Prostitution Regulation and the Fight Against Sexually Transmitted Infections Before Modern Medicine *

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Abstract

Sexually transmitted infections (STIs) were pervasive historically, yet we have little quantitative evidence on the health burden they imposed or the effectiveness of public health policies addressing them. This paper examines the health effects of Britain's Contagious Disease Acts, a canonical nineteenth-century policy to combat STIs. These acts required registration, periodic physical examination, and forced isolation of sex workers. We show that this policy substantially reduced infections, mortality, and childlessness in regulated districts, but at the cost of severely violating sex workers' rights. This was achieved by shrinking the market for sex and reducing the infection rate among sex workers.

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1 Introduction

Anecdotal evidence suggests that sexually transmitted infections (STIs) were pervasive in a variety of historical contexts, yet we know relatively little about either the health burden that they imposed or the effectiveness of the public health interventions that states adopted in order to combat them. The most common of these interventions were regulations that required the registration, periodic inspection, and (if found to have an STI) forced isolation of sex workers. Sex workers were a common target for regulation both because sex work was an important vector for the spread of STIs and because sex workers were a marginalized population with little ability to resist. This study examines in detail the consequences of one such regulation the Contagious Disease Acts (CDAs) in place in parts of the U.K. between 1864 and 1883.

One contribution of this study is to highlight the substantial mortality and morbidity costs of STIs before the introduction of effective modern treatments. We have collected a rich set of data that offer a unique window into the costs of STIs in the nineteenth century. Our mortality data show that STIs accounted for over 75,000 deaths in England and Wales between 1858 and 1899, an average of 1,800 per year, and that STI mortality reduced life expectancy at birth by 0.11 years.[1] This places STI mortality on par with other important infectious diseases, such as cholera, smallpox, or diphtheria (though less important than the largest infectious disease killers, such as tuberculosis, pneumonia, and diarrhea).[2] Moreover, morbidity effects, which are particularly difficult to measure, were likely even more substantial. To shed light on morbidity caused by STIs, we digitize a variety of military reports compiling data on soldiers and sailors infected with STIs. In the mid-nineteenth century, syphilis was the leading cause of hospitalization among soldiers which also highlights the substantial morbidity costs associated with STIs.

A second contribution of this study is to evaluate a canonical nineteenth-century policy intervention aimed at combating STIs. Britain's CDAs, which were modeled on laws in force in several other European countries, aimed to reduce the spread of sexually transmitted infections (STIs), particularly among men in the military. To achieve this aim, the CDAs imposed a rigorous system of physical health inspections on female sex workers, together with mandatory isolation of workers found to be infected with STIs. This system, which was implemented in two locations in 1864, was strengthened and expanded to cover 18 locations across the U.K. (including Ireland) by 1870. In each location, police were responsible for registering sex workers. These women were then required to undergo periodic invasive inspections by doctors, around 10 per year on average. Those workers found to be infected with an STI could be detained in a lock hospital for up to nine months. While

[1] To calculate life expectancy, we use the English life tables put together by the Registrar General's office in 1864 (Farr, 1864) and subtract out the share of mortality due to deaths classified as syphilis. In principle this approach could be biased if those who succumbed to syphilis were more likely to die of other causes than others of a similar age. This is unlikely to be a substantial concern for our results because (i) STI prevalence occurred across all parts of society, and (ii) most STI related deaths were among healthy babies or young adults who otherwise would likely have had normal mortality risk.

[2] In 1870, for example, there were 1,853 STI deaths recorded in England and Wales, compared to 1,065 deaths cholera deaths, 2620 smallpox deaths, and 2699 diphtheria deaths.

detained sex workers received medical care in the lock hospitals, the state of medical knowledge at the time meant that treatments (mainly ingesting mercury) were ineffective and actually harmful. However, because sex workers were typically isolated during the most infectious stage of their disease, this system may have reduced overall STI spread.

The goal of this study is to provide a rigorous quantitative evaluation of the direct mortality and morbidity consequences of the CDAs. Carefully measuring such effects is a critical input for evaluating any public health policy, and this is particularly true in a policy area, such as the regulation of sex work, where current evidence (reviewed later) remains limited. However, like many public health policies, ranging from quarantines and lockdowns to mask and vaccine mandates, the policy we study involved a violation of individual rights. The costs of such violations, which may also alter future healthcare utilization (Alsan and Wanamaker, 2018), are extremely difficult to quantify, but in the case we consider they were likely to be high. One indication of this is that fact that, after the CDAs became widely known to the public, they generated enormous backlash leading ultimately to repeal. We study the political economy of this repeal effort in a companion paper, Goehring and Hanlon (2025). While it is difficult to fully quantify and assess the costs associated with infringing on the rights of sex workers, some of the data we collect sheds light on the scale of such violations. For example, during the height of the CDAs in the 1870s between three and five thousand detentions occurred annually.

Several features of the historical context make it particularly useful for evaluating the impact of STIs and the effectiveness of historical policies for combating them. First, the CDAs were implemented in a relatively data-rich environment. The data we have collected allow us to study the impact of the CDAs along multiple dimensions: infection rates among soldiers and sailors, STI mortality among the general population, as well as rates of childlessness (one potential consequence of STI infections). In addition, we have data on the size of the market for sex, and on STI rates among sex workers, which help us shed light on the mechanisms behind the health effects that we document. Second, prior to the CDAs, the market for sex in the UK was effectively unregulated. Thus, this setting provides a unique opportunity to analyze the impact of regulating the sex trade relative to a laissez-faire environment. Third, the CDAs were applied to only a subset of locations within the country. This allows us to apply a difference-in-differences analysis strategy. Finally, we are able to observe some outcomes before the CDAs were implemented, while they were in force, and after they were eventually repealed in the 1880s. This feature allows us to adopt an off-on-off identification strategy in some of our analyses, which strengthens our identification approach while also allowing us to generate new results on the persistence of the effects of the CDAs after repeal.

Our first set of results use newly digitized data on STI infection rates among soldiers at army posts subject to the CDAs compared to those at posts not subject to the acts. This provides a rare opportunity to study morbidity rates, rather than mortality, in a historical context. Using a difference-in-differences analysis strategy we find clear evidence of reductions in STI infection rates in treated compared to untreated locations. The effects are surprisingly large: the CDAs

reduced STI infection rates by around one-third after four years and two-thirds after eight years. Our estimates do not appear to be driven by underlying differences between the locations since both types of locations show very similar trends prior to the CDAs. We also show similarly-sized effects in a separate analysis of syphilis rates among Navy sailors. Thus, the CDAs appear to have led to large reductions in STI infection rates among soldiers and sailors, the primary aim of the policy.

In a second set of results, we examine the impact of the CDAs on STI mortality among the general population. Here, we take advantage of rich mortality statistics from the Registrar General's office, which report the number of deaths due to syphilis annually at the county level (though diagnostic challenges mean that this category likely includes some other STI-related deaths). These deaths were concentrated among infants who would have caught the disease from their mothers at birth and then died soon afterward.[3] Our analysis exploits a panel of STI mortality data before the passage of the CDAs, while the acts were in force, and after they were repealed, which allows us to implement a particularly strong off-on-off identification strategy and to look for evidence of persistent effects. Our results show that syphilis death rates fell in counties where the CDAs were applied after the acts came into force, while we observe no evidence of differential trends in the pre-treatment period. In terms of magnitude, we find small initial effects that become large over time. After ten years under the CDAs, we find reductions equal to around 2.5 deaths per hundred thousand individuals, an almost 50% reduction in STI mortality relative to the baseline death rate of 5.2 per hundred thousand. Interestingly, these effects begin to disappear as soon as the CDAs are repealed, so that within a decade after the repeal we cease to observe statistically significant differences between syphilis mortality rates in treated compared to untreated locations.

In a third set of results, we examine the impact of the CDAs on the number of childless couples. STI rates may affect the prevalence of childlessness either because STIs cause infertility, because some STIs increase miscarriages and infant deaths, or because active infections may cause couples to reduce the frequency of intercourse. To study these effects, we use census microdata from two census waves before the CDAs (1851 and 1861) and two waves after the CDAs (1891 and 1901) and compare the number of childless couples in locations subject to the policy compared to other locations. We find that the share of childless couples declined by approximately 1.3 percentage points in CDA districts compared to non-treated districts in the post-treatment census waves. This provides a third set of results indicating that the CDAs had substantial health benefits.

In summary, our results show that STIs imposed a substantial disease burden in 19th century Britain, and that the CDA interventions were highly effective at reducing this burden. However, without any effective means of treatment, these public health policies came with a steep cost. In particular, the CDAs represented a substantial violation of the individual rights of sex workers, one that, despite the fact that the victims were a disenfranchised and marginalized group, catalyzed a resistance movement that eventually led to their repeal in 1886. Thus, while we show that historical

[3]This group made up 70-75% of all STI deaths in our data.

governments had the tools to combat STIs, doing so required such a violation of individual rights that maintaining such a system was possible only in settings where the state was willing and able to countenance such violations.

One implication of our results is that the sex trade must have been a primary vector for STI spread in the context that we study. In the last section of the paper, we examine some of the changes in the market for sex that could be behind the large improvements in public health that we identify. One potential way that the CDAs may have improved health is by reducing the size of the market for sex. Our setting provides a rare opportunity to study the impact of regulation on the market for sex, which is often challenging because the sex trade is illegal in many settings making it difficult to collect credible data on the market. Theoretically, the impact of the CDAs on the size of the market is ambiguous. While we would expect the burden of the regulation on sex workers to reduce supply, if the regulations improved the safety of purchasing sex they may also have increased demand (Immordino and Russo, 2015). Using newly digitized data and both time series and difference-in-differences analysis strategies, we provide evidence that the supply-side effect dominated. Specifically, we find that CDA districts experienced a decrease in both the number of sex workers and the number of brothels as a result of the regulations. The number of registered sex workers in CDA districts declined by approximately 60% while brothels declined by at least 35%. These effects do not appear to be driven by a movement of sex workers or establishments from CDA districts to nearby areas.[4] This reduction in the size of the market for sex was one mechanism through which the CDAs improved public health.

A second way that the CDAs may have reduced STI spread was by reducing the share of active sex workers with STIs. We provide evidence that the CDAs drastically reduced the prevalence of active STI infections among sex workers. This was not due to effective treatment, which was not available in the setting we consider. Instead, it appears to have been largely a consequence of the isolation of infected sex workers, particularly during the most infectious disease stages. Thus, reductions in STI rates among active sex workers appears to have been a second important mechanism through which the CDAs reduced the prevalence of STI infections.

Related literature and contribution: The primary contribution of our paper relates to the extensive literature on historical public health interventions. This is a very large literature, including work on topics ranging from digestive diseases and water supply improvements (Troesken, 2004; Cutler and Miller, 2005; Ferrie and Troesken, 2008; Beach et al., 2016; Alsan and Goldin, 2019; Anderson et al., 2020, 2021; Beach, 2022; Anderson et al., 2022; Chapman, 2022, 2019), food quality (McKeown, 1976; Anderson et al., 2023), public health efforts aimed at tuberculosis (Anderson et al., 2019; Clay et al., 2020; Egedesø et al., 2020), lead exposure (Clay et al., 2014), vaccination (Ager et al., 2018), interventions aimed at limiting the spread of influenza such as mask mandates and school closures (Markel et al., 2007; Correia et al., 2022; Dahl et al., 2023), and other

[4]The age of sex workers also increased after the introduction of the CDAs, consistent with a reduction of entry of younger women into the market.

medical interventions (Ager et al., 2023; Hoehn-Velasco, 2018).

Despite the breadth of this literature, STIs and public health interventions aimed at limiting them remain almost completely unexplored, with the notable exception of Fung and Robles (2016), which studies mandatory antenatal testing for syphilis which was adopted in many U.S. states in the 1940s. One explanation for this is that STIs were unlikely to have contributed to the mortality transition that began in the early 19th century, which is a primary focus of this literature. However, STIs were a meaningful component of mortality, particularly among infants. Moreover, STIs were likely to have had a particularly high morbidity burden (Siena, 2004; Szreter, 2014; Szreter and Schürer, 2019; Szreter and Siena, 2021), which is impossible to assess when looking only at mortality statistics. Relative to this literature, our study is the first rigorous quantitative evaluation of STIs and the primary form of public health policies used to combat them before the 20th century.

We also contribute to a small but growing set of modern studies focused on understanding the costs and benefits of regulating the sex trade, including Gertler and Shah (2011), Bisschop et al. (2017), Cunningham and Shah (2017), Cameron et al. (2021), and Gao and Petrova (2022).[5] Relative to existing work, this study expands our understanding of the consequences of regulating the sex trade along several dimensions. First, we are the first to examine the impact of imposing a system of registration and inspection in a laissez-faire environment. Our results show that, relative to an unregulated counterfactual, a system of licensing and medical examinations can substantially reduce STI rates, though at the cost of severely violating the rights of sex workers. Second, we are able to study how the impact of regulation evolves over several years, as well as the consequences of subsequently eliminating regulation. In particular, we offer new evidence showing that reducing STI rates in some locations had a persistent effect, but the half-life of that effect was rather short. Third, we examine outcomes downstream of STI transmission – namely fertility – that previous work studying modern regulations has not explored.

Third, our study contributes to the literature studying patterns of female employment over time. Much of this work focuses on broad trends in various aspects of female employment – such as the female labor force participation, gender wage gaps, and occupational sorting by gender – and how they have changed over time (Goldin, 1980; Rotella, 1981; Goldin, 1990; Horrell and Humphries, 1995; Burnette, 1997; Costa, 2000; Goldin, 2006; Burnette, 2008a,b; Humphries and Weisdorf, 2015; Albanesi and Olivetti, 2016; Vidart, 2024; Rashid, 2025). This literature tends to focus on the rise of women in textiles, domestic service, and clerical roles as Britain and the United States industrialized. Sex work has been largely unstudied by economic historians, even though it has been an occupation that women have turned to throughout history. Recent work has begun

[5]These empirical studies are motivated, in part, by theoretical work highlighting the trade-offs inherent in sex work. A seminal theoretical contribution in this area is Edlund and Korn (2002). More recent theoretical work includes Immordino and Russo (2015), which focuses on how policies toward the sex trade affect health risks, and how those risks, in turn, influence the market, and Lee and Persson (2022), which emphasizes the fact that the sex trade involves both voluntary and coerced workers. A slightly different line of work examines the factors that determine the size and spatial distribution of the market for sex. An example of work in this vein is Brodeur et al. (2018).

to explore parts of the market for sex historically by examining reasons why women entered the industry as well as different historical regulatory approaches such as criminalizing red-light districts (Goehring, 2023, 2025). Our study contributes to this small literature by examining one of the most common approaches to regulating sex work in nineteenth-century Europe.

Lastly, this paper contributes to the largely qualitative literature by historians and sociologists studying the CDAs (Blanco, 1967; Sigsworth and Wyke, 1972; Walkowitz and Walkowitz, 1973; Walkowitz, 1982). This literature has been heavily influenced by the arguments produced by the opponents of the CDAs, leading several authors to conclude that the CDAs were ineffective as public health measures. For example, in her influential book on the CDAs, Judith Walkowitz writes, "In pressuring for the medical inspection of prostitutes without imposing periodic genital examination on the enlisted men who were their clients, architects of the acts obliterated from the start whatever effectiveness as sanitary measures the acts might have had." (Walkowitz, 1982, p.3). In contrast, our quantitative evaluation shows that the CDAs were highly effective as public health measures. Thus, the CDAs in Britain, and similar policies in other countries, presented public authorities with a stark choice between improving public health and respecting individual freedoms.

The rest of the paper proceeds as follows. Section 2 presents historical background. Section 3 presents results on how the CDAs affected the market for sex. Section 4 presents our main empirical results on how the CDAs affected public health. Section 5 concludes.

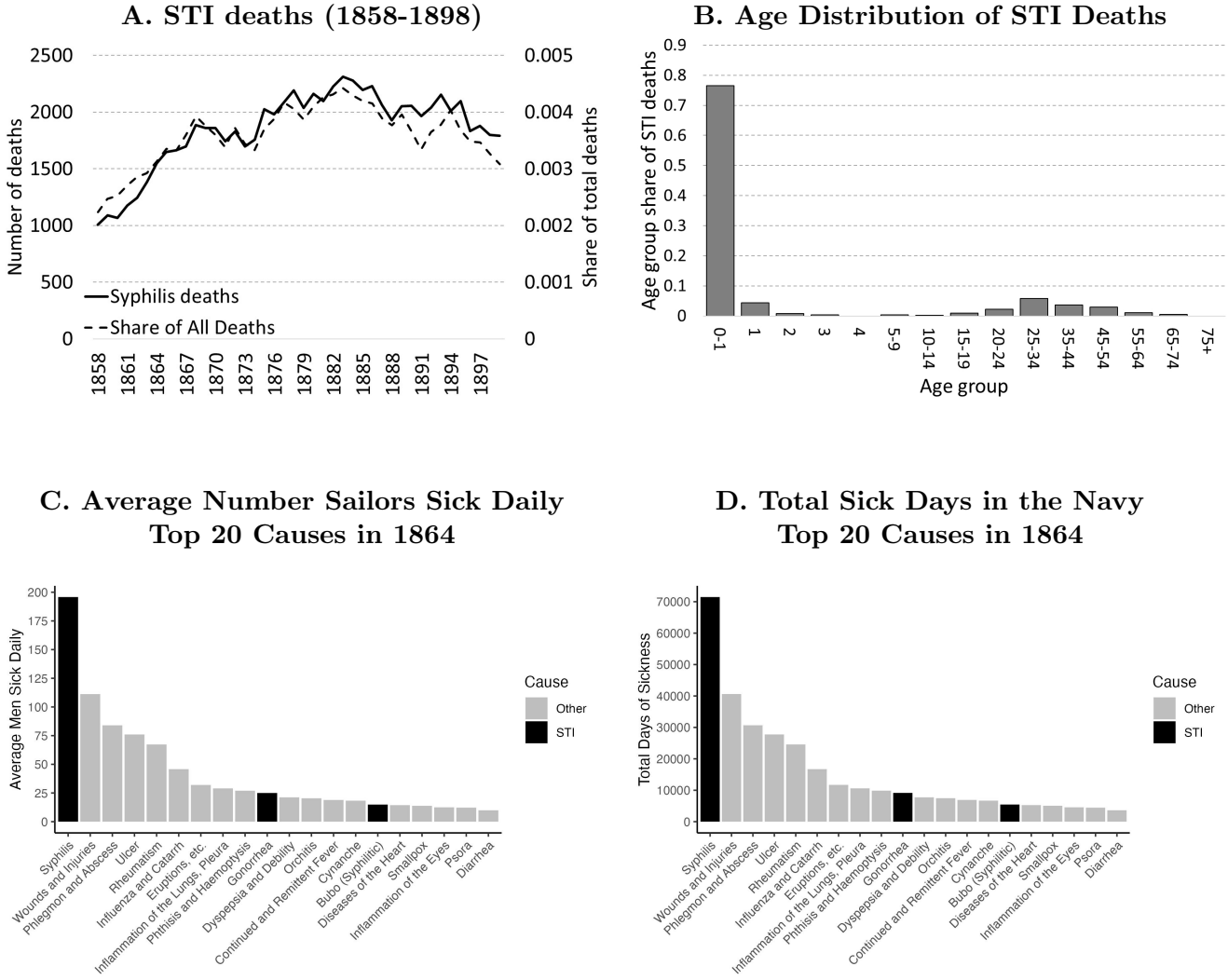
2 Background

This section provides historical context for our study. We begin by discussing STIs in our historical context. We then discuss the market for sex before the introduction of the CDAs. Finally, we describe the CDAs.

