The effect of becoming a legal sex worker in Senegal on health and wellbeing

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Abstract

Senegal is the only low-income country where prostitution is legal and regulated by a health policy. To solicit clients in public places, female sex workers need to register with a health facility and to attend monthly routine health checks aiming at testing and treating sexually transmitted infections. Compliance to those routine visits is recorded on a registration card that needs to be carried by FSWs in order to avoid penal sanctions. While this policy was first introduced in 1969 to limit the spread of sexually transmitted infections, there is no evidence so far on its impact on sex workers' health and wellbeing. The paper aims to fill this gap by exploiting a unique data set of registered and unregistered Senegalese sex workers. Using propensity score matching, we find that becoming a registered sex worker leads to an improvement in health but has a detrimental effect on wellbeing. Carrying a registration card and hiding it from relatives translates into greater stigma and low self-image. Registered sex workers are found to engage in riskier sex acts, are more likely to experience violence from clients and have less social support from their co-workers. We prove that those results are robust to the violation of the conditional independence assumption, to misspecification of the propensity score model and that covariate balance is achieved. The results suggest that more efforts should be deployed in order to reduce stigma associated with sex work in Senegal and that interventions improving the registration programme and addressing poor wellbeing and mental health of sex workers are urgently required.

1 Introduction

The legal status of prostitution varies widely across countries worldwide but prostitution is illegal in most countries and when legal, soliciting, pimping or running brothels often remain illegal. The reason for prostitution prohibition lies on moral concerns and on the idea that legalisation could increase the spread of HIV and sexually transmitted infections (STI) by leading to a higher number of commercial sex acts. However considering that criminalisation is associated with greater isolation and stigma toward female sex workers (FSWs) and clients (Weitzer,

2005), criminalising sex work is found to translate into more risk-taking and leads to greater STI transmission (Cameron et al., 2016; Cunningham and Shah, 2014; Gertler and Shah, 2011).

A few countries and regions have used the public health concern that pauses prostitution as an argument to regulate sex work and closely monitor FSWs' STI status. Senegal is the only country where sex work has been regulated by a public health policy over the last 50 years. Since 1969, Senegalese FSWs aged more than 21 years old are compelled to register with a health centre and to attend routine health visits in order to test (and treat) STIs and to receive free condoms (Chersich et al., 2013). An official registration card is issued (called "*carte sanitaire*") with the FSW's photography in order to keep a record of the visits made to the appointed health centre and this information is shared with the police. The card provides evidence regarding both their registration status and their negative STI status. If FSWs are tested positive for any STI, with the exception of HIV, the card is kept at the health centre during the whole course of treatment. HIV-positive FSWs are allowed to work if they adhere to antiretroviral treatment (ART), limiting the spread of the disease. Hence, an up-to-date health card gives FSWs the right to solicit clients and acts as an insurance against police arrests. FSWs who fail to present an up-to-date registration card may incur a prison sentence of between two and six months (cf. Code pénal articles 323/ 325). Anecdotal evidence indicates that such sanctions are enforced despite widespread corruption in the country.

Despite its legal status, prostitution is morally condemned by society members in Senegal because sex outside marriage is forbidden in Islam. Hence, keeping sex work secret is a central preoccupation of Senegalese FSWs. Becoming a registered FSWs may increase the probability that the sex work activity is discovered by relatives. Firstly, because registered FSWs would need to constantly hide their registration card from their relatives while at home. In addition, by soliciting clients in public places, FSWs can be identified by their relatives. Thirdly, the personal information of registered FSWs is stored on police records and will remain on the records even after quitting prostitution. FSWs fear that this information will be disclosed by policemen or will be discovered in case one of their relatives becomes a police officer. As a result, 80% of FSWs in Senegal and 57% in the capital city, Dakar, are not registered (APAPS and IRESSEF, 2015). This justifies that FSWs are still a main contributor in this concentrated HIV epidemic: with a prevalence of 6.6% they are up to 9 times more likely to be infected with HIV than the general population (APAPS and IRESSEF, 2015).

While many studies investigated the market-level effect of (de)criminalising sex work, there is weak evidence on the effect of regulation. The only causal evidence comes from Tijuana (Baja California), where registration was introduced in 2005 and shows that regulation led to a decrease in the incidence rate of trichomoniasis by 37 percent over 2005-2012 (Quast and Gonzalez,

2016). However, in context of high social stigma toward FSWs, one may question the positive effect of this policy on population health. In fact, if registration leads to psychological distress, this could translate into greater risk taking and worse health outcomes (DiClemente et al., 2001).

Given this context, the paper aims to evaluate the effect of becoming a registered FSW in Senegal on both health and subjective wellbeing. To do so, we first develop a theoretical framework that models the main effects of registration on health and wellbeing and points out the different channels at play. Based on the theoretical model, we show that the effect of registration on health is undetermined;, registration leads to a greater number of sex acts but at the same time is associated with greater investment in health capital. However the effect on wellbeing is negative through increased stigma. We then test the model predictions empirically by using a unique data set collected from a sample of 630 FSW in Dakar, stratified by the registration status. Given the voluntary nature of registration, we use propensity score matching in order to construct a balanced sample of registered and non-registered sex workers. Our empirical results indicate that registration has a positive effect on health but a detrimental effect on wellbeing. Empirical analysis also sheds light on several unintended consequences of the policy that accentuate its negative effect on wellbeing: firstly, registered sex workers engage in riskier sex acts and are more likely to experience physical violence. Secondly, they have less social support from their co-workers. We investigate the effect of the violation of the conditional independence assumption by simulating the effect of relevant unobserved confounders affecting both the treatment and the outcomes of interest. We show that the existence of such confounders is unlikely to affect the results. Finally, our empirical results are robust to two additional methods to improve the performance of the propensity score matching; namely the use of a super learner to improve the specification of the propensity score and the use of entropy balancing in order to achieve covariates balance.

