internet sites can have a detrimental effect on society. At the same time, we aim to generate interest in this key area of research and to spur academicians and practitioners to look into possible policy formulations that could reduce the negative impacts of unregulated websites.

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Figure 1: AIDS Trends before and after Craigslist's expansion
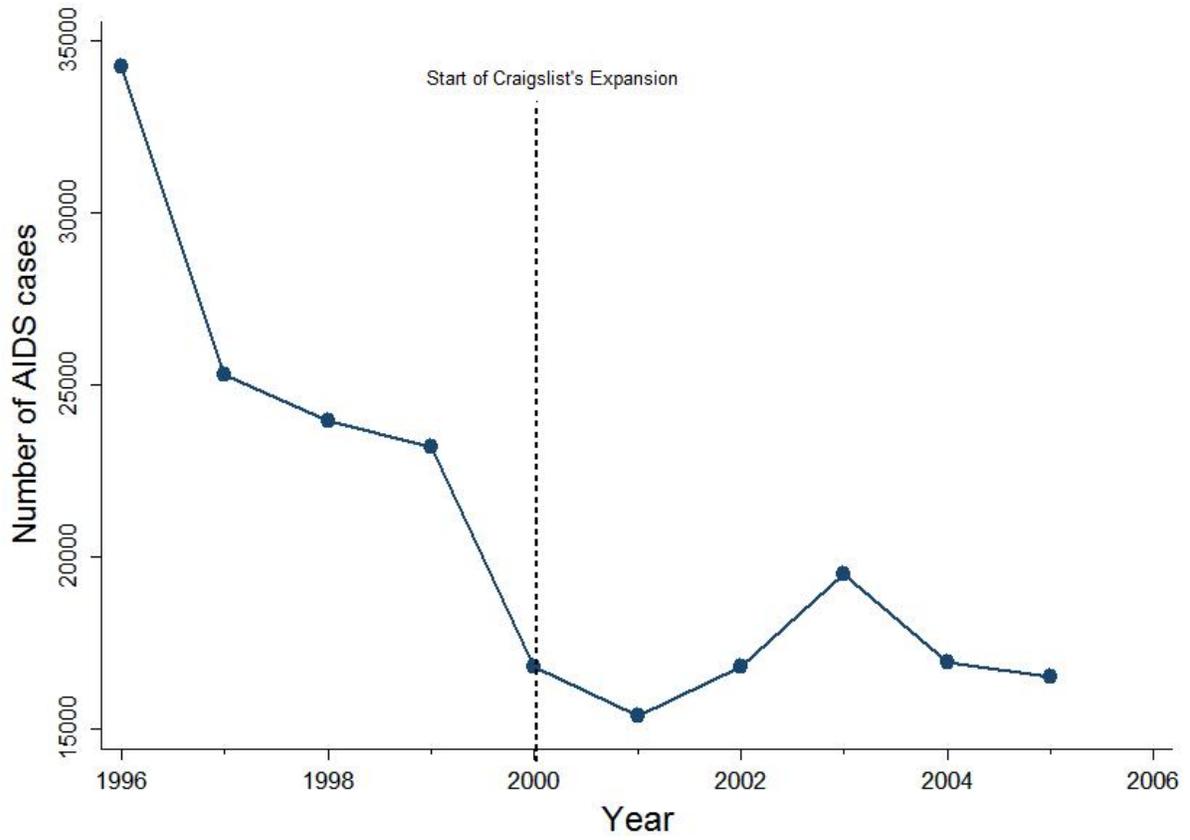
Figure 2: Syphilis Trends before and after Craigslist's expansion
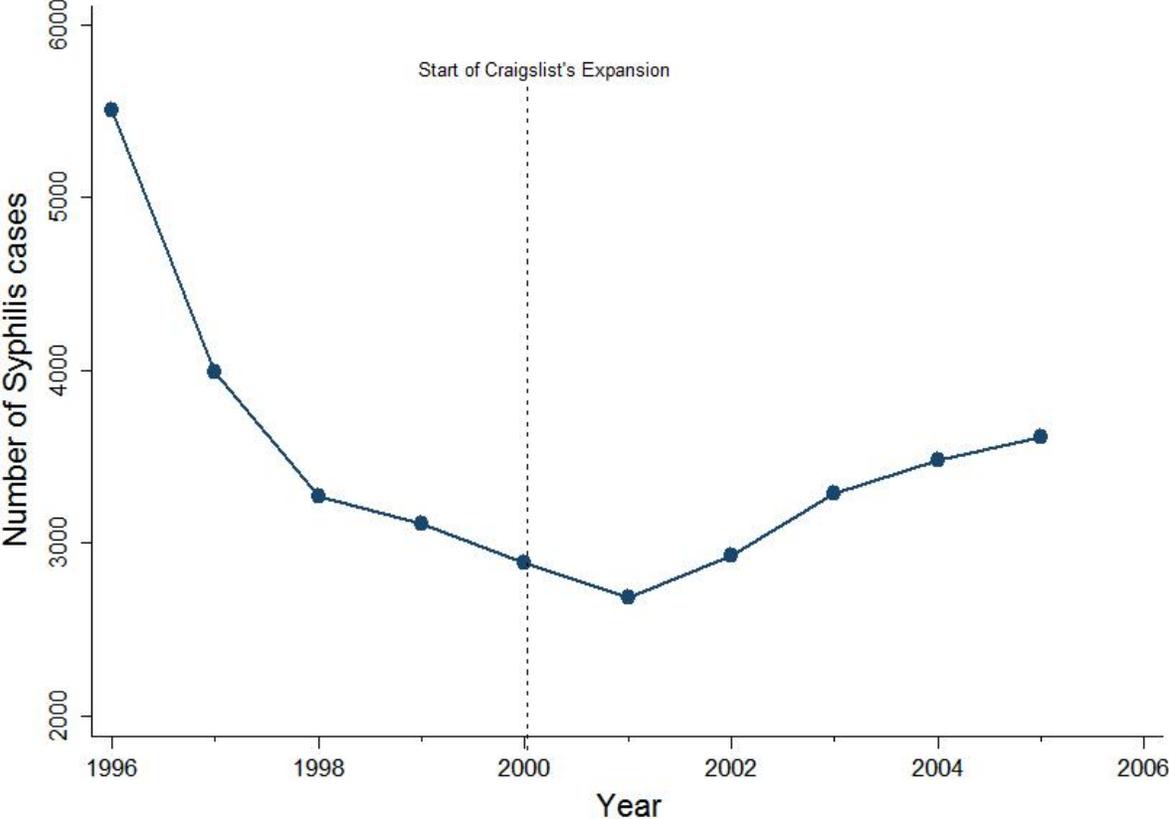
Table 1: Descriptive Statistics of Panel Data