2.1 STIs in the Nineteenth Century

Syphilis and other STIs accounted for between 0.2 and 0.4 percent of all deaths in England and Wales in the middle of the nineteenth century, and around 1.1 percent of infant deaths. Thus, STIs were not among the largest killers during this period, but STI deaths are comparable in magnitude to infectious diseases such as cholera, smallpox (still an important killer in the UK at this time due to spotty vaccination rates), and diphtheria. The panel A of Figure 1 shows that the share of deaths attributed to STIs was growing from the 1850s through the 1880s and slightly declining thereafter. Why syphilis deaths were increasing during most of this period is unknown; it may have been due in part to the introduction of disease by soldiers and sailors returning from the Crimean War. It is interesting to note, however, that the rate of growth was extremely rapid until the late 1860s and was much slower thereafter, which may reflect the impact of the CDAs. Panel B of Figure 1 shows the breakdown of deaths by age group. Clearly, STI deaths were concentrated among infants and young children, with young adults being the second most affected group.

Figure 1: Descriptive Patterns of STI Mortality and Morbidity



Note: Panel (A) of the figure plots data for deaths classified as "syphilis", a category that likely contains a basket of STI deaths, collected from the Annual Reports produced by the Registrar General's Office. Panel (B) plots the breakdown by age category based on the Annual Report produced by the Registrar General's Office for 1870. Panel (C) plots the daily average number of sick sailors for the top 20 causes in 1864. Panel (D) plots the total number of sick days accounted for among all sailors for the the top 20 causes in 1864. Naval data are taken from the *Statistical Report of the Health of the Navy, For the Year 1864, pg. 26-27.*

In addition to mortality, STIs were also associated with substantial morbidity in nineteenth-century Britain. Szreter and Siena (2021) write how secondary syphilis "when it arrives, typically produces debilitating pain and fevers lasting weeks and even months, which could not be ignored." Collecting systematic data on morbidity in the historical context is much more difficult than mortality. However, the British Navy collected detailed health information on its sailors that provide a glimpse of the morbidity consequences of STIs during the period. Panels (C) and (D) of Figure 1 provide data digitized from Naval reports depicting the top 20 reasons why sailors stationed in Britain were hospitalized in 1864. Syphilis was the number one cause of hospitalizations by a significant margin. In 1864, nearly 200 sailors were hospitalized for syphilis daily on average. Syphilis resulted in over 71,000 total sick days across all sailors stationed in Britain. Given sailors were generally young, unmarried men, they were likely more at risk of contracting syphilis than the broader population. However, these data illustrate how STIs were a significant health issue during the period.

An 1863 Army report reflects a similarly high morbidity burden. The report found that "The number constantly sick in hospital with *Venereal* was 1539, or 20.28 per 1,000 mean strength...the admissions from the same cause having been 306.8 per 1,000, we deduce the average duration of the cases to have been 24.10 days, and the resulting inefficiency to have been equal to the loss of the services of every man composing the home force for a period of 7.4 days."[6] The loss of a week of effort for every soldier in the home army is clearly substantial. In fact, it was the revelation of these morbidity costs that led to the adoption of the CDAs. The effects of STIs also affected Army recruiting efforts. Syphilis led to the rejection of 13.72 recruits out of every thousand UK recruits undergoing their first medical inspection in 1863, and an additional 4.41 per thousand at their secondary inspection. This suggests that almost two percent of recruits came in with a visible STI infection.[7]

Contemporaries had some understanding of the most common STIs in the second half of the nineteenth century, but with important gaps in their knowledge. An excellent source that reveals the level of their understanding is the report of a Committee appointed in 1864 by the Admiralty and the Secretary of State for War to survey the state of medical knowledge on STIs and what could be done to reduce their spread. This "Venereal Disease Committee", which included representatives of both the Army and Navy Medical Boards as well as leading private physicians, interviewed 56 leading medical professionals and provided a detailed report summarizing current medical knowledge related to STIs.[8]

Contemporaries understood that STIs such as syphilis–the most important STI in the context we study–were in fact real diseases (a fact which had been disputed by some) but they had trouble

[6] Army Medical Department Statistical, Sanitary, and Medical Reports, Vol. V, 1863, p. 11.

[7] Army Medical Department Statistical, Sanitary, and Medical Reports, Vol. V, 1863, p. 30.

[8] The final report is *Report of the Committee appointed to enquire into the Pathology and Treatment of Venereal Disease*, 1868, Parliamentary Papers. According to the report, the Committee also forwarded preliminary findings to Parliament in 1866, which played a role in the passage of the 1866 Contagious Disease Act.

precisely identifying different STIs. The Committee found syphilis was a disease "universally recognized by the medical profession" though "the term 'Syphilis' at the present day includes every variety of constitutional venereal disease."[9] This point indicates that the data on syphilis used in our analysis may be capturing a wider variety of STIs.

The report also reveals a basic understanding of the progress of syphilis through its various stages. Syphilis is most contagious during the first stage of the disease in which the infected individual has a sore that normally lasts up to six weeks. In the second stage, the sore heals and is usually followed by a rash. After the rash has disappeared the individual enters tertiary syphilis, and is normally no longer contagious. This stage can last years and lead to cardiovascular and neurological issues.[10] An understanding of these stages allowed contemporary doctors to diagnose the disease. However, this diagnosis relied on physical inspection, since medical advances allowing effective testing for syphilis were not invented until the early 1900s, well after our period of interest.[11]

While the diagnostic characteristics of the disease were well-understood, the etiology of the disease was not. It was understood that syphilis and other STIs could be spread through contact, but debate remained over whether it could also appear spontaneously. Moreover, the exact mechanism of spread was not well understood. However, it was understood that STIs could be transmitted through sexual intercourse, and contemporaries also knew that some, syphilis in particular, could spread from infected mothers to their infants. This "hereditary syphilis" was known to cause stillbirths and to kill many infants and young children.[12]

While contemporaries could generally diagnose STIs, they had almost no ability to effectively treat them. Simple primary syphilis sores, for example, were treated by "local applications" (compresses) to "allay pain or inflammation."[13] For more serious cases, the primary treatment was mercury "by mouth, by inuction, or by vapour baths." The committee found that "The weight of the evidence...preponderates in favour of the advantage of mercurial treatment..." though "it is contended by a minority of authorities that mercurial treatment...neither prolongs the interval of apparent health, nor modifies the severity of the future disease."[14] The main alternative to

[9] *Report of the Committee appointed to enquire into the Pathology and Treatment of Venereal Disease*, 1868, Parliamentary Papers, p. vi.

[10] This webpage from the Center for Disease Control provides a useful summary of the different stages of syphilis as well as information on its contagiousness and side effects: `https://www.cdc.gov/std/syphilis/stdfact-syphilis-detailed.htm`

[11] In 1905, German researchers identified the bacteria that causes syphilis. A year later the Wassermann test was invented which became the most common way to identify syphilis infection. (Brandt, 1985, p.40-41)

[12] *Report of the Committee appointed to inquire into the Pathology and Treatment of Venereal Disease*, 1868, Parliamentary Papers, p. xi.

[13] *Report of the Committee appointed to enquire into the Pathology and Treatment of Venereal Disease*, 1868, Parliamentary Papers, p. xvi.

[14] *Report of the Committee appointed to enquire into the Pathology and Treatment of Venereal Disease*, 1868, Parliamentary Papers, p. xvi. Mercury was thought to improve the symptoms of syphilis without directly attacking the disease. The report notes that mercury was not indispensable to recovery, but it was believed that it would shorten the duration of the disease. It is not clear where the belief that mercury was therapeutic came from, and the belief was not universal, but "the advocates of mercurial treatment greatly preponderate amongst the witnesses" (p. xviii).

mercury was ingestion of iodine. Neither of these approaches would have been therapeutic and neither would be recommended today. Effective treatments would not arrive until 1909, when an arsenic-based treatment known as Salvarsan became available. However, the drug was toxic and led to complications for early patients. A safer version of the drug was invented in 1912, and became the main treatment for syphilis in place of mercury (Brandt, 1985, p.40-41). Penicillin, the modern treatment, did not become widely used until the 1940s (Alsan and Wanamaker, 2018).

The Report's limited discussion of methods of preventing the spread of syphilis is also revealing. The main method of prevention discussed was reducing contact between infected and non-infected persons through identifying and isolating those with infections. Thus, while the medical officials examining sex workers as part of the CDAs could not have cured their syphilis, they could have identified women with sores and rashes which would indicate they were still in the contagious period of the disease. Other modern methods for reducing STI spread, such as condoms, were not widely available in the period we study.[15] Beyond isolating infected individuals, the only other method seriously recommended for preventing spread was the provision of facilities for washing after intercourse.

2.2 The market for sex before the CDAs

Before the passage of the Contagious Diseases Acts solicitation by sex workers was not criminalized in Britain (Walkowitz, 1982, p.14). Officials treated prostitution as a public nuisance and were primarily interested in containing it within particular areas of cities. This policy of geographically segregating sex work was common in other contexts as well, such as in U.S. cities in the late nineteenth century (Goehring, 2023). One consequence of this system of quasi-legal but suspect trade is that we have police records tracking the prevalence of brothels and other establishments where the sex trade occurred.

Figure 2 provides a sense of the size and geographic distribution of the sex trade in the U.K. just before the CDAs were enacted. We can see that the sex trade was practiced in all parts of the country, with particularly high concentrations of brothels and sex workers in counties with major port cities, particularly Hampshire in the south, which contained a major navy base in Portsmouth as well as the port of Southampton. The size of the market for sex was larger in counties that would be subject to the CDAs, where there was an average of around 250 sex workers per 100,000 people, than in control counties, where the average was 91 per hundred thousand. However, even within treated and control groups there was substantial variation.

Of the female sex workers themselves we know relatively little, and one should be careful about making generalizations. William Acton, one of the keenest contemporary observers of the sex trade wrote, "The shades of London prostitution...are as numberless as those of society at large" (Acton, 1870, p. 28). The CDAs were mainly aimed at a particular subset of the market for sex composed

[15] Vulcanized rubber was first used in condom production in 1855. However, condoms remained expensive, and thus rarely used, well into the twentieth century (Guinnane, 2011).

of working-class women for whom the sex trade was a primary occupation.[16] Of these women, Walkowitz finds (p. 15): "little to distinguish [them] from the large body of poor women who had to eke out precarious living in the urban job market." The vast majority were the daughters of unskilled or semi-skilled workmen. Many had been servants, or worked in "equally dead-end jobs, such as laundering, charing, and street selling."[17] Many had lost parents at a young age and were forced to fend for themselves; the typical age when women began sex work was 16.[18] Most would remain in the trade for just a few years.[19]

The working situation of these women also varied dramatically. At one extreme, (Acton, 1870) describes "dressing houses", where women were "virtually slaves, though nominally free." He suggests that these were becoming rare, at least in London, by the 1860s, a view echoed by Walkowitz (p. 24). Instead, most sex workers appeared to have some degree of independence and "the right of receiving and retaining their own money, and...accepting or declining, at their own discretion, the attentions offered by their visitors" (Acton, 1870, p. 10). "During most of the nineteenth century," Walkowitz writes (p. 25-26), "British prostitutes appear to be relatively independent of pimps...In fact, a strong female subculture was a distinguishing feature of nineteenth-century prostitution." Consistent with this assertion, contemporary sources such as Acton suggest that most brothel-keepers were working-class women.

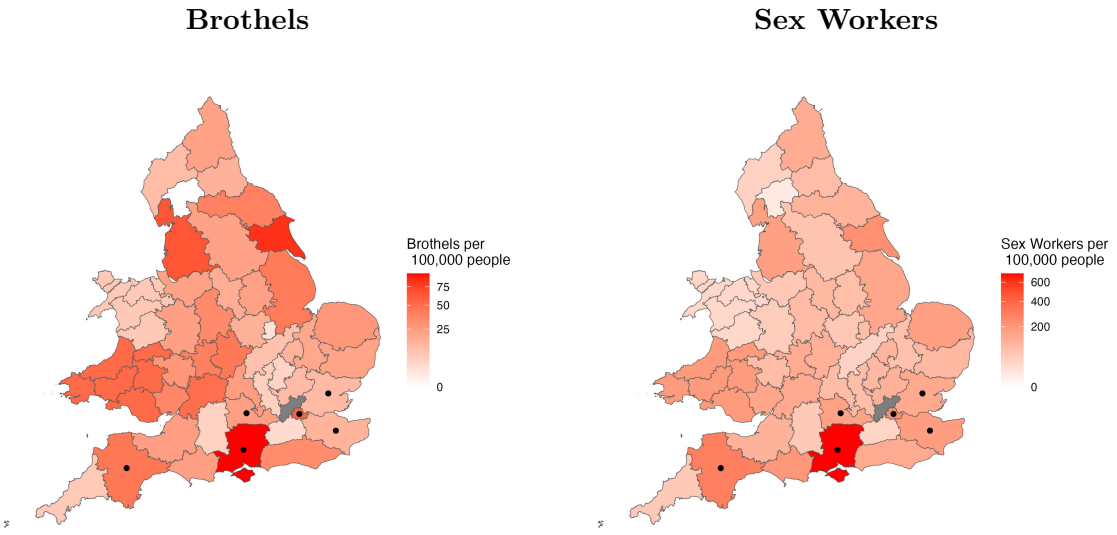
2.3 The Contagious Diseases Acts

The primary motivation behind Britain's Contagious Disease Acts can be traced to the Crimean War of 1854-1856. The death of substantial numbers of British soldiers due to poor sanitation and health care, rather than enemy action, was highlighted through the work and advocacy of Florence Nightingale, other reformers, and journalists. This led to a rethinking of how soldiers were treated, leading to the appointment of the Army Sanitary Commission in 1857.[20] Among the health concerns highlighted by this commission were high rates of STIs among soldiers.

The CDAs were also part of a trend of public health interventions undertaken in Britain in the middle of the nineteenth century. At this time, reformers such as Edwin Chadwick and John Snow were highlighting the need for government intervention to improve public health. This led to the passage of new regulations, such as the Public Health Act of 1848, which established the General Board of Health, and the Vaccination Acts of 1853, 1867, and 1871, which mandated smallpox vaccinations. As part of this broader trend, the CDAs represented the primary government effort to combat STIs. In fact, we are not aware of any other legislation aimed at reducing STIs during the period that we study, nor have we found evidence of any other new acts regulating the sex

[16] This likely includes many women who also made income in other ways. However, it excludes women who made most of their income from other sources and practiced sex work only occasionally.
[17] Walkowitz (1982), p. 15-16. Similar evidence is found in Bartley (2000), p. 3-4.
[18] Walkowitz (1982), p. 19.
[19] Walkowitz (1982), p. 19.
[20] Blanco (1967).

Figure 2: Size of the Sex Trade, 1859-1864



Note: The figures plot the geographic distribution of brothels and sex workers known to the police. The figure on the left plots the number of known brothels per 100,000 people for counties in England and Wales. The panel on the right plots the number of known sex workers per 100,000 people. The black points correspond to counties subjected to the CDAs. Each figure plot the average value over the years 1859 to 1864. The data are digitized from the *Judicial Statistics, England and Wales*.

trade during our study period, though when the CDAs were repealed in 1886 they were replaced by a new law (passed in 1885) that made it illegal to maintain brothels or to seek to induce any woman to become a sex worker.

The initial Contagious Diseases Act was passed in 1864 with the primary objective of reducing the prevalence of STIs among British troops. The 1864 act applied to eleven districts containing military garrisons, eight in England and three in Ireland. Specifically, the CDAs applied to military stations and all areas within a certain distance, typically five miles, of the station. This radius typically covers a substantial portion of the area and the population of the district in which the station is located. Given this, when we compare STI rates in military stations, we treat stations as the unit of treatment, while when looking at mortality or childlessness statistics for the population as a whole we take districts (a unit smaller than a county) as the treatment unit. Subsequent amendments in 1866 and 1869 expanded the geographic scope and broadened the powers police had to force sex workers to comply with the law. Each act added districts to the CDAs and extended the length sex workers could be detained in hospitals. By 1870, the CDAs were enforced in 18 subjected districts (CDA districts) located in the southern part of England as well as parts of Ireland. Appendix Table B.1 lists these locations and the year in which the CDAs came into force in each.[21]

[21]For the 1864 Act, which was considered a trial of the policy, we do not know how exactly the locations covered by the Act were picked. However, it seems likely that the initial locations were included because they were the most important Army and Navy stations in England. Subsequent acts then added districts with smaller garrisons in

The design of the system implemented by the CDAs was based on systems that already existed in France and Germany (Harsin, 1985). After the final amendment in 1869, the system for regulating sex work operated in the following manner.[22] Police in subjected districts were tasked with identifying and registering all sex workers. If a woman was suspected of engaging in sex work, the police would register her and the local court would issue a summons for her to report for a medical examination. If, upon examination, no STI was identified, she was free to continue working until her next examination. However, if she was found to have an STI she could be detained at a hospital for up to nine months. The duration of medical inspections would last a year, after which, if the woman still engaged in sex work and the police wanted to continue subjecting her to examinations, they would have to reregister her and seek new court approval. Sex workers could voluntarily submit to the law as well to avoid the judicial summons. If a woman wanted to be removed from the register to avoid future inspections before the year had elapsed she was entitled to a hearing in which she had to prove that she no longer engaged in sex work. Women that did not comply with the law could be forcibly detained. As a means of ensuring compliance with the system of licensing and inspections, the CDAs also gave the police the power to fine and arrest brothel keepers as well as the owners of other establishments where unregistered women practiced sex work.

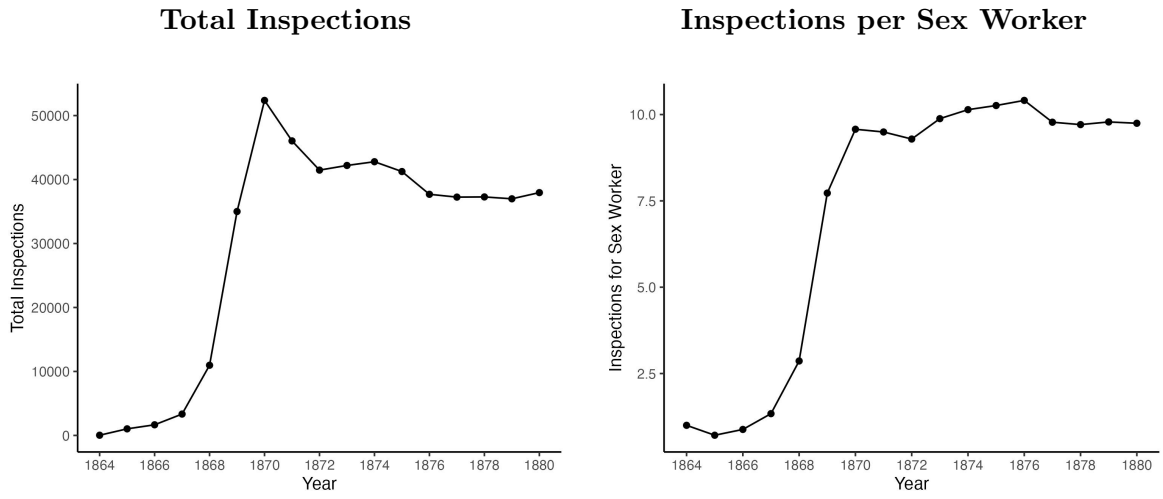
The CDAs were vigorously enforced in most subject districts. Police swept the streets, brothels, and other establishments (beer houses, public houses) to identify and register sex workers so that they could be tracked and subject to periodic medical examinations. These enforcement mechanisms became more effective over time, as local authorities gained experience. Using police records we digitized from the Parliamentary Papers, Figure 3 describes the number of inspections undertaken across all subjected districts. Between 1864 and 1870, the number of inspections increased as new districts were brought under the CDAs and the enforcement mechanism in existing districts became more comprehensive. In 1870, around 50,000 inspections (medical exams of sex workers) were conducted. After 1870, the number of inspections fell, leveling off at around 40,000 per year. By comparing the left and right-hand panels in Figure 3, we can see that the reduction in the total number of inspections was driven by a reduction in the number of sex workers active in the subject districts, a finding that we examine in more detail later, while the overall number of inspections per sex worker remained fairly constant at around ten per year. These inspections were backed up by an effective system of isolation for those workers who showed signs of having an STI. Between 1870 and 1880, the total number of hospitalizations ranged from 3,000 to 5,000 per year (see Figure 12). Overall, these patterns highlight the expansive scope of the CDAs, as well as the impressive level of state capacity involved in registering, inspecting, and isolating infected women.