To summarize, this paper contributes to the literature on the decriminalisation of sex work but, unlike previous studies, it adopts a unique angle by investigating the consequences of the decision to become a legal sex worker on sex workers' health and wellbeing. The paper also contributes to the literature on social stigma by highlighting the negative unintended effects of a public health policy introduced to limit the spread of STI and HIV/AIDS.

The remainder of the paper is organized as follows. In section 2, we model the theoretical framework. Section 3 presents the data and descriptive statistics. Section 4 presents the method to overcome the selection bias associated with the decision to register along with the sensitivity analysis undertaken to test the violation of the conditional independence assumption. Results and a series of robustness checks are presented in section 5 and discussed in Section 6. Finally, section 7 concludes.

2 Theoretical framework

2.1 Setup

Let us consider a country where prostitution is regulated. Sex workers can, in such context, choose between two types of prostitution: either they choose to solicit clients in public places or they choose to remain discreet. If they choose to solicit clients in public places, they will access a larger pool of clients, but to do so, they need to register with authorities to avoid penal sanctions. Therefore, a sex worker chooses both the number of sex acts a and her registration status $R = \{0, 1\}$ in order to maximise her utility. Let us denote a^0 and a^1 the number of sex acts performed by a clandestine FSW and a registered FSW, respectively.

Despite the legalisation of prostitution by a government, prostitution is often morally condemned by the society. We assume that if identified by her relatives, friends, or neighbours, a sex worker suffers from *external* stigma s. We assume that external stigma depends on the level of wealth of the family, $s(A) > 0, \forall A \in \mathbb{R}_+$, as it may damage a family reputation. More precisely, a wealthier family may feel more strongly than less wealthy families that their reputation is tarnished if one of their members is known to be working as a sex worker. Furthermore, poorer families may be less contemptuous when discovering the source of the revenues the sex worker brings to the household if they are strongly financially constrained. As a result, FSWs from poorer families are less likely to be excluded from the household although they may still experience some external stigma within the household. We thus assume $s'(A) > 0$ for all A. In addition, a FSW may also suffer from damages of her self-image and self-esteem when engaging in commercial sex acts. We call this negative utility *internal* stigma, τ. We assume that internal stigma is nondecreasing in the number of sex acts, $\tau'(a) \geqslant 0$ for all a.

Registration is widely believed to increase the probability δ of being identified as a sex worker by friends, neighbours, or relatives. This is a direct consequence of multiple elements related to registration that are implemented in Senegal, such as holding a registration card issued only to FSWs, working in public places, and being registered in police files. Accordingly, we assume that, for a given a, the probability of being identified as a sex worker by others is larger for registered FSWs than for clandestine FSWs, $\delta^1 \geqslant \delta^0$.[1][2]

While the costs of registration are not clear cut, its benefits are unambiguous. If FSWs do not register with authorities and solicit clients in public places, they risk a prison sentence

[1] This assumption of differential probability may seem to be conjectural rather than factual. However, based on anecdotes from focus groups discussions, we believe this assumption is realistic in the Senegalese context. Our data also show that the main reason for not registering is the preference for discreetness, which hints that FSWs believe $\delta^1 \geqslant \delta^0$.

[2] We also note that predictions of the model are sharper if we do not impose it and use $\delta^0 = \delta^1$ or $\delta^0 > \delta^1$ instead, yet we can still derive the results with $\delta^1 \geqslant \delta^0$.

and/or a fine which we denote collectively as a penalty $m > 0$. This penalty only applies to non-registered FSWs. The penalty sanction is likely to be stochastic in nature and its chance $r(a)$ is nondecreasing in a, $r'(a) \geqslant 0$ for all a. Another benefit of registration is that registered FSWs receive a medical follow-up that aims to prevent (through condom use distribution) and treat STIs, which is expected to have a positive effect on FSWs' health. We will introduce the health benefits of the registration program in a second step.

The utility of a FSW under registration status R depends on her consumption c^R, expected external stigma, internal stigma, and expected legal penalty. We assume consumption and various utility costs to be additively separable.

$$U = u(c^R) - \delta^R(a^R)s(A) - \tau(a^R) - (1-R)r(a^R)m. \tag{1}$$

We assume u is increasing and concave in c ($u'(c) > 0, u''(c) \leqslant 0, \forall c \in \mathbb{R}_{++}$), the chances of being known and being arrested are both nondecreasing in a ($\delta^{R'}(a) \geqslant 0, r'(a) \geqslant 0$), internal stigma is nondecreasing in a ($\tau'(a) \geqslant 0$), and external stigma is increasing in A ($s'(A) > 0$).[3]

Given that the non-registered FSWs cannot work in all venues and are limited to a subset of the market,[4] we conjecture that the market size is bigger for the registered FSWs. So the (inverse) demand for registered and non-registered FSWs differ, and the former is larger, i.e. $w^0(a) \leqslant w^1(a)$.[5] This implies that, for a given a, a marginal income of sex work is no smaller for the registered:

$$w^{1'}(a)a + w^1(a) \geqslant w^{0'}(a)a + w^0(a) \quad \forall a \in \mathbb{R}_+.$$

Based on this, we further assume that such a difference in market size is bounded from below: it is large enough that accessing a bigger market is beneficial even if it implies a greater chance of being identified as a sex worker, or, $\dfrac{\delta^{1'}}{\delta^{0'}}$, which is satisfied for $a\mu_{a^1}$ under a symmetric, bell-shaped density.