Variable	Obs	Mean	Std. Dev.	Min	Max
Log AIDS Rate	1632	2.913	1.038	0	6.617
Log Syphilis Rate[†]	1625	1.334	0.959	0	4.145
Craigslist Entry	1632	0.274	0.446	0	1.000
Log No. of Personal Ads	1632	2.678	4.632	0	15.733
Sexually Active Proportion	1632	0.278	0.016	0.245	0.344
Proportion of African American	1632	0.115	0.117	0.003	0.628
Proportion of High School Attainment	1632	0.854	0. 039	0.751	0.928
Log Median Income	1632	10.845	0.149	10.479	11.167
Log Internet Penetration[‡]	1352	12.074	1.511	6.840	15.789
Log Population Size	1632	15.038	1.033	13.103	17.393

[†] Some states did not report the number of new Syphilis cases in certain quarters, resulting in fewer than 1632 observations.

[‡]The Federal Communication Commission (FCC) collects yearly surveys on Internet adoption by households from 1999 onwards. Certain states have failed to report Internet adoption figures in certain years, thus resulting in 1352 observations.

Table 2: Impact of Craigslist's Entry on AIDS

	OLS (1) Log AIDS Rate	Poisson (2) No. AIDS Cases	OLS (3) Log AIDS Rate	Poisson (4) No. AIDS Cases
CL Entry (Binary)	0.114** (0.049)	0.201*** (0.061)	0.131** (0.050)	0.202*** (0.074)
Sexually Active Proportion			24.578** (10.718)	-4.622 (9.752)
High School Attainment Proportion			1.840 (1.543)	1.094 (1.273)
African American Proportion			7.422 (4.932)	4.522 (7.340)
Log Median Income			-0.703 (0.439)	-1.276*** (0.414)
Log Internet Penetration			0.052 (0.051)	-0.153* (0.083)
Log Population Size			-0.175 (1.061)	0.839 (0.780)
State fixed Effects	Yes	Yes	Yes	Yes
Year-quarter Fixed Effects	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes
Observations	1625	1625	1347	1347
R-Squared	0.065		0.067	

Notes: Dependent variable for Column 1 and 3 is the log of AIDS cases per 1M people. Dependent variable for Column 2 and 4 is the number of AIDS cases. Robust standard errors are clustered at state level.
* p < 0.10, ** p < 0.05, *** p <0.01

Table 3: Impact of Craigslist's Entry on Syphilis

	OLS (1) Log Syphilis Rate	Poisson (2) No. Syphilis Cases	OLS (3) Log Syphilis Rate	Poisson (4) No. Syphilis Cases
CL Entry (Binary)	0.204** (0.079)	0.396*** (0.101)	0.172** (0.067)	0.232** (0.118)
Sexually Active Proportion			38.772*** (13.113)	42.311 (28.175)
High School Attainment Proportion			-2.383 (2.322)	-9.007** (4.542)
African American Proportion			-12.602 (16.713)	-30.645 (28.896)
Log Median Income			0.664 (0.639)	1.464 (0.964)
Log Internet Penetration			-0.095 (0.126)	-0.290 (0.362)
Log Population Size			4.204 (2.653)	3.620 (3.632)
State fixed Effects	Yes	Yes	Yes	Yes
Year-quarter Fixed Effects	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes
Observations	1625	1625	1347	1347
R-Squared	0.033		0.081	

Notes: Dependent variable for Column 1 and 3 is the log of Syphilis cases per 1M people. Dependent variable for Column 2 and 4 is the number of Syphilis cases. Robust standard errors are clustered at state level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Impact of Personal Ads on AIDS and Syphilis

	OLS (1) Log AIDS Rate	Poisson (2) No. AIDS Cases	OLS (3) Log Syphilis Rate	Poisson (4) No. Syphilis Cases
Log No. CL Ads	0.016***	0.025***	0.036***	0.059***
	(0.006)	(0.006)	(0.008)	(0.014)
Sexually Active Proportion	26.698**	-2.814	44.063***	39.320
	(10.544)	(9.589)	(13.041)	(25.334)
High School Attainment Proportion	1.805	1.076	-2.241	-8.621**
	(1.547)	(1.346)	(2.281)	(4.387)
African American Proportion	8.953*	7.278	-8.709	-24.515
	(4.911)	(7.660)	(15.785)	(25.677)
Log Median Income	-0.716	-1.440***	0.697	1.221
	(0.437)	(0.409)	(0.623)	(0.896)
Log Internet Penetration	0.055	-0.174*	-0.083	-0.273
	(0.052)	(0.102)	(0.126)	(0.323)
Log Population Size	-0.392	0.481	3.427	2.348
	(1.059)	(0.801)	(2.629)	(3.313)
State Fixed Effects	Yes	Yes	Yes	Yes
Year-quarter Fixed Effects	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes
Observations	1347	1347	1347	1347
R-Squared	0.068		0.103	