Public criticism of the CDAs started soon after they were adopted. Several organizations were formed to lobby for their repeal. The most influential by far was the Ladies National Association for the Repeal of the Contagious Disease Acts (LNA), led by Josephine Butler. At the end of 1869,

Southern England or Ireland.

[22] Our description of the CDAs is based in part on the Report of the Select Committee on the Contagious Disease Acts of 1882 as well as Sigsworth and Wyke (1972, p.94-95).

Figure 3: Medical Inspections under the CDAs Over time



Note: The figure on the left displays the total number of medical inspections of sex workers conducted from 1864-1880. The figure on the right displays the number of medical inspections relative to the number of sex workers examined. Both graphs aggregate across all districts. The data are from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Appendix B.4 provides additional details.

the LNA issued a public appeal protesting against the CDAs that was published in newspapers across the country. This appeal criticized the CDAs on a number of grounds. One of their main objections had to do with the violation of women's basic rights inherent in the acts. This was a "momentous change in the legal safeguards hitherto enjoyed by women in common with men" which "so far as women are concerned...remove every guarantee of personal security which the law has established and held sacred, and put their reputation, their freedom, and their person absolutely in the power of the police."[23] The LNA also criticized the unequal treatment of women. It was "unjust to punish the sex who are the victims of a vice, and leave unpunished the sex who are the main cause both of the vice and its dreaded consequences; and we consider that liability to arrest, forced medical treatment, and (where this is resisted) imprisonment with hard labour, to which these Acts subject women, are punishments of the most degrading kind." A third critique was that the CDAs represented government legitimization of the sex trade. To oppose the CDAs, the LNA recruited sympathetic MPs to lead repeal efforts in Parliament, such as William Fowler, a Quaker, and the Radical Liberal James Stansfeld. The LNA held numerous public meetings and rallies, and during key debates often organized women's prayer meetings near Parliament.[24] While these efforts were rebuffed throughout the 1870s, they were eventually successful in eliminating compulsory examination in 1883 and completely repealing the CDAs in 1886 (Goehring and Hanlon, 2025).

[23] From Butler (1909). See Appendix A.1 for the full text.

[24] See Butler (1909), p. 79. At one such meeting, just before the crucial 1883 vote, Josephine Butler described "well-dressed ladies, some even of high rank, kneeling together (almost side by side) with the poorest, and some of the outcast women of the purlieus of Westminster."

3 Main analysis: Public health effects of the CDAs

This section presents our main analysis of the public health effects of the CDAs. The analysis is divided into several parts, each of which uses a slightly different outcome measure and analysis strategy. We begin by looking at whether the acts reduced STI cases among soldiers, their primary aim, using data collected from military reports. Then, we consider the impact on STI mortality in the general population using the national mortality statistics. Finally, we look at how the acts affected the rate of childless couples, using census microdata.

3.1 The Impact of the CDAs on STI cases among soldiers

Question: Were the CDAs effective at reducing STI prevalence among soldiers stationed in the locations where the CDAs were applied? Answering this question will tell us whether the CDAs achieved their primary objective. It also provides a natural preliminary step toward assessing the effects of the CDAs on the broader health outcomes among the general population.

Data: To assess changes in the spread of STIs we have collected and digitized data on the number of soldiers hospitalized with STIs at military stations in the UK (which included all of modern Ireland at this time) from 1860 to 1878. The data come from a report by a committee in Parliament that was investigating how the CDAs were operating in the subjected districts. The report contains information on the hospital admissions of soldiers from various STIs. For gonorrhea and primary syphilis, only data aggregated across treated and untreated stations is reported. However, for secondary syphilis the report provides disaggregated hospital admissions for 27 military stations. We drop two of these stations, Warley and Windsor, which do not report data for the entire period. Thirteen of these stations are located in a subjected district and twelve in untreated districts.[25] These data cover all Army stations with over 500 men. Additional details on these data are provided in Appendix B.2. Note that, to the extent that soldiers move between stations, our results will understate the impact of the CDAs on hospitalization rates.

We supplement the Army stations data with data from a similar report conducted by Parliament that contains hospitalization from syphilis of Navy sailors serving in ships stationed in a sample of treated and untreated ports from 1860 to 1875. We will not focus on the Navy data in the main portion of this analysis because those data only cover five ports in subjected districts and five ports in untreated districts. However, an analysis of the Navy hospitalization data, in Appendix C.2, generates results that match the findings from our analysis of the Army data below.[26]

Analysis strategy and results: The structure of our data on secondary syphilis allows us to use a difference-in-differences empirical strategy comparing syphilis hospitalization rates in

[25] Specifically, our data come from the *Report from the Select Committee on the Contagious Disease Acts, 28 July 1881* p. 445-455. The data in the report distinguish between primary and secondary syphilis. These refer to the stage in the progression of the disease. Appendix B.2 provides additional details on the data.

[26] Specifically, the estimated effect in the Navy data suggests that the CDAs reduced the syphilis hospitalization rate by approximately 26 hospitalizations per 1,000 sailors. This is approximately a 40% reduction relative to pre-treatment sample mean for treated ports of 65 hospitalizations per 1,000 sailors.

stations in treated versus untreated districts before and after the introduction of the CDAs. Our basic analysis specification is:

$$y_{lt} = \alpha + \sum_{s} \beta_s \mathbf{1}\{s = t - \tau_l\} + \alpha_l + \alpha_t + \epsilon_{lt} \tag{1}$$

where $\mathbf{1}\{s = t - \tau_l\}$ is an indicator equal to one for location l in the s'th year relative to when the location was treated in τ_l, and zero otherwise. β_s is estimated for each year s relative to treatment which allows us to assess the existence of pre-trends. α_l and α_t are location and year fixed effects, respectively. The main outcome in this regression is the hospitalization rate from secondary syphilis per 1,000 soldiers at the station.

Treated stations were subjected to the CDAs at different times. There has been a recent literature highlighting issues with the common two-way fixed effect approach when treatment timing is staggered and effects are heterogeneous (Goodman-Bacon, 2021; Baker et al., 2022). To address these concerns, we estimate results using the estimator in Callaway and Sant'Anna (2021).[27] Table B2 lists the stations in the data and the timing of treatment. Throughout the analysis when reporting event studies we estimate the dynamic treatment effects, β_s, for years in event time where all treated units have available data. We do this so that changes in the dynamic treatment effects are not being driven by the composition of treated units over time.

Raw data describing the trends in STI hospitalizations in treated (CDA) and untreated stations can be viewed in Appendix Figure C1. That figure shows that the treated and untreated stations had very similar trends in STI infection rates prior to the CDAs. Once the CDAs were in place, we observe a reduction in STI hospitalizations in treated stations relative to untreated locations, suggesting that the CDAs reduced STI rates among soldiers in treated areas.

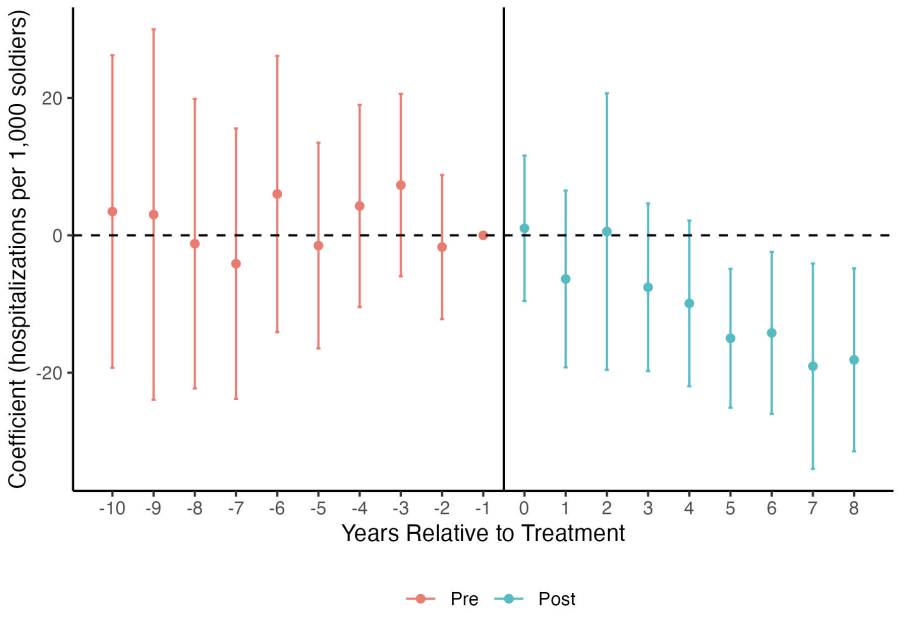
For one category of STI hospitalizations, secondary syphilis infections, we have data broken down at the station-level, allowing us to conduct a difference-in-differences analysis. Figure 4 presents the event study results generated by estimating Eq. (1) using the method in Callaway and Sant'Anna (2021) on the secondary syphilis hospitalization data.[28] The results show that, in years prior to implementation of the acts, hospitalization rates were not trending differently in subjected and untreated stations. After implementation, hospital admissions begin to decline in subjected stations relative to the untreated. The divergence between treated and untreated stations builds over time, consistent with what we would expect given that (i) enforcement effectiveness improved during the first few years in which the Acts were enforced and (ii) reducing disease prevalence should have cumulative effects, since reducing infections in one year lowers the chance of further spread in the next year.

[27] When using this estimator the researcher must choose if only never-treated units are in the control group or whether not-yet-treated units are also added. Throughout the paper, we choose to only include never-treated units as the control group so that the composition of the control group does not change over time. However, results are robust to using not-yet-treated units instead.

[28] Appendix Figure C2 shows that the results are very similar if we instead use the conventional two-way fixed effects approach to generate the event study.

In terms of magnitude, the estimated effects in Figure 4 are quite large; the average secondary syphilis hospitalization rate in the treated locations prior to treatment was 35, so these results indicate a reduction of around one-quarter after four years and one-half after the program had been in force for eight years. While this result is large, it is consistent with the very large reduction in STI rates among active sex workers that we will document later (Figure 12) and the fact that the sex trade was probably the primary mechanism through which STIs spread among soldiers (Britain maintained an almost entirely bachelor army during this period). This magnitude is also consistent with the 40% reduction in STI hospitalizations that we estimate among Navy sailors in Appendix C.2. Appendix Table C1 presents the average of the dynamic treatment effects corresponding to the results in Figure 4 as well as some additional robustness checks on these results. For example, we show that similar results are obtained if we use the hospitalization rate in logs rather than in levels as our outcome variable. We also show that similar results are obtained if we focus only on stations in England and Wales, a sample that corresponds more closely to the geographic area used in our other analysis.

Figure 4: The Effect of the CDAs on Hospital Admissions for Secondary Syphilis



Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in Eq. (1) estimated using the method from Callaway and Sant'Anna (2021) applied to the station-level hospitalization rate of soldiers from secondary syphilis. The x-axis is in event time relative to the year in which the CDAs became active in a district where the station was located. We estimate β_s for years in event time in which all treated stations have data available. The vertical line corresponds to the year of treatment. Standard errors are clustered at the station-level (27 stations).

Summary: The results in this subsection indicate that the CDAs substantially reduced STI

admissions rates among soldiers stationed in districts covered by the acts, relative to soldiers in stations where the CDAs did not apply. Our analysis of STI rates among sailors in the Navy, in Appendix C.2, reinforce these results. Next, we look at whether similar reductions appear to have occurred among the general population.

3.2 The impact of the CDAs on general STI mortality

In this section, we examine how the CDAs changed STI rates among the general population. Direct measures of STI rates among the general population are not available in the historical setting that we study. However, we are able to observe mortality rates due to the most important STI, syphilis, at the county-level for all of England and Wales. These STI deaths are interesting in themselves, and they also reveal underlying patterns of STI presence.

Question: How did the CDAs affect STI mortality rates among the general population in locations subjected to the acts? Answering this question speaks to the broader impacts of the CDAs on STI spread as well as the impact that untreated STIs had on health during the period that we study.

Data: The analysis in this section uses data on mortality due to STIs that we digitized from the Annual Reports of Births, Deaths, and Marriages produced by the Registrar General's office. By 1855, when our data begin, the Registrar General's office was overseeing an extensive network of local Registrars responsible for gathering comprehensive mortality statistics. Registrar General's reports, and particularly the mortality statistics, are generally regarded to be of very high quality.[29] However, it is important to note that challenges in diagnosing specific STIs mean that our syphilis mortality series likely includes deaths associated with other STIs as well, though most of these deaths were likely due to syphilis. We collect data from 1855 until 1906, allowing us to assess the existence of pre-trends for a decade before the CDAs were passed as well as two decades after the Acts were suspended. We end the sample in 1906 because that is the year the Wassermann test, the first diagnostic test for syphilis, was invented.

Our analysis uses data on syphilis deaths, which are reported annually for 45 counties in England and Wales. Syphilis deaths account for 3.6 out of every thousand deaths in England and Wales from 1860 to 1899, a total of 75,559 deaths. Most of these deaths occurred among infants and young children. From 1860 to 1865, 70% of syphilis deaths occurred among children aged 0-1 and 76.7% were among children aged 0-5. This fact is relevant for our analysis because it means that deaths are likely to respond fairly rapidly to changes in the underlying disease environment.

As a point of comparison, we have also collected data on all other causes of death in the Registrar General reports. After standardizing causes of death over time we end up with 99 detailed causes of death categories observed at the county level for 1855-80 period.[30]

[29] Woods (2000) calls the mortality statistics the "shining star of Victorian civil registration."

[30] We have not extended this dataset out to 1906 mainly because the longer the time series the more costly it is to digitize and the more difficult it is to construct consistent cause of death categories.

Analysis strategy and results: The structure of the STI mortality data allow us to use the same difference-in-differences empirical strategy described earlier where we estimate Eq. (1), but with some important differences. The most important difference is that we are able to look at effects in treated and control locations before the CDAs were passed, while the Acts were in operation, as well as after they were repealed. One common concern in difference-in-differences designs is that the parallel trends assumption might be violated. A standard approach to guarding against this concern is to study pre-trends in the data. While parallel pre-trends do not guarantee that the treated units would have also experienced parallel trends during the treatment period in the absence of treatment, parallel pre-trends at least suggest that such a concern is unlikely. While our analysis passes this test, our setting allows us to go further. In particular, the off-on-off nature of the policy we study means that our results cannot be due to differential trends except in the highly unlikely case that those differential trends reversed at precisely the moment when the policy was repealed. Given what we know about the sources of the repeal, which occurred across all treated locations in the same year as a result of national agitation for women's rights, it seems extraordinarily unlikely that the identification assumptions could be violated in a way that reveals precisely the patterns we will find. A second advantage of being able to look before the CDAs came into effect, while they were in force, and after they were repealed is that we are able to analyze whether any reductions in STI rates resulting from the regulations persist after the regulations are removed.

It is also useful to note that our unit of observation in this analysis is the county. We treat any county with a district subject to the CDAs in a particular year as treated. Counties are relatively large units; the whole of England and Wales are covered by just 45 counties.[31] One benefit of running our analysis at the county level is that it will help us deal with concerns that our results may be driven by spillovers between treated districts and other nearby districts. Since most districts that are neighbors to treated districts will be in the same county, and most spillovers are likely to occur over relatively short distances, results obtained from a county-level analysis will likely capture both direct treatment effects as well as any spillovers to other nearby districts. However, in Section 3.3 we can test for spillovers more directly, and the evidence suggests that spillovers were not important in our setting.

Before presenting the main regression results, Figure 5 plots the syphilis mortality rates in counties containing subjected districts and those without. As discussed previously, the CDAs were implemented over a period of several years as amendments to the acts were passed adding subjected districts. In the period prior to implementation, syphilis mortality rates in treated and control counties display a similar upward trend. After implementation, the two groups began to diverge as the mortality rate in the treated counties falls and the syphilis rate in control counties continues to increase. After 1883, when the CDAs were no longer enforced, the mortality rates in

[31] We omit the County of London from our main analysis since it is a unique county different from all others in Britain, but we also present robustness results showing that this does not affect our findings.

treated and control counties begin to re-converge.

Event study results obtained from applying the specification in Eq. (1) to the county-level syphilis mortality data are presented in Figure 6. As in the previous analysis, we deal with the fact that we have staggered treatment timing by using the estimation approach from Callaway and Sant'Anna (2021).[32] A first feature to notice in these results is that there is no evidence that counties treated by the CDAs had differential trends in syphilis mortality in the years leading up to treatment. Next, notice how after treatment we see a relative decrease in syphilis mortality in counties subject to the CDAs.

The shaded rectangle in the graph indicates the period, in event time, corresponding to the suspension of the CDAs. Note that while suspension occurred in the same year (1883) for all locations, it shows up at a different point in event time for counties depending on when they were initially treated. To the right of the shaded rectangle we see another important finding. After suspension, syphilis mortality in the treated counties begins to converge back toward zero. Within about six years, the difference relative to control counties becomes statistically insignificant. Furthermore, after two decades the coefficients have nearly converged back to no difference between treatment and control counties

In terms of magnitude, the results in Figure 6 suggest that syphilis mortality fell by around 2.5 deaths per hundred thousand people after 10 years, and by around 3 deaths per hundred thousand after 15 years. These magnitudes are large compared to the average syphilis mortality rate of 6.4 deaths per hundred thousand in treated locations prior to treatment.[33] While the magnitude of these effects is large, they are in line with the large declines in the STI hospitalization rates documented in the previous section as well as the declines in the STI rate among sex workers discussed in Section 4.2.

The size of the effects we estimate grows over time. This pattern, which is consistent with the results documented for hospitalization rates in the previous section, is likely a consequence of the nature of STI transmission, where eliminating one case of disease transmission reduced the risk of future infections. This compounding effect can help explain why we observe relatively modest short-run effects in the first few years of the CDAs that grow to be quite large a decade later.