Assumption 2.1 *For all $a \in \mathbb{R}_+$:*

$$\frac{w^{1'}(a)a + w^1(a)}{w^{0'}(a)a + w^0(a)} \geqslant \frac{\delta^{1'}(a)}{\delta^{0'}(a)}.$$

[3]For completeness, we note that we assume $s(0) > 0$, i.e. that even the poorest FSW feels external stigma if being identified as a sex worker. We further assume that δ and r follow symmetric, bell-shaped density functions, which implies that the density is increasing for values below mean and decreasing for values above mean, or $\delta^{R''}(a) \geqslant 0$ for $a \leqslant \mu_a$, $\delta^{R''}(a) < 0$ for otherwise, and $r''(a) \geqslant 0$ for $a \leqslant \mu_a$, $r''(a) < 0$ otherwise.

[4]This is confirmed in our database, in which a larger share of non-registered FSWs operate at home.

[5]In the descriptive statistics section, we found that price distributions for registered and non-registered FSWs overlap and their means are not statistically significantly different from each other. At the same time, the number of acts are larger for the registered FSWs and their mean difference is statistically significant. The registered FSWs derive larger incomes from sex acts than the non-registered FSWs. The strict inequality holds when a bigger registered market has clients who have higher willingness to pay for all sex act levels a.

The inequality in Assumption 2.1 assumes that the ratio of marginal incomes is larger than the ratio of marginal probabilities. Intuitively, it states that, under registration, the marginal gain in income is greater than the marginal loss in terms of chances of being identified as a sex worker. $\delta^{1'}(a) > \delta^{0'}(a)$ under Assumption 2.1 is consistent with bell-shaped density functions (under parallel displacement due to location parameter changes) when registration increases the probability of being known, $\delta^1(a) \geqslant \delta^0(a)$ for all a. Note also that it is independent of A, so any FSW will choose to supply more sex acts had they registered. This, of course, does not mean that all FSWs will be better off by registering and by supplying a larger number of sex acts.

2.2 The FSW's problem

A FSW's income is made of her sex work earning and other earnings such as assets, other occupation revenues, and transfers. We consider earnings outside sex work as exogenously given and summarise them as an asset A. A FSW under registration status R solves the following maximization program:

$$\begin{aligned} \max_{\{a^R\}} \quad & u(c^R) - \delta^R(a^R)s(A) - \tau(a^R) - (1-R)r(a^R)m \\ s.t. \quad & w^R(a^R)a^R + A = c^R \end{aligned} \tag{p1}$$

The first order condition (FOC) is:

$$F \equiv u' \cdot (w^{R'}a^R + w^R) - \delta^{R'}(a^R)s(A) - \tau'(a^R) - (1-R)r'(a^R)m = 0. \tag{2}$$

A FSW chooses a^R to equate the marginal consumptive utility with all marginal costs, expected external stigma, internal stigma, and a legal punishment if not registered ($R = 0$). As the marginal income is larger for the registered $w^{1'}(a)a + w^1(a) \geqslant w^{0'}(a)a + w^0(a)$, for a given A, equation (2) immediately gives that $a^1 \geqslant a^0$.

In Figure 1, the optimal a^R is given by the intersection e^R of u' and $\dfrac{\delta^{R'}s + \tau' + (1-R)r'm}{w^{R'}a^R + w^R}$.

To make sure that the solution is a maximiser, we assume the following (for more details on the concavity of the maximisation problem see Appendix 8.1):

Assumption 2.2 *Internal stigma τ is an increasing, convex function of a, such that it dominates the decrease in density $\delta^{R'}$ and $r'(a)$ for any level of A and m for a large a:*

$$\delta^{R''}(a)s(A) + \tau''(a) + (1-R)r''(a)m \geqslant 0.$$

For a small a under bell-shaped density for $\delta^{R'}$ and r', this is automatically satisfied.

A FSW will register if the value function under registration V^1 is larger than the one under illegality V^0. Because the FOC depends on A through marginal utility and marginal expected external stigma, the decision to register also depends on A. A FSW decides to register if:

$$\begin{aligned} V^0(A) &= u\left\{w\left(a^0\right)a^0 + A\right\} - \delta^0\left(a^0\right)s(A) - \tau\left(a^0\right) - r\left(a^0\right)m \\ &< u\left\{w^1\left(a^1\right)a^1 + A\right\} - \delta^1\left(a^1\right)s(A) - \tau\left(a^1\right) = V^1(A). \end{aligned} \tag{3}$$

In other words, a FSW will register if the sum of extra consumptive utility, obtained from the increased supply of sex acts and the disappearance of expected legal penalty, is greater than the expected increased external and internal stigma. By using the envelope theorem, one can show that V^R is increasing in A and the slope is greater for V^0 than V^1, because the marginal utility is greater and (negatively signed) probability of being known is no larger for the non-registered FSWs. So the inequality (3) is likely to hold for a small A (see Assumption 2.3).