Notes: Dependent variable for Column 1 and 3 is the log of STD cases per 1M people. Dependent variable for Column 2 and 4 is the number of STD cases. Robust standard errors are clustered at state level.
* p < 0.10, ** p < 0.05, *** p <0.01

Table 5: Hazard Models for Predicting Craigslist's entry

	(1) No Interaction	(2) Linear	(3) Exponential
Log Population Size	-1.095 (0.847)	-1.318 (0.865)	-0.968 (0.850)
Sexually Active Proportion	24.017*** (8.351)	26.658*** (8.581)	23.429*** (8.328)
High School Attainment Proportion	0.926 (6.026)	3.345 (6.368)	0.997 (6.088)
African American Proportion	0.639 (1.773)	-0.619 (2.352)	0.677 (1.719)
Log Median Income	-0.697 (1.413)	-1.573 (1.559)	-0.612 (1.446)
Log Internet Penetration	1.834** (0.798)	1.853** (0.784)	1.670** (0.827)
Log No. New AIDS Cases		0.018 (0.013)	16.478 (16.664)
Log No. New Syphilis Cases		-0.009 (0.009)	-12.405 (13.069)
Observations	963	959	959
Log Likelihood	-140.126	-139.341	-139.865

Notes: Cox-Proportional hazard models are estimated. STD variables are specified as time varying covariates in Models 2 and 3. In Model2, STD trends are modeled to vary linearly with time while STD trends in Model 3 are modeled to vary in an exponential fashion with time. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Falsification Tests

	(1) Log AIDS Rate	(2) Log AIDS Rate	(3) Log Syphilis Rate	(4) Log Syphilis Rate
Placebo Dummy	0.063 (0.045)	0.034 (0.052)	0.017 (0.062)	-0.033 (0.056)
CL Entry	0.152*** (0.050)	0.153** (0.058)	0.215** (0.094)	0.151** (0.074)
Sexually Active Proportion		24.105** (10.862)		39.220*** (13.711)
High School Attainment Proportion		1.782 (1.536)		-2.328 (2.418)
African American Proportion		7.173 (4.925)		-12.366 (27.921)
Log Median Income		-0.700 (0.439)		0.661 (0.632)
Log Internet Penetration		0.053 (0.051)		-0.095 (0.129)
Log Population Size		-0.195 (1.070)		4.223 (2.760)
State Fixed Effect	Yes	Yes	Yes	Yes
Year-quarter Fixed Effect	Yes	Yes	Yes	Yes
Time Trends	Yes	Yes	Yes	Yes
Observations	1625	1347	1625	1347
R-squared	0.066	0.067	0.033	0.082

Notes: Placebo dummy is labeled '1' for quarters one year prior to actual entry of Craigslist and '0' for all other quarters. Robust standard errors are clustered at state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Impact of Ad Types on AIDS and Syphilis

	(1) Log AIDS Rate	(2) Log Syphilis Rate
Log No. Casual Encounter Ads	-0.121 (0.230)	-0.203 (0.167)
Log No. Men Seek Men Ads	0.588* (0.298)	-0.137 (0.182)
Log No. Men Seek Women Ads	-0.249 (0.229)	0.311** (0.139)
Log No. Women Seek Women Ads	0.097 (0.358)	-0.156 (0.150)
Log No. Women Seek Men Ads	-0.008 (0.303)	0.340** (0.136)
Controls Included	Yes	Yes
State Fixed Effects	Yes	Yes
Year-quarter Fixed Effects	Yes	Yes
Time Trend	Yes	Yes
Observations	53	53
R-squared	0.718	0.567

Notes: Data on ad type is only available for 15 states over the period of 2002 to 2003 on Archive.org: Craigslist changed its homepage 2003 and did not provide breakdown of the number of personal ads for each category. Robust standard errors are clustered at the state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$