One implication of these large effects is that the market for sex was likely to have been a primary channel for STI spread in a Victorian society. This was a historical context in which women were harshly sanctioned for having sex outside of marriage while for men extra-marital sex was often excused. If a broad cross-section of men–particularly younger unmarried men–visited sex workers, and then transmitted STIs to their female partners, then sex workers may have been the critical node in disease spread.

Table 1 presents estimated average effects of the CDAs on the syphilis mortality rate in a variety

[32] Appendix Figure C5 shows that very similar and if anything somewhat stronger results are obtained if we use the conventional two-way fixed effects approach to generate the event study.

[33] Across the full sample, the mean death rate was 5.2 deaths per hundred thousand.

of different specifications.[34] Column 1 provides the baseline estimate where we restrict the analysis to the period up to 1883, when the CDAs were being actively enforced. Column 2 provides the estimate when using the full sample of data from 1855-1906 and corresponds to the average of the dynamic treatment effects from the event study in Figure 6. Column 3 includes London in the analysis. In Column 4, we look at the effect of the CDAs including only counties in the southern part of England. We do this because the CDAs were implemented only in districts in the south, which may mean that counties in the northern part of the England and Wales are not good control counties, though this appears to be unlikely given that in the event study results from Figure 6 show that treated and control counties were trending similarly prior to implementation. When we restrict our analysis to the counties in the south eastern, south midland, and south western divisions of England and Wales, in Column 4, the results are slightly smaller but still quite strong despite the fact that this specification restricts our sample to only 19 of 45 counties.[35]

A different concern is that our results may be affected by spillovers to control counties if sex workers leave districts where the CDAs operated. As we have discussed, several factors suggest that such spillovers are unlikely.[36] Nevertheless, in Column 5 we estimate results excluding any county that borders on a CDA county and show that our results are largely unchanged.

An additional concern is that in our setting we have only five treated counties, which might make traditional inference methods that depend on many treated units invalid in our context. To assess this possibility, Figure C6 presents the results of a permutation test (Fisher, 1935). The figure presents the distribution of t-statistics from a set of 1,000 alternative regressions, analogous to the specification in Column 1 of Table 1, where we randomly draw five placebo treated counties. The results in Appendix Figure C6 show that it is extremely unlikely that the results obtained from our true treated counties could be due to random chance.

As a final robustness check, we estimate the impact of treatment on all 99 of the consistent causes of death obtained from the Registrar General reports. Figure 7 plots the distribution of the t-statistics obtained from each of these regressions, together with a vertical line indicating the t-statistic obtained when syphilis is the dependent variable. The t-statistic for the estimated effect on syphilis mortality is -3.24, and in the far left-tail of the distribution. This suggests that it is highly unlikely that we would estimate this treatment effect through random chance. Thus, these results provide further evidence that the effects we have estimated are a consequence of the CDA treatment rather than a result of some other time-varying factor influencing mortality rates. It is

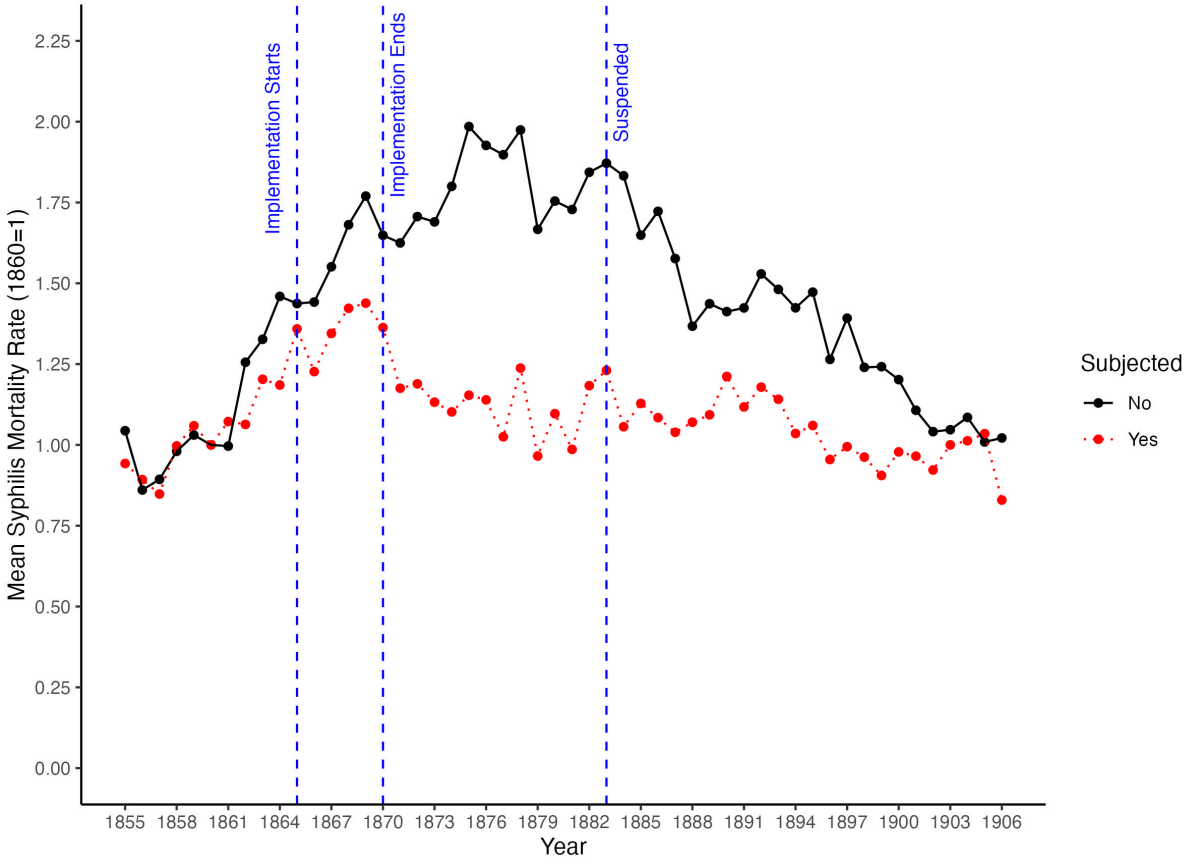
[34] The reported coefficients correspond to the average of the dynamic treatment effect using the procedure in Callaway and Sant'Anna (2021).

[35] In Table 1, the mortality rate is calculated as the number of syphilis deaths relative to the population. However, as we have previously highlighted, a large fraction of syphilis deaths were infants. Table C2 shows similar results when the outcome is calculated as the number of syphilis deaths per 1,000 live births.

[36] The historical accounts suggest the migration of sex workers during this period was local in nature. If job prospects were scarce in the countryside, women might move to a nearby town to practice sex work (Walkowitz, 1982). Furthermore, there is work by economic historians suggesting there was less geographic mobility in the UK relative to the US (Long and Ferrie, 2004). Finally, in the analysis in Section 3.3 we look at whether there is any evidence of cross-district spillovers within counties. The fact that we find no evidence of cross-district spillovers suggests that cross-county spillovers are even less likely to be an issue.

also interesting to consider some of the other causes of death that show a strong relationship to the CDA treatment. While some of the 99 causes of death that we study are likely to be related to treatment simply due to random chance, it is interesting to note that among the five causes of death showing the strongest relationship to treatment, in addition to syphilis we also observe malformations (i.e., birth defects) and ovarian dropsy. Both of these seem likely to be related to the rate of STI infections and thus to the CDA treatment for reasons other than random chance.

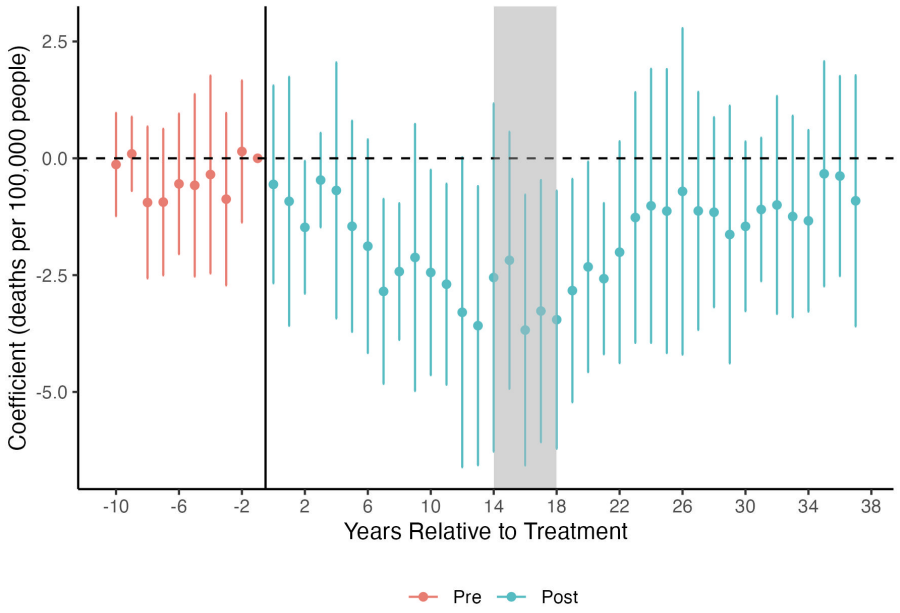
Figure 5: Syphilis Mortality in Treated and Untreated Counties



Note: The figure plots the average syphilis mortality rate in counties containing districts subjected to the CDAs and counties without treated districts (excluding the County of London). The dashed, red line shows the average mortality rate for the subjected counties. The solid, black line shows the average mortality rate for untreated counties. Rates are normalized, so for each group the value is equal to one in 1860. The first vertical line represents the year where the CDAs began to be implemented. The second vertical line represents the year implementation was complete in all subjected districts. The third vertical line shows the year the CDAs were suspended from operation in all subjected districts.

Summary: These results tell us that the CDAs led to a reduction in STI mortality in treated districts, and that this effect begins to reverse after the CDAs were repealed. The fact that we observe clear responses both to treatment and to the removal of treatment is notable, because it means that our results are extraordinarily unlikely to be due to differential underlying trends.

Figure 6: The Effect of the CDAs on Syphilis Mortality



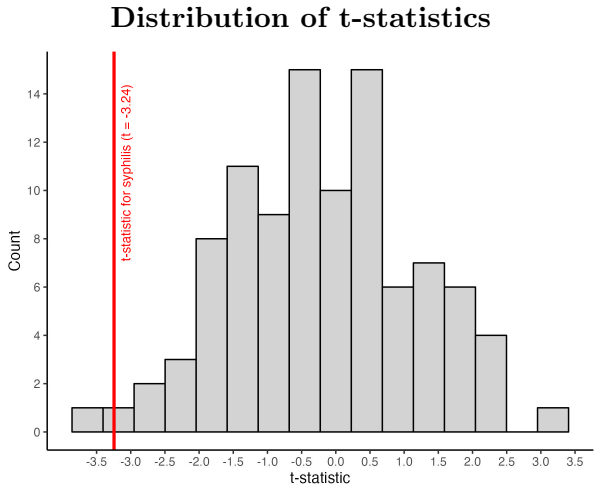
Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in Eq. 1 estimated using the method from Callaway and Sant'Anna (2021) applied to the county-level syphilis mortality rate. The x-axis is in event time relative to the year in which the CDAs became active in any district within the county. We estimate β_s for years in event time in which all treated counties have data available. The vertical line corresponds to the year of treatment. The shaded region corresponds to the years in event time when the law was suspended. While suspension occurs in 1883 for all counties, this occurs in different years of event time because of staggered treatment timing. Standard errors are clustered at the county-level (45 counties). London is excluded from the analysis.

Table 1: The Effect of the CDAs on County-Level Mortality Rates

	DV: Syphilis Mortality Rate				
	Up to 1883 (1)	Full period (2)	Including London (3)	Southern counties only (4)	No nearby counties (5)
ATT	-1.918***	-1.777**	-1.742***	-1.314**	-1.876***
	(0.517)	(0.748)	(0.496)	(0.667)	(0.494)
Dep. Var. Mean	5.165	5.165	5.297	5.545	5.769
Observations	1232	2288	1260	532	924

Note: *** p<0.01, ** p<0.05, * p<0.1. Each column provides the average of the dynamic treatment effects from estimating Eq. 1 using the method from Callaway and Sant'Anna (2021) for different types of mortality. In all specifications, the outcome is the mortality rate, calculated as the number of deaths per 100,000 people. Data are annual at the county-level. The county of Greater London is excluded unless stated otherwise. The first column presents the results for syphilis restricting the sample prior to 1883 when the CDAs are suspended. The second column presents the results for syphilis using the full sample from 1855-1906. This specification corresponds to the event study in Figure 6. The third row presents the estimate when the Greater London county is added to the analysis and restricting to pre-suspension. The fourth column restricts the analysis to counties in the south-western, south midland, or south-eastern registration areas pre-suspension. The fifth column removes counties that border treated counties and restricts to pre-suspension. Standard errors are clustered at the county-level (45 counties).

Figure 7: Distribution of the estimated effect of treatment on all 99 causes of death



Note: The figure shows the results of estimating Eq. (1) for all 99 causes of death in the Registrar General reports from 1855 to 1880. The outcome in each regression is the cause-specific mortality rate per 100,000 individuals. The histogram plots the distribution of t-statistics corresponding to the estimated effect of the CDAs on each cause. The red, vertical line corresponds to the t-statistic where the syphilis mortality rate is the outcome of interest.

3.3 CDAs and childless couples

Question: Exposure to STIs comes with a risk of infertility, increased risk of miscarriage or stillbirth, and a higher chance of infant mortality. Several different STIs, including chlamydia and gonorrhea, when untreated, can lead to pelvic inflammatory disease resulting in infertility.[37] STIs, particularly syphilis, can also increase the chances of miscarriages and stillbirths as well as mortality among infants that contract the disease from their mothers. Finally, STI infections may increase childlessness if they cause couples to have intercourse less frequently. These medical facts, together with the changes to STI prevalence documented in previous sections, raise the following question: did the CDAs affect the prevalence of childless couples in treated districts?

Data: To analyze whether the CDAs affected the rate of childless couples in treated locations, we turn to the census microdata for England and Wales. Using information on household structure included in the census, we identify all households with both a husband and wife present. We focus on couples where the wife's age falls into a middle age range, since older couples are likely to have children who have left the home and younger couples may not have been married long enough to have conceived even if they are able (the census does not include information on the year that couples were married). In our main analysis, we use couples where the wife is between 25 and 40. In robustness exercises we extend this window out to age 45 and show that our results are not particularly sensitive to this choice. For each couple satisfying this criteria, we then count the number of children in the household and identify childless couples. We aggregate the data to the district level. This geographic unit is substantially smaller than the counties analyzed in the previous section; there are over 600 districts in England and Wales compared to just 45 counties. This feature allows us to analyze spillovers from CDA districts into other nearby districts within the same county.

We draw our data from four census waves: 1851, 1861, 1891, and 1901. The first two provide pre-CDA observations, while 1891 and 1901 will reflect post-treatment outcomes. We do not consider the 1881 census because families in the age range we consider would have had some fertile years before the CDA and some years during the CDA, so that is not clearly either a pre-treatment or treatment observation (microdata for the 1871 census are not currently available to our knowledge).

Table 2 presents some basic statistics showing the rate of childless couples in the country as a whole as well as in the CDA and non-CDA districts and the difference between those two. In the first column, we can see that the rate of childless couples was high in 1851 and 1861, fell in 1891, and then increased again by 1901. There are two forces that can help explain this pattern. First, we know that health was improving in the second half of the nineteenth century, and that this improvement was particularly notable in terms of the reduction in child mortality (Woods et al., 1988). This trend, which begins in the 1860s, will tend to reduce the rate of childless couples.

[37] There is some descriptive work in demographic history connecting STI prevalence in Britain historically to infertility (Szreter and Schürer, 2019). In modern developing countries, STIs remain an important cause of childlessness (Baudin et al., 2020).

Table 2: Rates of Childless Couples in CDA and Non-CDA Districts

Year	All districts	CDA districts	Non-CDA districts	Rate in CDA districts - rate in non-CDA districts
1851	0.159	0.189	0.158	0.030
1861	0.154	0.184	0.153	0.031
1891	0.143	0.165	0.143	0.022
1901	0.165	0.189	0.164	0.025

Note: This table presents the share of couples with wives aged 25-40 with no children in the home in CDA and all other districts in each census based on census microdata. Districts in London are not included.

However, starting in 1877, fertility in Britain began to rapidly decline, a factor that will tend to increase the rate of childless couples, particularly by 1901 (Beach and Hanlon, 2023).

The statistics in Columns 2 and 3 show that CDA districts had higher rates of childless couples in the pre-CDA period. One explanation for this is the higher rate of STI prevalence in the CDA districts in the pre-treatment period. However, we also see, in Column 4, that the gap between the rates in CDA and non-CDA districts falls sharply between 1861 and 1891, when the CDA was in operation. This pattern provides suggestive evidence consistent with a relative reduction in infertility, miscarriages, stillbirths, and infant/child mortality in CDA districts following the introduction of the CDAs.

Analysis strategy and results: We apply a difference-in-differences analysis strategy to study the impact of the CDAs on the rate of childless couples in a district. Our main regression specification is:

$$CHILDLESS_{it} = \beta(CDA_i * POST_t) + \gamma_i + \eta_t + \epsilon_{it} \tag{2}$$

where $CHILDLESS_{it}$ is the share of childless couples in district i in census year t, CDA_i indicates CDA districts, $POST_t$ indicates post-CDA periods (1891 and 1901), and γ_i and η_t are district and time fixed effects. We cluster standard errors by district to allow for serial correlation. In our main specification, we exclude London, though we also examine robustness to this choice.

Before we come to our main results, we present some event study results, in Figure 8, where in place of the $POST_t$ term in equation (2) we include a vector of year fixed effects, with 1861 as the reference decade. We can see that there is no evidence of pre-trends from 1851-1861 and a clear reduction in the rate of childless couples in CDA districts in the post-CDA years.

Table 3 presents our main results. The simplest specification, in Column 1, shows that couples living in CDA districts were substantially less likely to be childless in 1891 and 1901 than in the pre-CDA years (1851 and 1861). In terms of magnitude, these results suggest the share of childless couples declined by around 1.3 percentage points. This is equivalent to a decrease of around 7% in the rate of childlessness observed in the CDA districts in the pre-CDA period (see Table 2).

Figure 8: The Effect of the CDAs on Childless Couples: Event Study Results

Note: The figure shows the estimated coefficients and 95% confidence intervals for coefficients estimated using Eq. 2 but replacing $POST_t$ with a set of year indicator variables. Data cover all couples in England and Wales where the wife's age at the time of the census is in [25-40]. N = 1,572. The unit of observation is the district-year and standard errors are clustered by district. The regression includes district and year fixed effects. Districts in the County of London are excluded from the analysis.

One advantage of using district-level data in these regressions is that we can look for evidence of spillovers from CDA districts into other nearby districts. We do this in Columns 2, 3, and 5. In Column 2, we look at how the rate of childlessness evolved in CDA counties overall in the post-CDA period, while separately estimating the effect in the CDA districts. We observe no evidence of spillovers from CDA districts to other districts in the same county. In Columns 3 and 5, we look for evidence of spillovers into just those districts that border CDA districts.[38] In these results, we see weak evidence of reduced childlessness in nearby districts. This pattern suggests that STI reductions in CDA districts may have also led to smaller reductions in bordering districts, though we would not want to draw strong conclusions from these results. None of these results provide any support for the possibility that reductions in STI rates in CDA districts may have been due to a displacement of the sex trade into other nearby districts. That makes sense given that districts were large enough (at least outside of London) that customers in CDA districts were unlikely to be able to travel to nearby unregulated districts in order to purchase sex.