Assumption 2.3 *Equation* (3) *holds for a small enough A.*

Given that external stigma depends positively on household wealth, one can show that the decision to register R switches from 0 to 1 as A becomes smaller. That is, there exists $\underline{\mathrm{A}}$ such that $V^1(A) > V^0(A)$ for $A \leq \underline{\mathrm{A}}$ as shown in Figure 2.

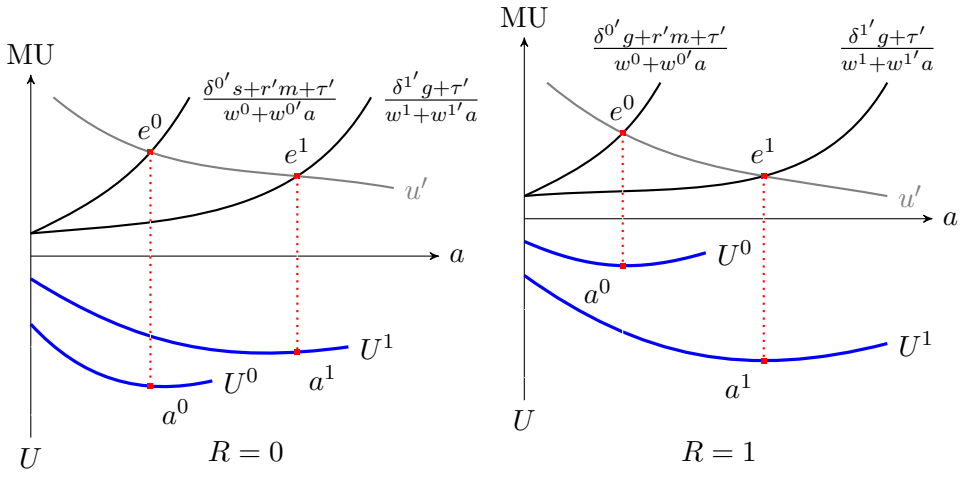
In a related manner, we note that a FSW with a smaller A provides more sex acts hence finds more benefits in registration. This is seen by deriving the following comparative static result:

$$\frac{da^R}{dA} = -\frac{F_A}{F_a} = -\frac{u'' \cdot (w^{R'}a^R + w^R) - \delta^{R'}(a^R)s'(A)}{\mathrm{SOC}}.$$

The denominator is the SOC$= u'' \cdot (w^{R'}a^R + w^R)^2 + u' \cdot (2w^{R'} + w^{R''}a^R) - \{\delta^{R''}s + \tau''(a) + (1-R)r''(a)m\}$ that holds strictly under the assumptions we have made (SOC $= F_a < 0$). Then, the above fraction has a negative sign: the poorer the FSW is, the more sex acts she will perform and the more likely she will decide to get registered.

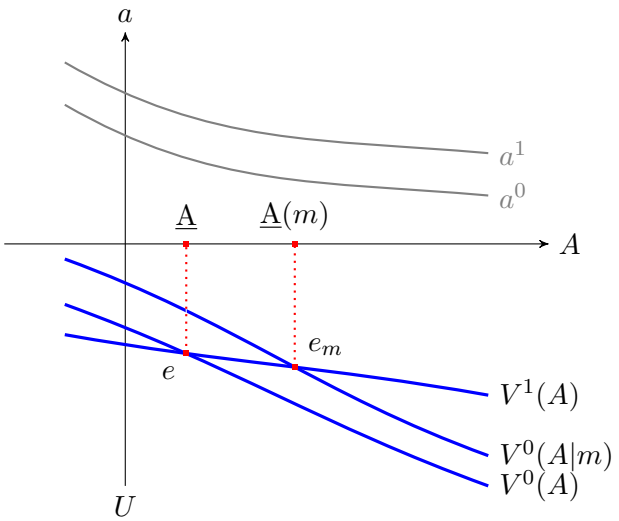
We also note the effects of a penalty m. As it increases the marginal cost of supplying a, a larger m decreases the number of sex acts a^0 for the non-registered FSWs. In Figure 2, one can see the effects of the introduction of a penalty m on the registration decision. More precisely, it shifts down the value function of non-registration, changing the intersection to b_m and thus the associated threshold asset to a larger level denoted as $\underline{\mathrm{A}}(m)$ with $\underline{\mathrm{A}}'(m) > 0$, $\underline{\mathrm{A}}(m) > \underline{\mathrm{A}}(0)$ for $m \in \mathbb{R}_{++}$. To sum up, a larger penalty induces FSWs with a larger A to register.

Figure 1: A large A case (left) and a small A case (right)



Note: u' indicates marginal utility and the fractions indicate marginal costs adjusted for marginal incomes, both for a given A.
The optimal a^R is given by the intersection e^R of u' and $\frac{\delta^{R'}s+\tau'+(1-R)r'm}{w^{R'}a^R+w^R}$.
Based on the assumptions we made, $\frac{\delta^{0'}s+\tau'+r'm}{w^{0'}a^0+w^0} \gtrless \frac{\delta^{1'}s+\tau'}{w^{1'}a^1+w^1}$ so $a^1 \gtrless a^0$ as shown.
Blue lines are utility functions. The choice of a^R, R are given for a large A on the left figure, for a small A on the right figure.

Figure 2: Registration decision over A



Note: Blue lines are value functions.
$V^0(A|m)$ indicates the value function of an non-registered FSW who faces the penalty $m>0$. $\frac{dV^0}{dA} \gtrless \frac{dV^1}{dA}$, and we assume $V^1(A)>V^0(A)$ for A small.
$\underline{A}(m)$, $\underline{A}$ are asset thresholds for registration with and without a penalty, respectively. FSWs with asset levels below the threshold register.