Columns 4 and 5 present results from a specification that includes county-by-year fixed effects. We can see that the inclusion of these fixed effects has almost no effect on our main results despite the fact that they absorb a large share of the variation in the data (as indicated by the R-squared).

In Appendix Table C3 we consider the robustness of our results. In one robustness check, we look at how our results change if we extend our sample to include couples where the wife's age was between 25 and 45. In a second check, we extend the geographic scope of the analysis to include

[38] Bordering districts are included regardless of whether they are in the same county as the CDA district.

Table 3: Analysis of the Effect of the CDAs on Childless Couples

	DV: Share of childless couples				
	(1)	(2)	(3)	(4)	(5)
CDA District x Post	-0.0133***	-0.0161***	-0.0137***	-0.0121**	-0.0161**
	(0.00485)	(0.00597)	(0.00487)	(0.00538)	(0.00635)
CDA County x Post		0.00327			
		(0.00397)			
Bordering dist. x Post			-0.00502		-0.00714
			(0.00332)		(0.00540)
District FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes		
County-year FE				Yes	Yes
Observations	1,572	1,572	1,572	1,568	1,568
R-squared	0.148	0.149	0.149	0.694	0.694

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by district. Based on couples where the wife's age is between 25 and 40. London is excluded from the analysis. Based on specification in Eq. 2.

London. Neither of these modifications has any meaningful impact on our results.

We can also generate similar results using households rather than districts as the unit of observation. Household-level results have the advantage that we can include some individual-level controls such as wife's and husband's age. However, those results use a linear probability model which relies on assumptions that may not be as valid. Household-level results, presented in Appendix Table C4 show that households living in CDA districts were less likely to be childless in the post-treatment years, though the results are only marginally statistically significant (90% level). Interestingly, we also find clear reductions in childlessness among couples where either the husband or the wife was born in a CDA county, suggesting that couples were likely affected by whether they grew up in a treated location in the CDA or post-CDA period.

Summary: The results in this section show that couples who were exposed to the CDAs were less likely to be childless, a pattern that is consistent with what we would expect to observe in the presence of lower STI rates in CDA districts. This provides additional evidence that the CDAs improved public health, while also showing that those health improvements had meaningful impacts on people's lives.

4 Mechanisms

In this section, we examine some of the mechanisms through which the CDAs led to reduced STI rates. In the first part, we focus on how the CDAs affected the size of the market for sex. If, as

seems likely, the sex trade was an important vector for STI spread, then reducing the size of the market is one mechanisms that could have led to a reduction in STI rates. Thus, examining how the CDAs affected the market for sex can help us understand the mechanisms behind the health improvements that we have documented. In addition, this context also provides a rare opportunity to study how regulation affects the market for sex, which few modern studies have been able to look at because of data constraints, with the notable exception of Cameron et al. (2021).

Another channel through which the CDAs may have reduced STI rates is by reducing the share of active sex workers with STIs, and thus the risk of STI spread in any particular encounter. In the second subsection below, we offer some evidence suggesting that the CDAs led to a substantial reduction in STI rates among active sex workers, achieved in part through the hospitalization of large numbers of infected sex workers. A third potential mechanism is that the changes in the market for sex created by the CDAs may have influenced the rate at which male sex purchasers spread STIs into the broader population. This channel is impossible to explore given the paucity of data on sex purchasers, though it represents a potentially interesting avenue for future inquiry.

4.1 The CDAs and the Size of the Market for Sex

Question: How did the CDAs affect the size of the market for sex? If the CDAs reduced the market for sex, that could have been an important mechanism through which they reduced STI spread. However, the impact of the CDAs on the quantity of sex transacted is theoretically ambiguous. On one hand, the CDAs represented an increase in the cost and hassle faced by women who sold sex. Sex workers incurred time costs associated with the frequent inspections. The history literature also suggests the examinations were mentally taxing for sex workers. Many did not want to be examined and considered it to be a breach of privacy. In addition, the police actively worked to discourage sex workers from practicing the trade, particularly those new to it, and to connect sex workers with resources that helped them exit the trade. We would expect all of these factors to shift supply inward. On the other hand, if the CDAs increased buyers' perception of the safety of purchasing sex, then they might also have increased demand.[39] We would expect both of these forces to increase the price in the market (which unfortunately we are unable to observe) but the effect on quantity—which is what matters for disease transmission—is ambiguous.

Data: We use two sources of data to track the impact of the CDAs on the market for sex. The first, which was produced by the police as part of the CDA intervention, we digitized from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* for 1881 (hereinafter the "police data"). The advantage of this data source is that it contains detailed information on the sex trade in each district subjected to the CDAs. The disadvantage is that it is available only for the treated districts, and only starting from

[39] Immordino and Russo (2015) present a model of the sex trade capturing these various elements. The health risk in the market is endogenous to the number of sex workers and clients. They study how various regulations of the sex trade, either prohibition or licensing regimes, impact equilibrium quantities, prices, and health risk.

the year the act came into effect. Additional details are provided in Appendix B.4.

To complement the police data, we use a second data set – the "Judicial Statistics data" – which we digitized from the *Judicial Statistics of England and Wales*. These data give the number of active brothels in British counties from 1860 to 1871.[40] The main advantage of this source is that it contains data for both CDA and non-CDA locations before and after the introduction of the CDAs, allowing us to conduct a difference-in-difference analysis.

There are some caveats that should be kept in mind when using both of these data sets. First, the data reflect only the number of sex workers and brothels known to the police through the registration process. They do not capture women that evaded the law and continued practicing sex work. However, as we have seen, the CDA regulatory regime was quite extensive, and so there are unlikely to be substantial numbers of unregistered women selling sex in the subject districts. Second, the number of sex workers or establishments is not a perfect measure of the quantity in the market, because it will not capture the intensive margin of supply. However, we believe that it is likely to be a good approximation of quantity because most of the women who sold sex (at least those captured in our data) did so on a full-time basis.[41] There is a clear economic rationale for this, as pointed out by Edlund and Korn (2002).

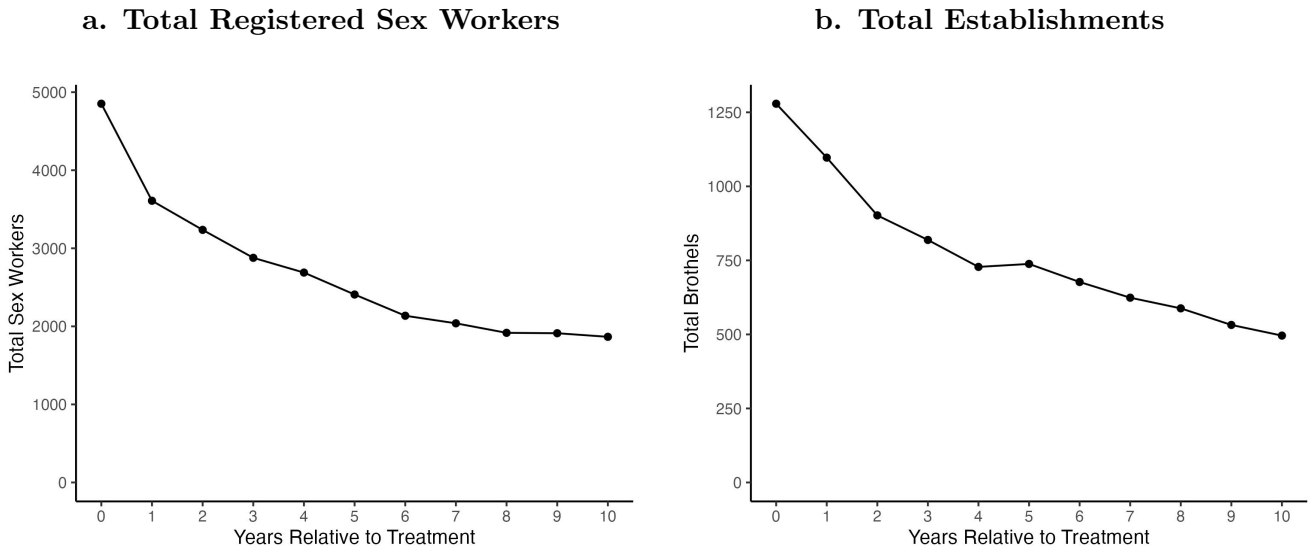
Analysis of the police data: We start by using the police data to provide a series of descriptive facts on how different aspects of the sex trade changed over time in the treated districts. As a starting point, Figure 9a shows the change in the number of sex workers in CDA districts in event time, i.e., relative to the first year in which the district came under the CDAs and the sex workers in the district were registered. The reduction in sex workers over the first few years in which the CDAs were in operation is clear. Starting from a total of nearly 5000 women in the initial year, the number of sex workers in CDA districts dropped to around 2000 after about five to seven years and then leveled off. Overall, this represents an approximately 60% reduction in the number of sex workers during the period. This drop is observable in nearly all of the CDA districts, as shown in Appendix Table C5, though there is some variation resulting from the particular circumstances in each district as well as the vigor with which the regulations were enforced. The fact that we observe such a precipitous drop in the number of sex workers following the introduction of the CDAs strongly suggests that the new regulations effectively reduced the size of the sex trade.

The reduction in the supply of sex workers coincides with a similar decline in the number of establishments where the sex trade took place. Figure 9b shows that the total number of establishments declined by approximately 60% in the first decade after implementation. Furthermore, the types of establishments also changed. In the first year the CDAs were implemented, public and beer houses comprised approximately 32% of locations. Some of these pubs would rent out

[40] For unknown reasons, after 1871 the number of brothels is no longer reported in the Judicial Statistics reports.

[41] When discussing the prevalence of women that engaged in sex work only part-time, the historian Judith Walkowitz writes, "Experts doubted that working women could maintain a dual identity over any extended period – slaving away fourteen hours a day at dressmaking or laundressing and then going on the streets in the evening." (Walkowitz, 1982, p.14-15)

Figure 9: Registered Sex Workers & Brothels in Subjected Districts

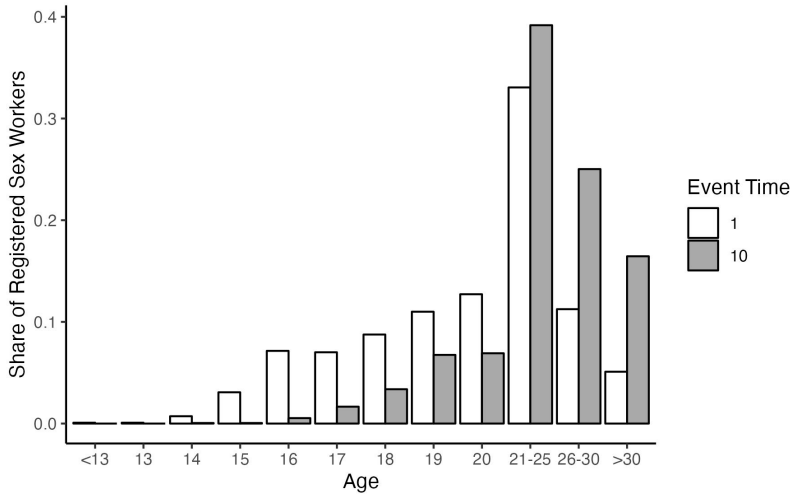


Note: The figure on the left displays the total number of registered sex workers over time. The figure on the right displays the total number of establishments where sex work took place. Both graphs aggregate across all districts in event time. The data are from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Appendix B.4 provides additional details.

permanent housing for women to reside in the bar while other sex workers resided elsewhere. A decade later, the share of public and beer houses had declined to approximately 7%. Overall, these facts reflect the reduction in the size of the market as well as the formalization of the sex trade as sex work concentrated in brothels and away from locations such as public and beer houses where other types of leisure activity occurred.

The police data also offer insight into the mechanisms through which the reduction in the number of sex workers occurred. As part of the registration process local police collected data on the age of all registered sex workers in subject districts. Figure 10 presents the distribution of sex worker ages in the first year in which the CDAs were in force in each district and the tenth year. There is clear evidence that the average age of sex workers shifted up between these two observations, consistent with a reduction in entry into sex work by younger women. During this period the average age increased nearly 4 years from 21 to 25. This pattern suggests a reduction in younger women entering the sex trade and existing sex workers remaining in the market for longer. Younger women choosing whether to enter the sex trade might have been dissuaded given the higher costs associated with frequent testing, or because of police interventions encouraging them not to enter, whereas the sex workers that remained may have been those with few outside options. The historians Judith and Daniel Walkowitz have presented anecdotal evidence of this fact and have argued that the CDAs led to the "professionalization" of the sex trade where women remained in the industry longer and had less occupational mobility (Walkowitz and Walkowitz, 1973).

Figure 10: The Age Distribution of Registered Sex Workers in CDA Districts Over Time



Note: The figure shows the age distribution of registered sex workers for first year after treatment (light bars) and a decade after treatment (shaded bars). The data are from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Appendix B.4 provides additional details.

Analysis of the judicial statistics data: While the police data provide detailed information on the sex trade in the treated districts, a potential concern is that the observed decline in supply could be driven by other confounding factors. To address this, we use the Judicial Statistics data, which allows us to apply a difference-in-differences analysis strategy to study the impact of the CDAs on the number of brothels in a county, from 1860-1871, and the number of sex workers in a county, from 1860-1868.[42]

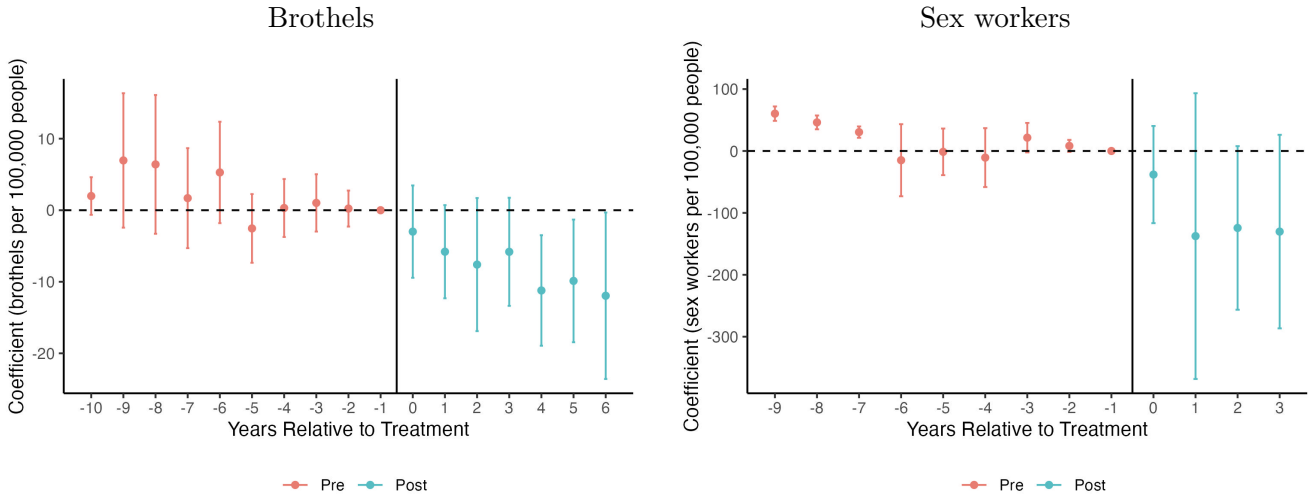
We follow the same empirical strategy used in Section 3. We estimate Eq. (1) where the main outcome is the number of brothels in the county or the number of sex workers in the county, per one hundred thousand residents. Analyzing county-level data helps address a potential concern that our results may be affected by spillovers from treated into non-treated neighboring districts, although the results from Section 3.3 suggest spillovers are unlikely to be significant in our context. As in the previous analysis, since treated counties are subject to the CDAs at different times (see Table B3) we estimate Eq. (1) using the estimator in Callaway and Sant'Anna (2021).

Figure 11 displays the event study results from estimating Eq. (1). While noisy, the estimated coefficients suggest treated and control counties are not trending differently prior to implementation of the CDAs. After implementation, both the number of brothels and the number of sex workers in counties containing treated districts begins to decline. Appendix Table C6 provides the average treatment effect corresponding to the results presented in Figure 11, as well as some robustness checks. The average effect implies that after the CDAs were implemented treated counties had

[42]The data in the Judicial Statistics on the number sex workers is no longer reported after 1868, while the brothels series is discontinued in 1871.

approximately 8 fewer brothels per one hundred thousand individuals, a 33% reduction for the average county.[43]

Figure 11: The Effect of the CDAs on the Number of Brothels and Sex Workers



Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in Eq. 1 estimated using the method from Callaway and Sant'Anna (2021) applied to the county-level number of brothels (left panel) or sex workers (right panel) per hundred thousand residents. The x-axis is in event time relative to the year in which the CDAs became active in any district within the county. The vertical line corresponds to the year of treatment. Standard errors are clustered at the county-level. The County of London is excluded from our analysis. Note that we observe fewer post-treatment periods in the right-hand panel. That is because the Judicial Statistics reports stopped reporting the number of sex workers just a few years after the CDAs were enacted.

Summary: Both the patterns revealed by the police data and our analysis of the judicial statistics data indicate that the CDAs substantially reduced the size of the market for sex in the districts in which they applied. A reduction in the size of the sex market is one mechanisms through which the CDAs led to the reductions in STI hospitalization rates and STI mortality documented in our main analysis.

4.2 The CDAs and the STI rate among sex workers

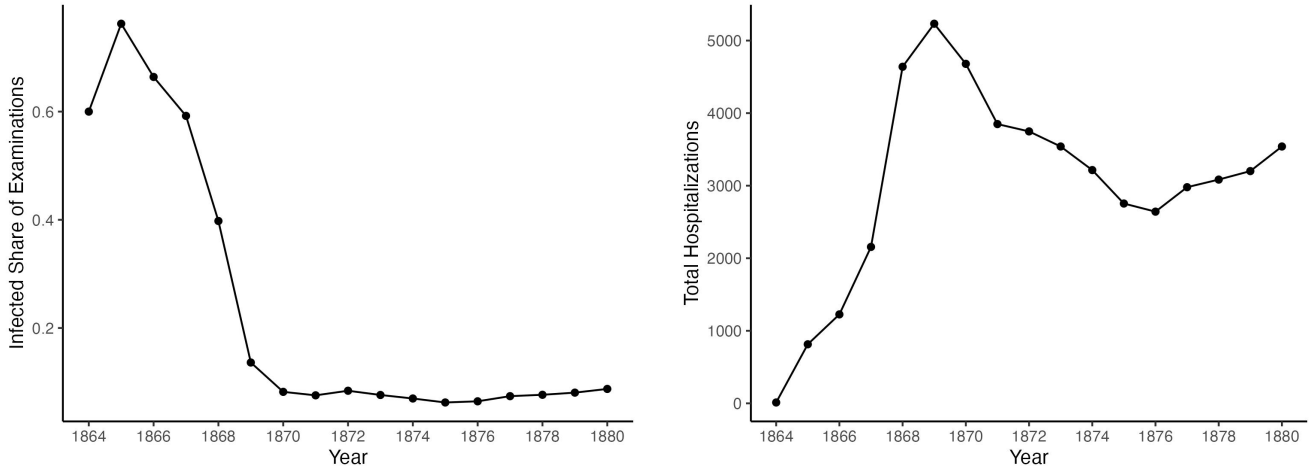
Another channel through which the CDAs may have improved public health is by shifting the share of active sex workers with STIs. This mechanism would have reduced STI spread even in the absence of a reduction in the number of transactions.

We are able to offer some direct evidence of this effect, because as part of the CDAs, the police collected data on the share of exams that led to a positive STI diagnosis. The left-hand panel of Figure 12 shows that the rate of STI infections per exam dropped precipitously in the first few years of the CDAs, from over 60% to under 10%. Thus, the pool of active sex workers was becoming

[43]Figure C8 shows similar results if the event study is estimated using the conventional two-way fixed effects approach.

much less likely to spread STI infections in any particular sexual encounter. This precipitous drop is in part a mechanical effect of the fact that a large number of infected sex workers were isolated in lock hospitals under the CDAs. The right-hand panel of Figure 12 shows the number of hospitalizations in each year under the CDAs. Note that the x-axis here is year rather than event time. The increase in hospitalizations from 1865 to 1869 is likely due to the extension of the acts to additional districts across that period, which was accompanied by the opening of new lock hospitals. Hospitalizations peaked in 1869 and then fell, a pattern that reflects both fewer sex workers overall and a reduction in the share of active sex workers with STIs. There are two important points to note when considering these patterns. First, hospitalizations need not have resulted from an inspection that uncovered an STI. Sex workers could have also checked themselves into a hospital voluntarily, or because they knew that they would fail an upcoming inspection. Second, we do not have information on the typical length of hospitalization, and or how many sex workers were hospitalized more than once during the same year. Multiple hospitalizations can help explain the large number of hospitalizations that we observe relative to the number of sex workers.

Figure 12: STI Rates and Hospitalizations Under the CDAs Over Time



Note: Data from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Appendix B.4 provides additional details.

5 Conclusions

Our results show that the CDAs substantially reduced STI infection rates and STI mortality, as well as the rate of childlessness, in treated districts. These findings correct previous qualitative work suggesting that the CDAs were ineffective. In fact, our results show that these regulations were highly effective as public health measures. One implication of our results is that the market for sex was a primary conduit for the spread of STIs in Victorian Britain. This finding improves our understanding of patterns of sexual relations in a context in which available information is

severely limited.

However despite their public health benefits, the CDAs failed as public policy and were ultimately repealed in 1886. Behind this failure, which we examine in detail in a companion paper (Goehring and Hanlon, 2025), was the fact that the CDAs imposed a substantial violation of the rights of sex workers. Thus, while we find that governments had the ability to effectively combat STIs before the introduction of effective modern treatments, this ability relied on draconian violations of basic rights.

Our results also shed new light on the health consequences of regulating the sex trade in a laissez-faire environment. This has been difficult to study in modern settings, but it remains relevant given that licensing and inspection systems are still used to combat STI spread in locations where the sale of sex is legal. We show that sex trade regulations that impose a system of inspection and isolation of infected sex workers led to a reduction in the size of the market for sex, despite the fact that it made the purchase of sex safer. This finding runs counter to the predictions of some existing theoretical work (Immordino and Russo, 2015).

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Appendix

A Empirical setting appendix

A.1 LNA protest of 1870

Below is the text of the protest published by the LNA in the *Daily News* at the beginning of 1870, as quoted from Butler (1909), p. 44. Butler claims that 120 names were attached to the original protest but that the number of signatories eventually reached over two thousand, including many notable women such as Harriet Martineau and Florence Nightingale.

> We, the undersigned, enter our solemn protest against the Acts.
>
> (1) Because, involving as they do such a momentous change in the legal safeguards hitherto enjoyed by women in common with men, they have been passed not only without the knowledge of the country, but unknown in great measure to Parliament itself; and we hold that neither the Representatives of the People nor the Press fulfill the duties which are expected of them when they allow such legislation to take place without the fullest discussion.
>
> (2) Because, so far as women are concerned, they remove every guarantee of personal security which the law has established and held sacred, and put their reputation, their freedom, and their person absolutely in the power of the police.
>
> (3) Because the law is bound, in any country professing to give civil liberty to its subjects, to define clearly an offence which it punishes.
>
> (4) Because it is unjust to punish the sex who are the victims of a vice, and leave unpunished the sex who are the main cause both of the vice and its dreaded consequences; and we consider that liability to arrest, forced medical treatment, and (where this is resisted) imprisonment with hard labour, to which these Acts subject women, are punishments of the most degrading kind.
>
> (5) Because by such a system the path of evil is made more easy to our sons, and to the whole of the youth of England, inasmuch as a moral restraint is withdrawn the moment the State recognises, and provides convenience for, the practice of a vice which it thereby declares to be necessary and venial.
>
> (6) Because these measures are cruel to the women who come under their action–violating the feelings of those whose sense of shame is not wholly lost, and further brutalising even the most abandoned.

(7) Because the disease which these Acts seek to remove has never been removed by any such legislation. The advocates of the system have utterly failed to show, by statistics or otherwise, that these regulations have in any case, after several years' trial, and when applied to one sex only, diminished disease, reclaimed the fallen, or improved the general mortality of the country. WE have on the contrary the strongest evidence to show that in Paris and other continental cities, where women have long been outraged by this system, the public health and morals are worse than at home.

(8) Because the conditions of this disease in the first instance are moral not physical. The moral evil, through which the disease makes its way, separates the case entirely from that of the plague, or rather [sic] scourges, which have been placed under police control or sanitary care. We hold that we are bound, before rushing into experiments of legalising a revolting vice, to try to deal with the causes of the evil, and we dare to believe, that with wiser teaching and more capable legislation, those causes would not be beyond control.

B Data appendix

B.1 Locations covered by the CDAs

Table B1 describes the locations included in the CDAs, including details on the Act in which the location was included and the year in which enforcement actually began. Note that there may be some delay between when the Act was passed covering a location and when enforcement began. This delay was due to the need in some locations to expand hospital facilities to accommodate women who were being isolated.

The last two columns indicate whether the location is included as part of either the station-level analysis, in Section 3.1, or the county or district level analyses in Sections 4.1, 3.2, and 3.3. Note that the station-level analysis includes only locations with an Army barracks (our analysis using Navy data is presented separately in Appendix Section C.2) and the district and county-level analyses use data that is only available for England and Wales.

B.2 Data appendix for the station-level analysis

This appendix provides more details on the data used in the station-level analysis of STI hospitalization rates presented in Section 3.1.

Data: To assess how STI transmission changed after the CDAs were implemented, we use data on the number of hospital admissions of British soldiers due to various STIs. The data we use is contained in the *Report from the Select Committee on the Contagious Diseases Acts* published in 1881. This document contains the minutes of the Committee as they interviewed health and government officials in favor of the CDAs as well as opponents of the laws. A medical official, Inspector General Lawson, was called before the committee to provide statistics in defense of the Acts. Lawson compiled data on hospital admissions of British soldiers at stations subjected to

Table B1: Locations covered by the CDAs

Location	**Country**	**Primary service**	**Authorizing act year**	**Enforcement begins**	**In stations analysis** (Army only)	**In district or county-level analysis** (Eng./Wales only)
Portsmouth	England	Both	1864	1864	Yes	Yes
Plymouth/Devpt	England	Both	1864	1865	Yes	Yes
Woolwich	England	Army	1864	1866	Yes	Yes
Greenwich***	England	Navy	1864	1870	Yes	Yes
Chatham	England	Both	1864	1865	Yes	Yes
Sheerness	England	Navy	1864	1865	Yes	Yes**
Deal****	England	Both	1864	1870	Yes	Yes
Aldershot	England	Army	1864	1867	Yes	Yes
Colchester	England	Army	1864	1869	Yes	Yes
Shorncliffe	England	Army	1864	1868	Yes	Yes
The Curragh	Ireland	Army	1864	1870	Yes	
Cork	Ireland	Army	1864	1870	Yes	
Queenstown	Ireland	Navy	1864	?		
Windsor	England	Army	1866	1868	No*	Yes
Canterbury	England	Army	1869	1870	Yes	Yes
Dover	England	Both	1869	1870	Yes	Yes
Gravesend	England	Navy	1869	1870		Yes
Maidstone	England	Army	1869	1870	Yes	Yes
Southampton	England	Navy	1869	1870		Yes
Winchester	England	Army	1869	1870	Yes	Yes

Note: *Windsor is an army station but it is excluded from the station-level analysis because of missing data. ** Sheerness is included in the station-level analysis because it is grouped with Chatham, which included an Army garrison. *** Greenwich is not listed as a separate location in the acts, but part of the district is included under Woolwich. However, enforcement in Greenwich began later than in Woolwich. **** Deal was not listed separately in the acts, but was included as part of Sheerness. For English stations, the date when enforcement begins is from The *Annual Report, for 1874, of Captain Harris, Assistant Commissioner of Police of the Metropolis, on the Operation of the Contagious Disease Acts*, 12 March 1875.

the CDAs and those that were untreated. We digitize these statistics which are located on pages 445-455 of the report.

For hospital admissions due to gonorrhea and primary syphilis, Lawson only reported the data aggregated across all treated and untreated stations in the United Kingdom. Therefore, for these outcomes we cannot conduct a conventional difference-in-differences analysis.

However, Lawson provides station-level data for secondary syphilis hospital admissions from 1860-1878 for each station in England, Wales, Scotland, Northern Ireland, and Ireland averaging at least 500 soldiers annually. This yields an annual panel with fourteen stations in subjected districts and thirteen stations not under the CDAs. Table B2 presents the stations in the data presented by Lawson as well as the country it is located in as well as its treatment status.

The following list provides the specific data within the report used in our analysis.

- Figure C1A: annual primary syphilis hospitalizations per 1,000 soldiers is taken from Table 1 (page 445).

- Figure C1B: the number of soldiers in the hospital daily for secondary syphilis per 1,000

soldiers is taken from Table 2 (page 446).

- Figure C1C: annual gonorrhea hospitalizations per 1,000 soldiers is taken from Table 1 (page 445).

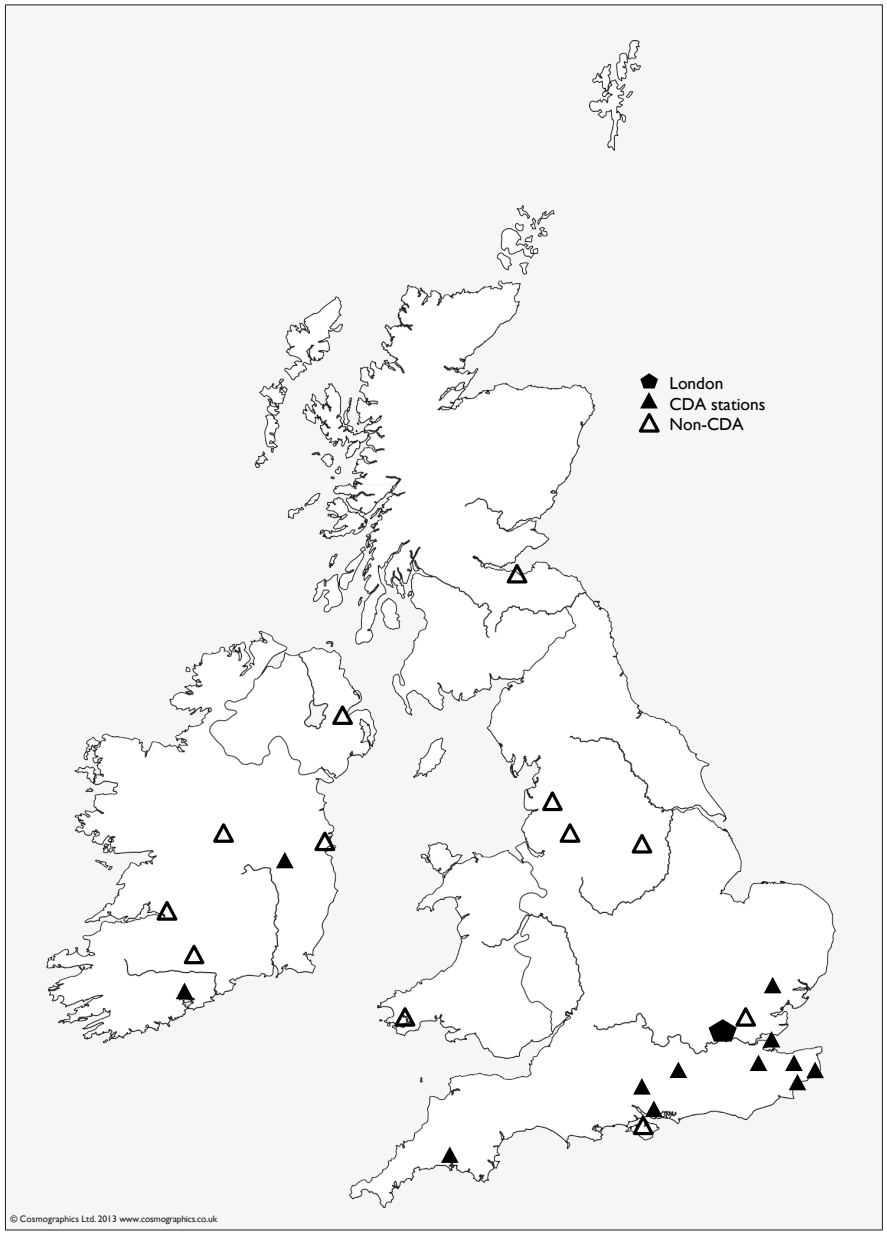
- Figure 4: the station-level secondary syphilis data used in the event study analysis are taken from Appendix No.5 (pages 454-455).

Defining treatment status: Table B2 describes the set of stations used in the analysis. This includes all of the stations for which complete data are available over the analysis period. Note that this is not a complete list of locations subject to the CDAs, since some locations with Navy stations were also subject to the CDAs but do not appear in the hospitalization analysis, which is based on Army data only. Figure B1 shows the locations of these stations.

Table B2: The List of Military Stations in the Analysis of Hospital Admissions for Syphilis

Station	Country	Subjected	Treatment Year
Athlone	Ireland	No	
Belfast	Northern Ireland	No	
Dublin	Ireland	No	
Edinburgh	Scotland	No	
Fermoy	Ireland	No	
Hounslow	England	No	
Isle of Wight	England	No	
Limerick	Ireland	No	
Manchester	England	No	
Pembroke Dock	Wales	No	
Preston	England	No	
Sheffield	England	No	
Aldershot	England	Yes	1867
Canterbury	England	Yes	1870
Chatham & Sheerness	England	Yes	1865
Colchester	England	Yes	1869
Cork	Ireland	Yes	1870
Curragh	Ireland	Yes	1870
Devonport & Plymouth	England	Yes	1865
Dover	England	Yes	1870
Maidstone	England	Yes	1870
Portsmouth	England	Yes	1864
Shorncliffe	England	Yes	1868
Winchester	England	Yes	1870
Woolwich	England	Yes	1866

Figure B1: Map of military stations included in the analysis in Section 3.1



Note: London is included in this figure as a point of reference, but the London station is not included in the analysis because syphilis cases at London were pooled with cases at Windsor for the first few years of the analysis. However, Hounslow, on the outskirts of London, is included in the analysis.

B.3 Treatment in the county-level and district-level analyses

This appendix provides more detail on how treatment status was assigned in the county-level analysis of brothels in Section 4.1 and of STI mortality in Section 3.2 as well as the district-level analysis of childless couples in Section 3.3. Note that all of these analysis focus on England and Wales exclusively, because the outcome data are not available for Scotland or Ireland.

The timing of when districts were subjected to the CDAs was taken from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Table B3 shows names of the treated districts as well as the dates the CDAs began operation. As amendments to the 1864 CDA were passed in 1866 and 1869, additional districts were subjected to the laws. In total, seventeen locations were treated between 1864 and 1870. For analysis conducted at the county level, Table B3 shows the counties where the subjected districts are located. In this context, a county is defined as treated in the first year the CDAs begin to operate in one of its districts. Figure B2 shows CDA districts and CDA counties in England and Wales.

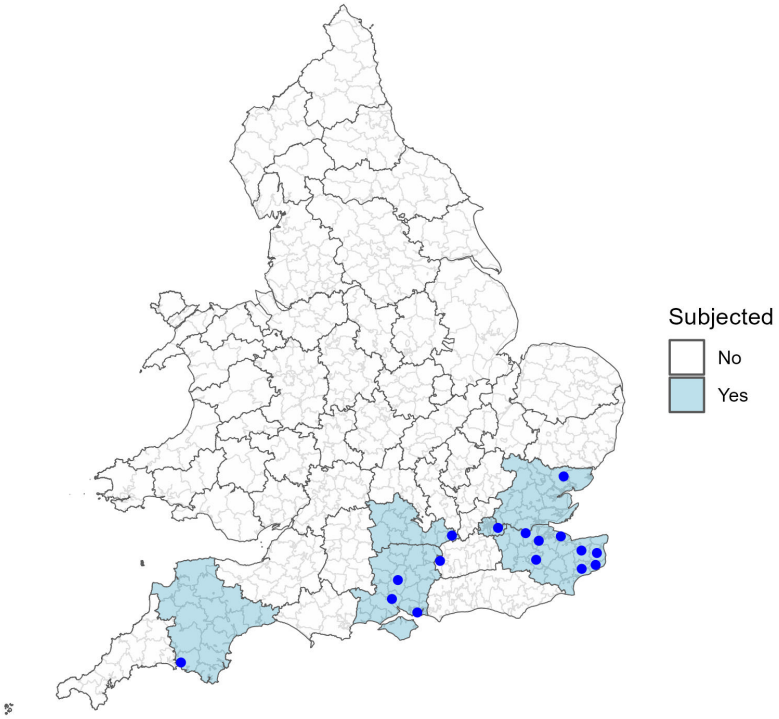
Table B3: Timing of When Districts Became Subjected to the CDAs

Subjected District	Date of Operation	County
Portsmouth	1864-12-03	Hampshire
Plymouth/Devonport	1865-04-01	Devonshire
Sheerness	1865-06-09	Kent
Chatham	1865-06-12	Kent
Woolwich	1866-11-14	Greater London
Aldershot	1867-04-12	Hampshire
Windsor	1868-04-01	Berkshire
Shorncliffe	1868-07-27	Kent
Colchester	1869-01-27	Essex
Greenwich	1870-01-06	Greater London
Winchester	1870-01-06	Hampshire
Dover	1870-01-19	Kent
Canterbury	1870-01-21	Kent
Deal	1870-02-05	Kent
Maidstone	1870-02-15	Kent
Gravesend	1870-02-17	Kent
Southampton	1870-05-27	Hampshire

B.4 Police data

The Parliamentary Papers contain the detailed records officials kept on how the CDAs operated in subjected districts. We digitize parts of the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. This report contains

Figure B2: Map of Counties & Districts Subjected to the CDAs



Note: The figure shows the locations where the CDAs were implemented. The darker boundaries are the counties in England and Wales. The lighter boundaries are districts (the level of treatment assignment). The dots correspond to the treated districts that are subjected to the CDAs. The shaded counties are the six counties that contain treated districts. Data on the treated districts are from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881.

information related to the total number of registered sex workers, their ages, the establishments where the sex trade took place, and information on the examinations and hospitalization of sex workers. Information is reported for seventeen subjected districts in England from the first year of treatment through 1880.