All the results obtained are summarised in the following propositions and corollaries.

Proposition 2.1 *There exists* $\underline{A}$ *such that* $V^1(A) \geqslant V^0(A)$ *for* $A \leq \underline{A}$*: For a small enough level of wealth, a FSW decides to register.*

Proposition 2.2 $a^1 \geqslant a^0$*: For a given level of asset* A*, a registered FSW performs more sex acts than a clandestine FSW.*

Proposition 2.3 a^R *decreases with the level of asset* A*.*

Proposition 2.4 $\underline{A} < \underline{A}(m)$*: A legal penalty of nonregistration induces FSWs with a larger* A *to register.*

Corollary 2.1 $w^1(a^1)a^1 \geq w^0(a^0)a^0$*: A registered FSW earns more.*

Corollary 2.2 $\delta^1(a^1)s(A) \geq \delta^0(a^0)s(A)$ *and* $\tau(a^1) \geq \tau(a^0)$*: A registered FSW suffers from greater external and internal stigma.*

2.3 Health risk

We assume that a FSW is endowed with health which gives the utility level of 0. For the number of sex acts chosen, there is a probability π that the FSW will be infected with a STI. If infected, the health utility will be reduced by I, which is the cost of illness. For simplicity, we assume that a FSW first chooses a and finds out her infection status after completing these sex acts. This ordering of events corresponds to the periodic timing of routine visits to the health center after supplying sex acts for a while. We assume that a STI is a curable disease as in syphilis or a treatable disease as in the case of HIV/AIDS. We therefore let the health capital recovers to the original level if treated.

The probability π of being infected is a function of the number of sex acts, with the chance nondecreasing in a, $\pi'(a) \geqslant 0$. All FSWs are assumed to face the same infection risk.[6] On the other hand, with a periodical medical follow-up provided to registered FSWs, STI symptoms are more likely to be noticed and treated by health providers. We therefore assume that the probability of having a STI cured $\beta^R \in [0, 1]$ is greater for registered FSWs than for clandestine FSWs, $\beta^0 \leqslant \beta^1$. The net effect of registering on health is unambiguously beneficial for any level of a: $-\pi(a)(1-\beta^0)I \leqslant -\pi(a)(1-\beta^1)I$.

[6]One may argue that clients' riskiness differs between registered and non-registered FSWs. With a bigger market size for the registered, one may conjecture that there will be riskier clients, while one can also argue that the non-registered will face the clients in the underground market which may be riskier. Given there is no evidence on client's self-selection process, we choose not to make a strong assumption on it.

The health inclusive utility is given as $U = u - \delta s - \tau - (1-R)rm - \pi \cdot (1-\beta^R)I$.

After introducing the health risk, we modify Assumptions 2.1, 2.2, 2.3 in the following way (see Appendix 8.2 for more details on Assumption 2.1′):

Assumption 2.1′ *For all $a \in \mathbb{R}_+$:*

$$\frac{w^{1'}(a)a + w^1(a)}{w^{0'}(a)a + w^0(a)} \gtrless \frac{\alpha\delta^{1'}(a) + (1-\alpha)\pi'(a)(1-\beta^1)}{\alpha\delta^{0'}(a) + (1-\alpha)\pi'(a)(1-\beta^0)}, \quad with \quad \alpha = \frac{s(A)}{s(A)+I}.$$

Assumption 2.2′ *Internal stigma τ is an increasing, convex function of a, such that it dominates the decrease in density $\delta^{R'}$, $r'(a)$, and $\pi'(a)$ for any A, m, β^R, I for a large a:*

$$\delta^{R''}(a)s(A) + \tau''(a) + (1-R)r''(a)m + \pi''(a)(1-\beta^R)I \geqslant 0.$$

For a small a under bell-shaped density for $\delta^{R'}$ and r', this is automatically satisfied.

Assumption 2.3′ *Equation* (16) *holds for a small enough A.*

Then we can derive the following (see Appendix 8.3 for details on the comparative statistics leading to Propositions 2.5, 2.7 and 2.8):

Proposition 2.5 *There exists $\underline{A}_I$ such that $V^1(A) \geqslant V^0(A)$ for $A \leq \underline{A}_I$: For a small enough level of wealth, a FSW decides to register, and $\underline{A}_I \geqslant \underline{A}$.*

Proposition 2.6 *$a^1 \geqslant a^0$ holds under the health risks. This holds even under $\beta^0 = \beta^1$. a^R is smaller than in the absence of infection risk for $R = \{0, 1\}$.*

Proposition 2.7 *The greater the probability β^R of being cured, the greater the sex act supply a^R. The access to quality health services increases the number of sex acts.*

Proposition 2.8 *The greater the damage I, the smaller the sex act supply a^R. The severity of a disease reduces the number of sex acts.*

Remark 2.1 *If the relative risk of being infected for registered FSWs compared to non-registered FSWs is lower (greater) than the relative probability of being treated, i.e. $\frac{\pi(a^1)}{\pi(a^0)} < (>) \frac{(1-\beta^0)}{(1-\beta^1)}$, registration ensures a lower (greater) physical health damage.*