The following list provides the specific tables and variables within the report that are used to produce the figures in the paper. Throughout the list we abbreviate columns, for example, when referring to column 22 we report `c22`.

- Figure 3A: total medical inspections is taken from Table 1, `c22`.
- Figure 3B: inspections per sex worker is defined as total inspections per the number of women that attended for examination from Table 1 (`c17/c22`).
- Figure 9A: total registered sex workers is taken from Table 2, `c13`.
- Figure 9B: the total number of establishments hosting the sex trade is taken from Table 3, `c15`.
- Table C5: the data on district-level total registered sex workers is taken from Table 2 in the report, `c13`.
- Figure 10: the age distribution of registered sex workers is taken from Table 2 (`c1 to c12`).
- Figure 12A: the infected share of total examinations is taken from Table 1 (`c17/c22`).
- Figure 12B: the total number of hospitalizations is taken from Table 1. It is the sum of four variables: the total hospitalized that were discharged cured and continued to engage in sex work, the total hospitalized that were discharged cured and not engaging in sex work, the total hospitalized that were discharged incurable, and the total remaining in the hospital (`c23+c24+c25+c26`).

C Results appendix

This section provides additional results supporting the findings presented in the main text.

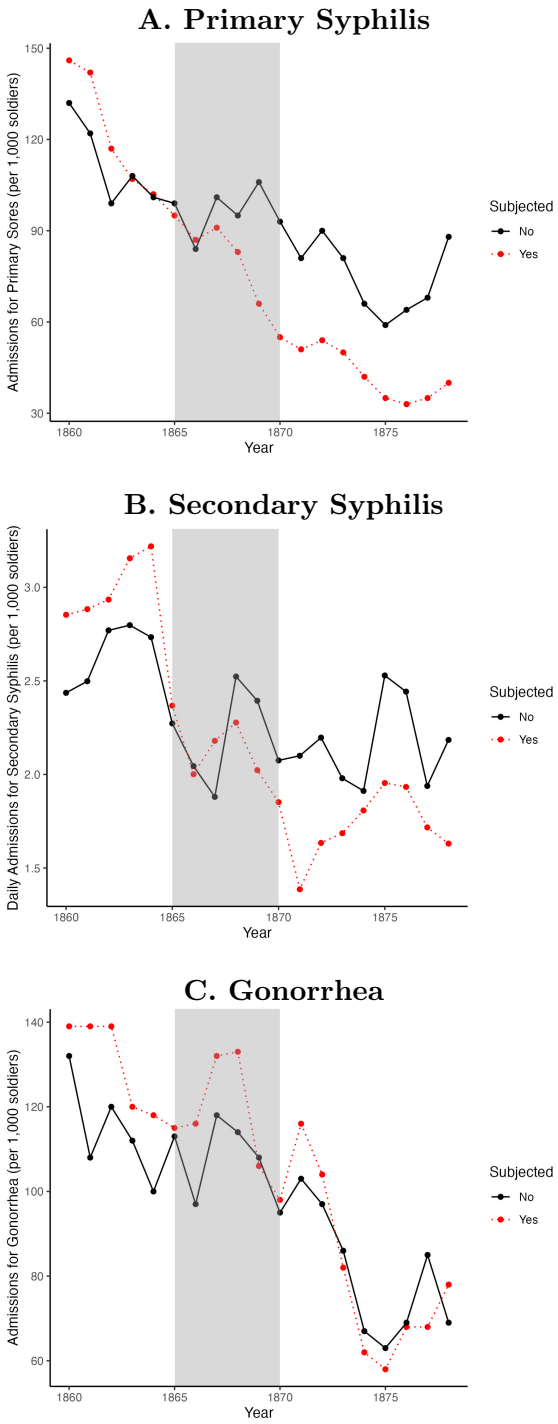
C.1 Appendix to the analysis of STI rates among soldiers

This section presents additional results related to the analysis in Section 3.1. Figure C1 looks at the raw trends in three aggregated STI series reported for treated and untreated stations (note that for only one of these, secondary syphilis infections, do we have the data broken down by station). The top panel shows average daily hospitalizations per 1,000 soldiers for primary syphilis sores in treated vs. non-treated stations in the U.K. before and after the CDAs came into operation. We can see that both treated and control locations had similar levels and trends in the period leading up to the introduction of the CDAs. Starting during the period in which the CDAs were introduced–between 1865 and 1870, indicated by the shaded region in the graph–the two groups of stations diverge and the treated stations show substantially lower hospital admission rates. A similar pattern is visible in the middle graph, which focuses on daily admissions for secondary syphilis, a later stage of the disease that typically arrives several months after the primary syphilis sores disappear. The bottom graph shows the pattern for gonorrhea. For this disease, stations subject to the CDA had on average higher rates in the period before the CDAs came into operation. After the CDAs were operating, this difference disappears and the two groups exhibit similar rates of gonorrhea hospitalization. Thus, all three of these figures provide suggestive evidence that the introduction of the CDAs reduced STI rates in treated stations relative to those not treated.

Next, Table C1 presents the average treatment effects across the treatment period. The first column uses a specification that corresponds to the one used in the event study in Figure 4. At the bottom of the table we report the mean of the dependent variable. So, the estimated effect in Column 1 implies a reduction in the rate of about one-third. Column 2 shows that similar results are obtained if we restrict the sample only to stations in England and Wales. In Columns 3 and 4 we verify that we obtain similar results if we use the log rate as the dependent variable. In fact, those results suggest an even greater reduction in the syphilis hospitalization rate in percentage terms.

Figure C2 presents event study results corresponding to those presented in Figure 4 in the main text, but using a two-way fixed effects approach in place of the method from Callaway and Sant'Anna (2021). It is clear that the two-way fixed effects approach generates results that are similar to those obtained from the approach from Callaway and Sant'Anna (2021) but with generally smaller standard errors. Thus, our results appear to be fairly robust to the choice of estimation method.

Figure C1: STI Hospitalizations at CDA vs. non-CDA Military Stations



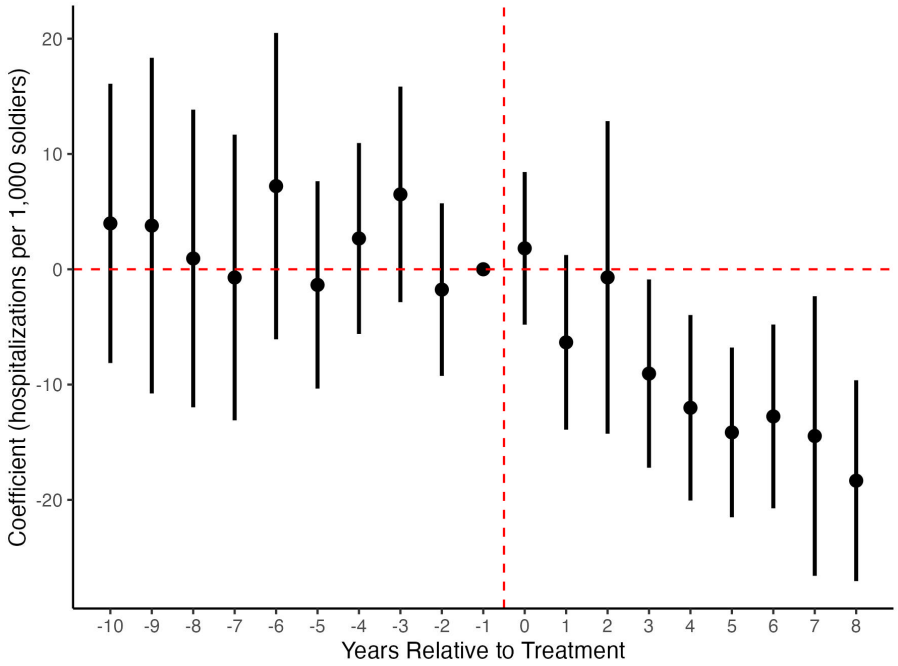
Note: Panel A shows the annual hospital admissions for primary syphilis per 1,000 soldiers. Panel B displays the daily average number of soldiers hospitalized for secondary syphilis per 1,000 soldiers. Panel C reports the annual hospital admissions for gonorrhea per 1,000 soldiers. All graphs report the aggregated values for subjected and untreated districts. The shaded region corresponds to the period in which the CDAs were being implemented (see Table B3). The data are from the *Report from the Select Committee on the Contagious Disease Acts, 28 July 1881* p. 445-455. Appendix B.2 provides additional details.

Table C1: The Effect of the CDAs on Hospital Admissions for Secondary Syphilis

Dep Var:	$rate_{dt}$	$rate_{dt}$	$\log(rate_{dt})$	$\log(rate_{dt})$
Spec.:	Baseline	England & Wales	Baseline	England & Wales
	(1)	(2)	(3)	(4)
ATT	-9.848***	-8.550*	-0.463***	-0.451*
	(3.860)	(4.629)	(0.161)	(0.234)
Dep. Var Mean	29.479	30.202	3.248	3.276
Observations	475	361	475	361

Note: *** p<0.01, ** p<0.05, * p<0.1. The table provides the average of the dynamic treatment effects from estimating equation (1) using the method from Callaway and Sant'Anna (2021). In column 1, the outcome is the syphilis hospitalization rate, defined as the number of annual hospitalizations from secondary syphilis per 1,000 soldiers. In column 2, the outcome is the syphilis hospitalization rate and the sample is restricted to military stations in England and Wales. In column 3, the outcome is the syphilis hospitalization rate in logs. In column 4, the outcome is the log of the syphilis hospitalization rate and the sample is restricted to military stations in England and Wales. Standard errors clustered at the station-level are in parentheses.

Figure C2: Two Way Fixed Effect Analysis of the Hospitalizations Data



Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in equation (1) estimated using a two-way fixed effects approach, i.e., including a full set of county and year fixed effects. The outcome variable is the station-level hospitalization rate of soldiers from secondary syphilis. The x-axis is in event time relative to the year in which the CDAs became active in the district where the station was located. The vertical line corresponds to the year of treatment. Standard errors are clustered at the station level.

C.2 Appendix analyzing STI rates among Navy sailors

This section analyzes how STI hospitalization rates changed among sailors in the Navy after the CDAs were implemented. Our primary analysis in section 3.1 focused on hospitalizations among soldiers because Parliament compiled more systematic data on hospital admissions from STIs in Army stations. However, Parliament did conduct a smaller analysis on how hospital admissions changed in Navy ports located in districts subjected to the CDAs.[44] The Parliamentary report contains hospitalizations of soldiers at the ship-level from 1860 to 1875 for ships stationed in five ports located in districts subjected to the CDAs and five ports in untreated districts. Figure C3 provides an excerpt of the data we digitize. The report lists the number of STI hospitalizations from syphilis and gonorrhea of sailors in each ship, the total number of sailors on the ship, and the length of the year the ship was stationed at the port.

To analyze how hospitalizations changed among sailors, we use the same empirical strategy used to analyze soldiers in section 3.1 with a few exceptions given differences in how the data are reported. We estimate Eq. (1) where treatment status is defined when the district containing the port becomes subjected to the CDAs. In cases where there are multiple ships per port we aggregate the data to the port-level. In contrast to the Army data, this data combines primary and secondary syphilis in some years. Therefore, the outcome variable is the log of the total syphilis hospitalization rate, defined as the sum of primary and secondary syphilis hospitalizations relative to 1,000 sailors. Lastly, the report does not report hospitalization rates in every year from 1860-75 for every port. For example, Dartmouth, which was in a subjected district, does not report data until 1863 (see Figure C3). Given the small number of ports and pre-period years in the data, we allow for an unbalanced panel.

Panel A of Figure C4 displays the syphilis hospitalization rates in ports in subjected and untreated districts. During the period before treatment hospital admissions in the two groups trend similar, although noisily. As the CDAs are implemented hospitalizations in the subjected ports declines relative to untreated ports. Panel B of Figure C4 displays the corresponding event study plot when we estimate Eq. (1) using the estimator in Callaway and Sant'Anna (2021) where the syphilis hospitalization rate per 1,000 sailors is the outcome. Although noisy, before treatment there is no clear trend in the estimated effects. After treatment, the estimated dynamic treatment effects become consistently negative suggesting a reduction in syphilis hospitalizations. The average effects corresponds to approximately 26 fewer hospitalizations per 1,000 sailors. The pre-treatment mean number of hospitalizations in ports stationed in subjected districts was approximately 65 hospitalizations per 1,000 sailors. This implies the CDAs reduced the hospitalization rate by approximately 40% relative to the pre-treatment mean.

[44] The Parliamentary report containing the data on hospitalization rates among sailors is titled, *Return Of Number Of Cases Of Venereal Diseases in H.M. Ships and Vessels Stationed at Home Ports, at which Contagious Diseases Acts have been in Operation, 1860-75.*

Figure C3: Example of Data on STI Hospitalization Rates of Sailors

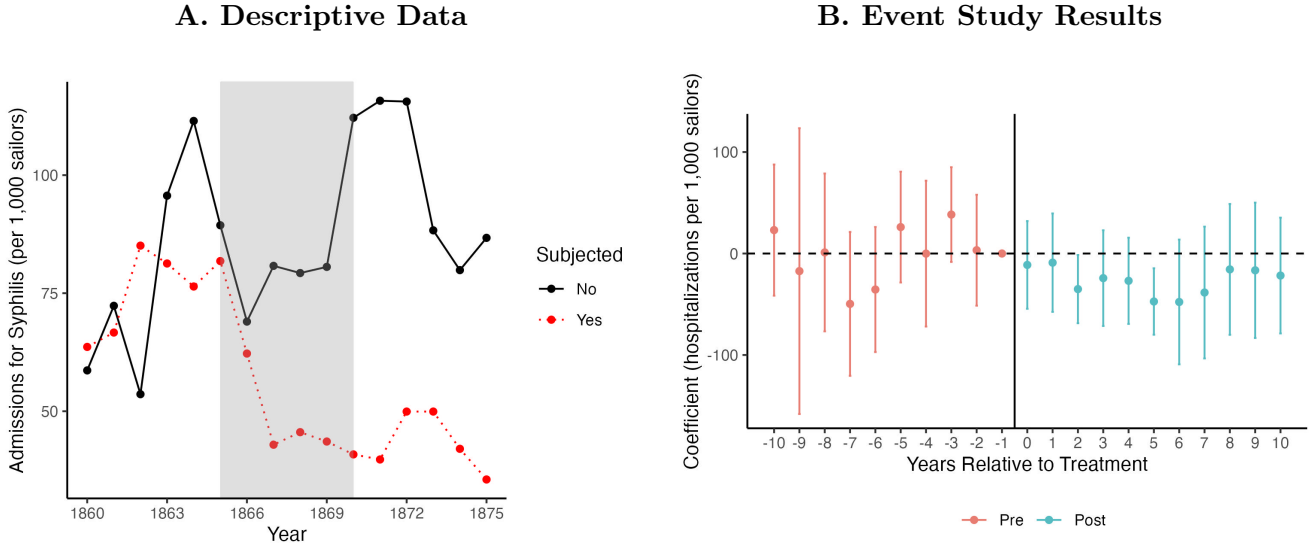
PORTS UNDER THE ACTS.

DARTMOUTH.

Year.	SHIP.	Period of Stay.	Average Complement Corrected for Time.	Number of Cases.		
				Primary Syphilis.	Secondary Syphilis.	Gonorrhœa.
1863	Britannia - - -	3 months - -	100	4		2
1864	„ - - -	Year - - -	450	33		1
1865	„ - - -	„ - - -	440	27		6
1866	„ - - -	„ - - -	420	12	–	3
1867	„ - - -	„ - - -	405	2	–	1
1868	„ - - -	„ - - -	400	1	1	4
1869	„ - - -	„ - - -	380	3	1	4
1870	„ - - -	„ - - -	360	4	-	2
1871	„ - - -	„ - - -	360	2	2	1
1872	„ - - -	„ - - -	385	–	3	1
1873	„ - - -	„ - - -	370	3	4	3
1874	„ - - -	„ - - -	370	4	3	1
1875	„ - - -	„ - - -	335	3	3	5

Note: This figure provides an excerpt of the ship-level data on STI hospitalizations of soldiers. The excerpt is from the Parliamentary report titled, *Return Of Number Of Cases Of Venereal Diseases IN H.M. Ships and Vessels Stationed at Home Ports, at which Contagious Diseases Acts have been in Operation, 1860-75.*

Figure C4: The Effect of the CDAs on Hospital Admissions from Syphilis among Navy Sailors



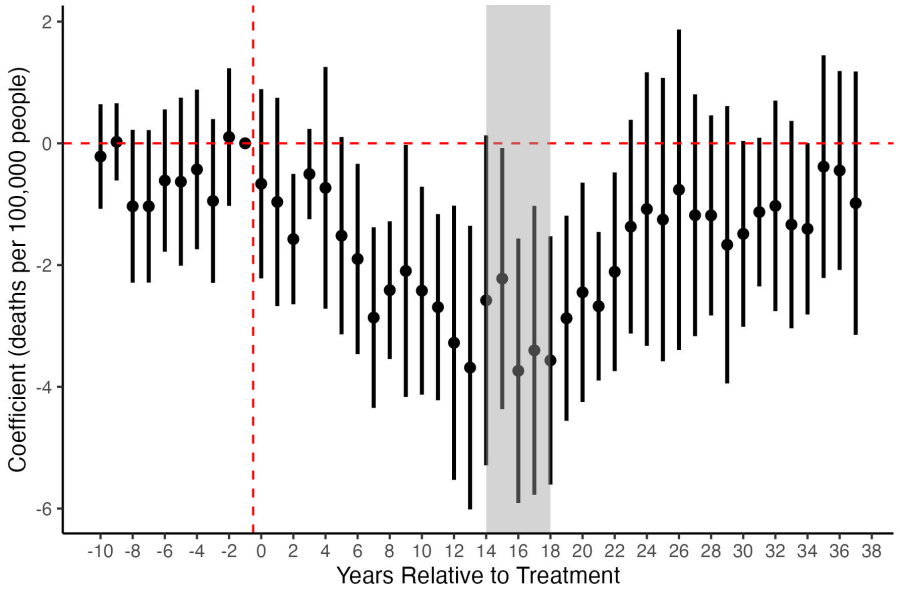
Note: The figure on the left displays the syphilis hospitalization rate, defined as the number of hospitalizations from syphilis per 1,000 sailors, for ports in treated and untreated districts over time. The shaded region corresponds to the period in which the CDAs were being implemented (see Table B3). The figure on the right shows the estimated coefficients and 95% confidence intervals for β_s in equation (1) estimated using the method from Callaway and Sant'Anna (2021) applied to the log syphilis hospitalization rate at the port-level. Standard errors are clustered at the port-level.

C.3 Appendix to the analysis of STI mortality among the general population

This appendix presents some additional results related to our analysis of mortality patterns among the general population.

Figure C5 presents event study results corresponding to those presented in Figure 6 in the main text, but using a two-way fixed effects approach in place of the method from Callaway and Sant'Anna (2021). These results are very similar to those obtained using the approach from Callaway and Sant'Anna (2021) and presented in the main text.

Figure C5: Two Way Fixed Effect Analysis of Syphilis Mortality



Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in Eq. 1 estimated using a two-way fixed effects approach, i.e., including a full set of county and year fixed effects. The outcome variable is the log county-level mortality rate from syphilis. The x-axis is in event time relative to the year in which the CDAs became active in any district within the county. The vertical line corresponds to the year of treatment. The shaded region corresponds to the years in event time when the law was suspended. While suspension occurs in 1883 for all counties, this occurs in different years of event time because of staggered treatment timing. Standard errors are clustered at the county-level. London is excluded from the analysis.

Table C2 presents results on how the CDAs affected syphilis mortality analogous to Table 1, but changing how the mortality rate is calculated. Instead of using the total population in the denominator, the table shows the results where the outcome is the number of syphilis deaths per 1,000 live births. This is a potentially useful denominator given that most syphilis deaths occurred among infants and young children, and because unlike population births are observed annually rather than being interpolated.

Table C2: Robustness to Calculating Mortality Rates Relative to Live Births Instead of Population

	DV: syphilis mortality rate			
Spec.:	Pre-Suspension	London	Southern	No Nearby
	(1)	(2)	(3)	(4)
ATT	-0.576***	-0.522***	-0.410*	-0.546***
	(0.173)	(0.162)	(0.215)	(0.157)
Dep. Var. Mean	1.650	1.691	1.707	1.652
Observations	1,232	1,260	532	924

Note: *** p<0.01, ** p<0.05, * p<0.1. Each column provides the average of the dynamic treatment effects from estimating Eq. 1 using the method from Callaway and Sant'Anna (2021). In all specifications, the outcome is the number of syphilis deaths per 1,000 live births at the county-level. Data are annual from 1855-1882 which cover the main sample period prior to the suspension of the CDAs in 1883. The county of Greater London is excluded unless stated otherwise. The first column presents the baseline results. Column two presents the estimate when the Greater London county is added to the analysis. Column three restricts the analysis to counties in the south-western, south midland, or south-eastern registration. The fourth column removes counties that border treated counties. Standard errors are clustered at the county-level.

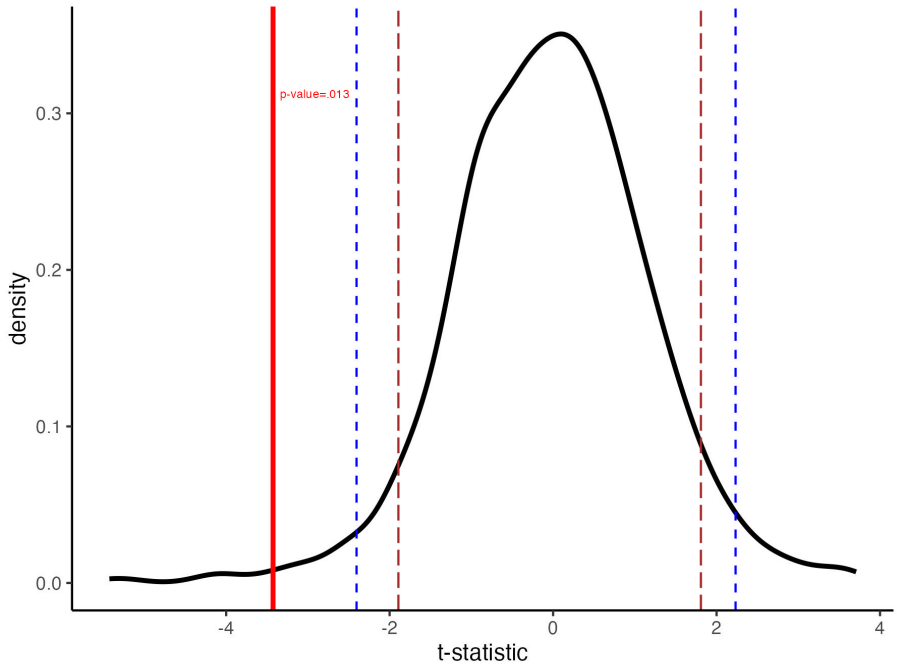
C.4 Permutation tests

In the next set of results, we undertake a permutation test to address the potential concern that our results might be influenced by the fact that we have relatively few treated counties. We have 44 counties in the data, five of which are treated. The basic idea in this permutation exercise is to randomly draw groups of five counties from the 44 available, treat those as if they were the treated counties, and then apply our standard analysis strategy to obtain estimated coefficients and t-statistics. Repeating this exercise 1,000 times, we can then construct a distribution of results to compare to the results obtained when using the true set of treatment counties.

When choosing 5 "treated" counties out of 44 total counties, we have 1,086,008 potential options. We select a random sample of 1,000 of these options, so each sample has 5 "treated" counties out of 44 total. Next, we need to assign treatment years to our placebo treatment counties. In our true data, our five treated counties have the following treatment years: 1865, 1865, 1865, 1868, and 1869. We randomly assign these five dates to the five treatment counties in each of our 1,000 samples. Thus, each sample contains a panel of 44 counties with 5 treatment counties each with a treatment start year ranging from 1865 to 1869, exactly the same structure as the data used in our main analysis (Table 1). We then apply exactly the same procedure used in Table 1 to obtain ATT coefficients and t-statistics.

Figure C6 plots the distribution of t-statistics obtained from 1,000 randomly drawn samples. The dashed lines in this figure indicate the 90% and 95% range of the distribution, while the heavy red line at the left indicates the t-statistic obtained from our analysis of the true treated counties. As this graph shows, it would be extremely unlikely for us to have randomly ended up with a t-statistic as large as that obtained from our analysis of the true treatment districts purely by chance. This suggests that our results are extremely unlikely to be due to random chance.

Figure C6: Permutation Test Distribution of t-statistics for the Effect of the CDAs on the Syphilis Mortality Rate



Note: The figure presents the distribution of t-statistics obtained from applying our baseline analysis procedure to 1,000 randomly drawn sets of placebo "treatment" counties. The dashed lines represent the 90% and 95% range, while the thick red line indicates the t-statistic obtained from our analysis of the true treated counties.

C.5 Appendix to the analysis of childless couples

Table C3 presents some additional results looking at the impact of the CDAs on the rate of childless couples. These results use the district-level analysis specification in Eq. 2. The first three columns look at how the results change if we expand our sample to include couples where the wife's age was between 25 and 45 years old. The next three columns look at how the results are affected by including London in the analysis. Both sets of results are very similar to those presented in the main text.

Table C3: Robustness results for childless couples analysis

Dep. Var.:	Share of childless couples					
Spec.:	Couples with wives aged 25-45			Including London (wives aged 25-40)		
	(1)	(2)	(3)	(4)	(5)	(6)
CDA Dist	-0.0145***	-0.0159***	-0.0114**	-0.0136***	-0.0131**	-0.0119**
x Post	(0.00480)	(0.00601)	(0.00529)	(0.00465)	(0.00548)	(0.00509)
CDA County		0.00173			-0.000656	
x Post		(0.00406)			(0.00345)	
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes		Yes	Yes	
County-yr FE			Yes			Yes
Observations	1,572	1,572	1,568	1,645	1,645	1,640
R-squared	0.128	0.129	0.696	0.159	0.159	0.761

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by district.

Next, we consider an alternative approach to analyzing the rate of childless couples that focuses on households, rather than districts, as the unit of observation. The advantage of this approach is that it allows us to include household-level controls as well as to study whether rates of childlessness are also affected by parents' birth locations. However, because the outcome variable is an indicator, the estimated coefficients are less straightforward to interpret. The household-level linear probability model is:

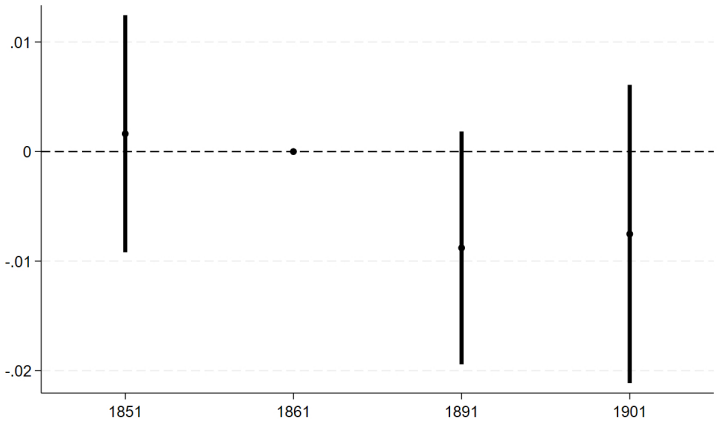
$$\begin{aligned} CHILDLESS_{hit} &= \beta(CDA_i * POST_t) + \eta^F(birthCDA_i^F * POST_t) \\ &+ \eta^M(birthCDA_i^M * POST_t) + X_{hit}\Lambda + \gamma_i + \eta_t + \epsilon_{hit} \end{aligned} \tag{3}$$

where $CHILDLESS_{hit}$ is an indicator for whether household h in district i in census year t is childless, $birthCDA_i^F$ and $birthCDA_i^M$ are indicators for whether the father or mother was born in a county with a CDA district (district of birth is not consistently observed), X_{hit} is a set of household-level controls, and the other variables are defined as above. As in the district-level results, we cluster standard errors at the district level and exclude London, though we have verified

that our findings are not sensitive to these choices.

Figure C7 presents some event study results based on the specification in Eq. 3 but replacing $POST_t$ with a set of year indicator variables. The results show no evidence of differential pre-trends between treatment and control locations, while we see a fairly substantial drop in the estimated coefficients in the post-treatment period.

Figure C7: Event study for the household-level analysis of childless couples



Note: The figure shows the estimated coefficients and 95% confidence intervals for coefficients estimated using Eq. 3 but replacing $POST_t$ with a set of year indicator variables. Data cover all couples in England and Wales where the wife's age at the time of the census is in [25-40]. N = 5,586,446. Standard errors are clustered by registration district. The regression includes district and year fixed effects as well as controls for wife's age and husband's age. Districts in the county of London are excluded from the analysis.

Table C4 presents household-level results based on Eq. 3. Column 1 presents results corresponding to Column 1 in Table 3 in the main text. The estimated coefficient in these linear probability regressions reflects the impact of being resident in a CDA district in the post-CDA period on childlessness. As in the main results, we observe a negative and economically significant relationship between residence in a CDA district and childlessness, though the results are not significant at traditional confidence levels (they are significant at the 85% confidence level). The difference between these estimates and the district-level results in the main text appears to be due to the different weighting implicit in the linear probability model, which treats individuals rather than districts as the unit of observation.

The addition of controls for the ages of the wife and the husband, in Column 2, has almost no impact on the results. Columns 3 and 4 look for evidence of spillovers, either within the county or to bordering districts. Consistent with the results obtained in the main text, neither of these show any evidence of substantial spillovers to nearby districts.

In Columns 5 and 6, we look at the impact of either the wife or the husband being born in a CDA county. In these specifications, we include county-year fixed effects, which means that the effect of wife's and husband's birth county is identified by those who moved across counties. We

can see that being born in a CDA county is associated with a reduction in childlessness in the post-CDA period, consistent with an effect of the CDAs operating through exposure earlier in life. In these specifications, the coefficient on being resident in a CDA district (top row) indicates a somewhat larger and more statistically significant (90% confidence level) negative impact of the CDAs on the rate of childlessness.

Overall, while not quite as strong as the district-level regressions presented in the main text, the household level regressions in Table C4 confirm the same basic relationships. Moreover, these results also show that being born in a CDA county was associated with reduced rates of childlessness in the post-CDA period.

Table C4: Household-level analysis of childless couples

	Dep. Var.: Indicator for childless couple					
	(1)	(2)	(3)	(4)	(5)	(6)
CDA x POST	-0.0103*	-0.0104*	-0.00992*	-0.0106*	-0.0110*	-0.0107*
	(0.00548)	(0.00537)	(0.00587)	(0.00545)	(0.00586)	(0.00627)
Treated county x Post			-0.000664			
			(0.00426)			
Nearby x POST				-0.00265		0.000892
				(0.00485)		(0.00429)
Wife born CDA county x Post					-0.00577***	-0.00577***
					(0.00220)	(0.00219)
Husband born CDA county x Post					-0.00570***	-0.00571***
					(0.00174)	(0.00174)
Husband's age		-0.00166***	-0.00166***	-0.00166***	-0.00167***	-0.00167***
		(9.10e-05)	(9.11e-05)	(9.11e-05)	(9.08e-05)	(9.08e-05)
Wife's age		-0.00447***	-0.00447***	-0.00447***	-0.00447***	-0.00447***
		(0.000127)	(0.000127)	(0.000127)	(0.000127)	(0.000127)
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes		
County-yr FE					Yes	Yes
Observations	5,652,204	5,648,403	5,648,403	5,648,403	5,648,403	5,648,403
R-squared	0.004	0.011	0.011	0.011	0.011	0.011

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by district. Based on couples where the wife's age is between 25 and 40. London is excluded from the analysis. Based on specification in Eq. 3.

C.6 Appendix to the analysis of the police data

Here we present some additional results on the impact of the CDAs on the market for sex. We begin with some additional descriptive data.

Table C5: Total Supply of Sex Workers Over Time by District

	Total Sex Workers			Percent Change	
District	$t = 0$	$t = 5$	$t = 10$	5 Years	10 Years
Aldershot	266	235	154	-11.7	-42.1
Canterbury	42	36	44	-14.3	4.8
Chatham	220	281	175	27.7	-20.5
Colchester	158	37	31	-76.6	-80.4
Deal	26	13	9	-50.0	-65.4
Plymouth/Devonport	1,770	557	442	-68.5	-75.0
Dover	92	50	34	-45.7	-63.0
Gravesend	47	33	30	-29.8	-36.2
Greenwich	151	74	98	-51.0	-35.1
Maidstone	58	19	21	-67.2	-63.8
Portsmouth	1,355	590	494	-56.5	-63.5
Sheerness	73	59	33	-19.2	-54.8
Shorncliffe	70	38	21	-45.7	-70
Southampton	154	139	104	-9.7	-32.5
Winchester	76	23	12	-69.7	-84.2
Windsor	54	24	12	-55.6	-77.8
Woolwich	240	200	152	-16.7	-36.7

Note: The table provides the supply of sex workers for each of the 17 treated locations. Columns two through four show the total registered sex workers for the year the district was treated, after 5 years, and after 10 years. Columns five and six display the percent changes in supply. The data are from the *Annual Report of the Assistant Commissioner of the Police of the Metropolis Relating to the Contagious Diseases Acts* in 1881. Appendix B.1 provides additional details.

C.7 Appendix to the analysis of the judicial statistics data

Next, we present some additional results using the judicial statistics data. Column 1 Table C6 presents the average effect corresponding to the event study in Figure 11. This implies treated counties had approximately 39 fewer brothels after the implementation of the CDAs. Columns 2-4 present several robustness checks. First, one concern is that all treated counties are located in the southern part of England. This might raise concerns that counties in the north and in Wales are not effective control counties. Column 2 addresses this by restricting the analysis to counties in the south western, south midland, and south eastern divisions. The estimated effect is similar to the baseline specification including all counties as controls. An additional concern is that there might

be spillovers from treated to nearby counties. While this is a potentially larger concern for the public health analysis later in the paper, we address this in column 3 by dropping all counties that border a county subjected to the CDAs. The estimated effect is nearly identical to the baseline specification. Lastly, London is one of the counties subjected to the CDAs. Given that it is an outlier, throughout the paper we drop London from the baseline analysis. Column 4 presents the estimated effect when London is included. The next two columns provide the estimated effects when the log of total brothels is used as the outcome variable.

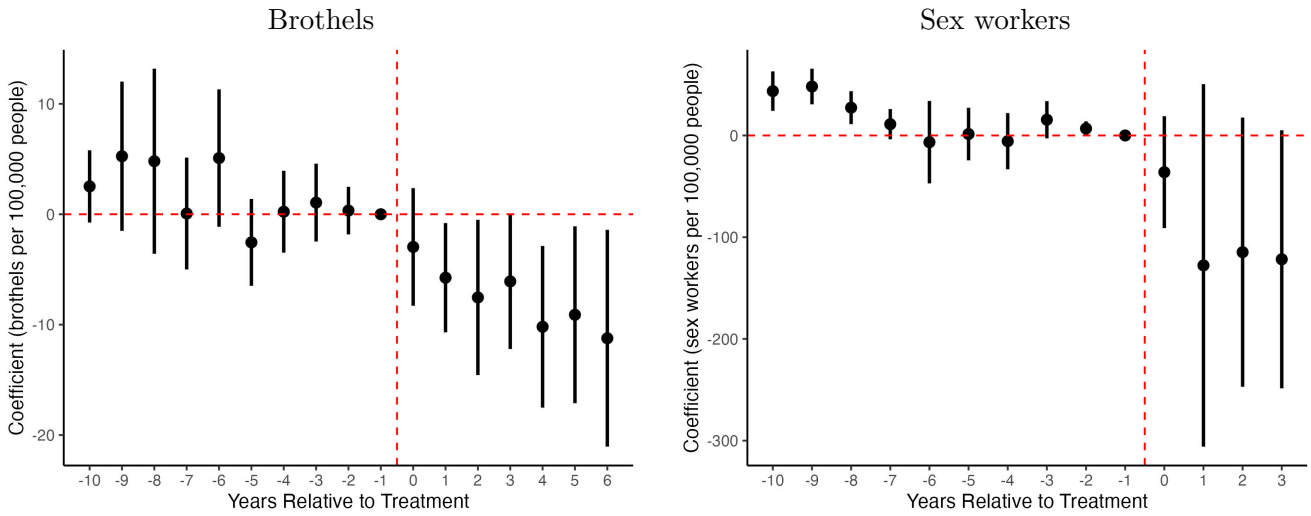
Table C6: The Effect of the CDAs on the Number of Brothels

Dep Var:	Brothels	Brothels	Brothels	Brothels	Sex Workers	Sex Workers
Spec:	Baseline	Southern	No Nearby	London	Baseline	London
	(1)	(2)	(3)	(4)	(5)	(6)
ATT	-7.893***	-8.028***	-8.456***	-8.369***	-107.542	-91.394
	(2.840)	(2.499)	(2.764)	(2.536)	(72.894)	(65.059)
Dep. Var. Mean	23.452	19.233	26.871	23.877	111.145	113.370
Observations	559	234	416	572	430	440

Note: *** p<0.01, ** p<0.05, * p<0.1. The table provides the average of the dynamic treatment effects from estimating Eq. (1) using the method from Callaway and Sant'Anna (2021). The county of London is excluded from the analysis unless stated otherwise. In column 1, the outcome is the number of brothels per 100,000 people at the county-level. Column 2 restricts to counties in the south western, south midland, or south eastern registration areas. Column 3 removes counties that border treated counties. Column 4 includes London in the analysis. In column 5, the outcome is the number of known sex workers per 100,000 people at the county-level. Column 6 includes London in the analysis. Standard errors clustered at the county-level are in parentheses.

Next, Figure C8 presents the event studies based on a two-way fixed effects specification instead of the estimation method of Callaway and Sant'Anna (2021) which we use to estimate the event studies in Figure 11. As the figures show, the results are very similar regardless of the approach used to estimate the event studies.

Figure C8: Two Way Fixed Effect Analysis on the number of Brothels and Sex Workers



Note: The figure shows the estimated coefficients and 95% confidence intervals for β_s in Eq. 1 estimated using two-way fixed effects, i.e., including a full set of county and year fixed effects. The outcome in the left panel is the number of brothels per 100,000 people. The outcome on the right is the number of sex workers per 100,000 people. The x-axis is in event time relative to the year in which the CDAs became active in any district within the county. The vertical line corresponds to the year of treatment. Standard errors are clustered at the county-level. The County of London is excluded from the analysis.