Proposition 2.5 shows that the threshold asset level of registration is larger than in the absence of infection risk due to the relative curative effectiveness under registration. Proposition 2.6 shows that registered FSWs still work more intensively than clandestine FSWs even if this

leads to greater infection risks. It shows that the prospect of health damage and subsequent access to health services for registered FSW make registration more attractive. It also shows that, even if there is no difference in the probability of being treated, $\beta^0 = \beta^1$, it is possible for a FSW to register and supply larger a relative to non-registered status. This can pose a challenge to public health because the non-health merits of registration induce FSWs to register, under which they supply more a and get infected more frequently, and unless they have a superior cure rate, it translates to higher STI incidence. Proposition 2.7 reflects the moral hazard resulting from a higher probability β^1 of being cured. In fact, if the probability of being cured is 1, the supply of sex act will no longer be affected by infection risk and the maximisation problem (p2) is reduced to (p1). Proposition 2.8 expresses that there is a negative relationship between the severity of STIs that FSWs could contract and the number of sex acts they supply. Finally, Proposition 2.6 indicates $\pi(a^1) \geqslant \pi(a^0)$ while we assume $1 - \beta^0 \geqslant 1 - \beta^1$. Therefore, Remark 2.1 indicates that the expected health damage may or may not increase after registration $\pi(a^1)(1 - \beta^1) \gtreqless \pi(a^0)(1 - \beta^0)$. The effect of registration on health outcomes is ambiguous and will depend on the the extent of increase in infection risks $\pi(a^1) - \pi(a^0)$.

3 Data and descriptive statistics

Data were collected from 320 registered and 310 clandestine over-21 years old FSWs living in Dakar suburbs in June and July 2015. Our sample represents 15% of the total estimated number of FSWs in the region of Dakar (APAPS, 2011-2012). Given that sexual health services are integrated to reproductive health in Senegal, registered FSWs were recruited by midwives while clandestine FSWs were recruited by NGOs staffs and peer FSWs. FSWs were asked to come to the health centre and were interviewed at the health facility in private dedicated rooms. All active registered FSWs from the four STI health centres located in Dakar suburb (Pikine, Rufisque, Mbao and Sebikotane) were contacted to participate in our study and were surveyed. However, due to the snowball design of the recruitment of non-registered FSWs, our sample of clandestine FSWs probably excludes the most isolated and vulnerable girls.

Besides a large set of socio-economic information, interviewed FSWs were asked about their health and wellbeing. Information on the demand for prevention services, their sex work environment, social network and self-image was also gathered. Table 1 presents the descriptive statistics of registered and clandestine FSWs. On average, FSWs of the sample are 36 years old and have low level of education. Most of FSWs are divorced and hence do not receive any financial support from their partner, which is consistent with the fact that 92% of FSWs report to have entered the prostitution market because of financial reason. Regarding household composition, they live in households of six persons on average, 34% live with their parents, 62% with their children and 48% with their brother and they have two children on average. Regarding

sex work activity, on average, FSWs have been in the prostitution business for 8 years. FSWs report a monthly earning of USD 229 (CFAF 133,492) and have monthly household expenditure of USD 607 (CFAF 353,881) and a monthly per capita expenditure of USD 165 (CFAF 96,520), which is 2.2 times higher than the level of per capita expenditure in Dakar reported in national statistics (CFAF 43,260) (ANSD, 2013). In the sample, the demand for HIV and STI prevention is high since 74% of FSWs are affiliated to a STD centre and 57% went to the STD centre less than a month ago. Self-reported condom use is also high since 98% report that they have used a condom with the last client, however when elicited indirectly via a list randomisation condom use rate is 77% (Treibich and Lépine, 2016). In general, FSWs self-report taking low risk in sexual behaviours: only 2% report to have engaged in anal sex and 6% had sex with more than one client at a time. Despite this, 6% of FSWs declare to have a probability of 100% of being infected with HIV today and 22% report having experienced STI symptoms over the last 30 days. Finally, respondents were 25% to declare being not satisfied at all with their life and 15% to have a very low self-esteem.

Table 1: Descriptive statistics

Variables	All FSWs		Clandestine FSWs		Registered FSWs		
	N	**Mean**	*N*	**Mean**	*N*	**Mean**	***p-value***
Socio-demographic characteristics							
Age (in years)	*630*	36.42	*310*	36.01	*320*	36.81	0.257
Divorced (%)	*630*	0.708	*310*	0.668	*320*	0.747	0.029
No education (%)	*629*	0.278	*310*	0.226	*319*	0.329	0.004
Has at least one child (%)	*630*	0.888	*310*	0.897	*320*	0.881	0.536
Father or mother lives in Dakar (%)	*630*	0.548	*310*	0.626	*320*	0.472	0.000
Preference towards the future (%)	*630*	0.210	*310*	0.181	*320*	0.238	0.080
Altruism (USD)	*630*	0.47	*310*	0.37	*320*	0.58	0.000
Risk aversion (CRRA based on Gneezy and Potters game)	*630*	0.754	*310*	0.759	*320*	0.749	0.859
Beauty (score out of 10)	*630*	5.78	*310*	5.85	*320*	5.71	0.308
Entered the sex business alone (%)	*630*	0.532	*310*	0.577	*320*	0.488	0.024
Fatality (%) †	*628*	0.635	*309*	0.702	*319*	0.571	0.001
Own house (%)	*630*	0.200	*310*	0.268	*320*	0.134	0.000
Final outcomes							
Physical health							
Has been sick or injured in the past 4 weeks	*630*	0.419	*310*	0.461	*320*	0.378	0.035
Had lower abdominal pain in the past month	*629*	0.116	*310*	0.145	*319*	0.088	0.025
Wellbeing							
Is not happy	*630*	0.303	*310*	0.258	*320*	0.347	0.015
Is not satisfied at all in general	*629*	0.245	*310*	0.210	*319*	0.279	0.043
Strongly disagree with "Overall I am satisfied with myself"	*629*	0.146	*310*	0.106	*319*	0.185	0.005

Notes: † Fatality =0 if strongly disagree with if someone is meant to have a disease he will. *N* stands for the number of observations.

Table 1: Descriptive statistics - continued

Variables	All FSWs *N*	All FSWs Mean	Clandestine FSWs *N*	Clandestine FSWs Mean	Registered FSWs *N*	Registered FSWs Mean	*p-value*
Intermediate outcomes							
Prevention							
Received free condoms	*621*	0.680	*303*	0.472	*318*	0.877	0.000
Is affiliated to a STD centre	*627*	0.740	*308*	0.542	*319*	0.931	0.000
Went to a health centre in the last month	*630*	0.567	*310*	0.274	*320*	0.850	0.000
Had a HIV screening in the past year	*630*	0.810	*310*	0.674	*320*	0.941	0.000
Sought care last STI	*267*	0.775	*112*	0.768	*155*	0.781	0.806
Sought care last illness	*630*	0.721	*310*	0.710	*320*	0.731	0.547
Unhealthy behaviours							
Cigarette expenses in the last 7 days	*627*	1,152	*310*	895	*317*	1,403	0.096
Alcohol expenses in the last 7 days	*627*	984	*309*	347	*318*	1,602	0.003
Sex work environment							
Number of clients per week	*627*	6.514	*310*	5.145	*317*	7.852	0.000
Attracts usually clients in bars or night clubs	*630*	0.421	*310*	0.245	*320*	0.591	0.000
Last client was an occasional client	*624*	0.442	*307*	0.358	*317*	0.524	0.000
Had alcohol before last sex act	*619*	0.076	*305*	0.039	*314*	0.111	0.001
Last client consumed alcohol	*617*	0.152	*306*	0.085	*311*	0.219	0.000
Multiple clients relationship during last sex act	*583*	0.062	*297*	0.037	*286*	0.087	0.012
Used a condom during last sex act	*562*	0.977	*296*	0.973	*266*	0.985	0.327
Anal intercourse during last sex act	*624*	0.022	*307*	0.013	*317*	0.032	0.119
Fellatio during last sex act	*624*	0.064	*307*	0.059	*317*	0.069	0.584
Is not satisfied at all with sex work	*627*	0.418	*310*	0.342	*317*	0.492	0.000
In the past year:							
Suffered from violence of an occasional client ∗	*364*	0.291	*177*	0.243	*187*	0.337	0.049
Suffered from police violence ∗	*553*	0.061	*310*	0.039	*243*	0.091	0.012
Fear police							
In the past year:							
If suffered from client violence went to report it to the police ∗	*74*	0.257	32	0.188	*42*	0.310	0.240
Earnings and savings							
Monthly earnings from sex work (FCFA)	*628*	133,492	*310*	100,461	*318*	165,692	0.000
Savings in the past month (FCFA)	*624*	15,964	*308*	3,482	*316*	28,131	0.000
Leaving prostitution							
Is sure that she will no longer be a sex worker in 3 years §	*563*	0.355	*278*	0.371	*285*	0.340	0.456
Social network							
Rivalry ‡	*630*	139	*310*	87	*320*	188	0.000
Altruism towards other sex worker	*630*	137	*310*	125	*320*	148	0.174
Life satisfaction with friends †	*612*	2.466	*304*	2.559	*308*	2.373	0.011
Has at least one FSW to go to be reassured	*603*	0.474	*306*	0.533	*297*	0.414	0.004
Has at least one FSW to borrow money to	*603*	0.393	*306*	0.438	*297*	0.347	0.022
Stigma							
Family knows about her sex work activity	*620*	0.281	*306*	0.235	*314*	0.325	0.013
Life satisfaction with family †	*629*	2.571	*309*	2.654	*320*	2.491	0.024
Self-image							
Strongly disagree with:							
"I feel that I have a number of good qualities"	*629*	0.013	*310*	0.006	*319*	0.019	0.167
"I feel that I am a person of worth"	*628*	0.011	*308*	0.003	*320*	0.019	0.065
"I take a positive attitude toward myself"	*626*	0.013	*308*	0.003	*318*	0.022	0.037

Notes: N stands for the number of observations. ‡ Rivalry is measured as the difference in the amount given to an NGO that takes care of street children and the amount given to another sex worker in two dictator games. ∗ FSWs who registered less than a year before the interview were excluded. † Life satisfaction is measured on a scale going from 1 to 4 and increasing with satisfaction. § FSWs who did not understand the scale proposed were excluded.

4 Method

4.1 Propensity score matching

In order to evaluate the impact of the registration policy one would ideally need to compare the outcome Y_1 for a registered FSW ($R = 1$) with the outcome Y_0 that we would observe if this FSW was not registered ($R = 0$). Unfortunately, because FSWs are either official or clandestine, such counterfactual is never observed. If the registration status was randomly assigned, a simple difference in outcome means between legal and illegal FSWs would provide accurate estimates of the impact of the policy. However, given that FSWs register to the policy on a voluntary basis, registered FSWs may not closely resemble to clandestine ones as shown in Table 1 - Panel Socio-demographic characteristics. In order to circumvent the selection bias due to observables, we use propensity score matching.

Following the notation of Blundell and Costa Dias (2000), we want to estimate the effect of being a registered FSW given by:

$$\alpha_t = E(Y_1 - Y_0|X, R = 1) \tag{4}$$

This is the expected difference in the outcomes between the treated and the control after accounting for the observable characteristics (X).

Given that we evaluate the impacts on different outcome measures in response to the registration decision, the aim of matching is to pair every registered FSW with similar FSWs from the control group based on their observable characteristics (X). Our analysis relies on the conditional independence assumption (CIA) that the outcomes of the non-treated FSWs (Y_0) and treated FSWs (Y_1) are independent of the registration status R once one controls for the observable variables (X).

$$(Y_0, Y_1) \perp R|X \tag{5}$$

Given the high dimension of X, a more feasible option is to match on a function of X. It has been shown that the probability to register $P(X)$, or the propensity score, can serve as such a function under the overlap assumption, which states that FSWs who are similar along the selected set of observable characteristics (X) must have a strictly positive probability to be either treated or untreated:

$$0 < Pr(R = 1|X) < 1 \tag{6}$$

Hence we matched on the propensity score to create a balanced sample. CIA and the overlap

assumption are combined as the strong ignorability assumption (Rosenbaum and Rubin, 1983):

$$(Y_0, Y_1) \perp R|P(X) \tag{7}$$

Once the closest matches among the controls have been found for each treated unit based on the propensity score, they are different ways to match the non-treated observations with each treated one, i.e. take the closest match, a fix number of close matches or use a weighted combination of the control units. We use the Gaussian Kernel matching estimator that matches all treated units with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of treated and controls. In other words, control units that are more similar in terms of propensity score receive more weight. Valid standard errors were obtained by bootstrapping.

$$\alpha_t = \frac{1}{N_t} \sum_{i \in T} \left\{ Y_i^T - \frac{\sum_{j \in C} Y_j^C G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k \in C} G\left(\frac{p_k - p_i}{h_n}\right)} \right\} \tag{8}$$

where N_T is the number of units in the treated group i and N_C in the control group j, p is the propensity score, $G(.)$ is a kernel function and h_n is a bandwidth parameter.

Let $S^\star$ be the space of X that is simultaneously observed among registered and non-registered FSWs (common support of X). The expected average effect of the registration policy among treated participants (ATT) for whom we can find a comparable non-treated match is given by:

$$\frac{\int_{S^\star} E(Y_1 - Y_0|P(X), R = 1) dF(P(X)|R = 1)}{\int_{S^\star} dF(P(X)|R = 1)} \tag{9}$$

4.2 Sensitivity analysis

Our main analysis is based on the CIA which assumes that there is no unobservable characteristics which explains both the decision to register and the outcomes of interest. Ichino et al. (2008) propose a simulated sensitivity analysis to test whether the results obtained with the propensity score matching are robust to specific failures of the CIA. The idea is to assume that the selection on observables assumption is not satisfied given the observables considered (equation 10) but could be if one could observe an additional binary variable U (equation 11).

$$(Y_0, Y_1) \not\perp R|X \tag{10}$$

$$(Y_0, Y_1) \perp R|X, U \tag{11}$$

Ichino et al. (2008) define the selection effect Λ as the effect of U on the relative probability to be assigned to the treatment and the outcome effect Γ as the effect of U on the relative probability to have a positive outcome in the absence of treatment.

$$\Lambda = \frac{\frac{P(R=1|U=1,X)}{P(R=0|U=1,X)}}{\frac{P(R=1|U=0,X)}{P(R=0|U=0,X)}} \tag{12}$$

$$\Gamma = \frac{\frac{P(Y=1|R=0,U=1,X)}{P(Y=0|R=0,U=1,X)}}{\frac{P(Y=1|R=0,U=0,X)}{P(Y=0|R=0,U=0,X)}} \tag{13}$$

Put differently, an outcome effect of $\Gamma > 1 (< 1)$ means that the unobserved U positively (negatively) affects the outcome variable. Similarly, a selection effect of $\Lambda > 1 (< 1)$ means that the unobserved U increases (decreases) the probability to register.

In order to study the robustness of the results obtained with the propensity score matching to the violation of the CIA, Ichino et al. (2008) propose two alternatives. A first approach relies on the assumption that the unobserved variable U should have similar selection and outcome effects as important observed variables. To implement this test, we fix $p_{ij} = P(U = 1|R = i, Y = j)$ according to their values for the set of covariates used in the propensity score equation. A second approach is to search for the existence of parameters p_{ij} such that if U were observed the estimated ATT would be driven to zero. To do so, we simulate all possible distributions of U.[7] Then one can assess the plausibility of the configurations of parameters killing the results obtained with the propensity score matching. In the case where the needed distribution of U can be considered as unlikely, the exercise would support the robustness of the estimates derived under CIA.

5 Results

In this section, we first model the decision to register with authorities and estimate the propensity score. In a second step, we present the average treatment effects on the treated (ATT) using Kernel matching. We then implement the sensitivity analysis to study the consequences of the violation of the CIA on the main findings. Finally, we investigate the robustness of the results by using multivariate reweighing method to produce balanced samples and by further improving the specification of the propensity score by using machine learning.

[7] We fixed $p_{11} = p_{10}$ and then made vary the values of p_{11}, p_{01}, p_{00} from 0.1 to 0.9 (Ichino et al., 2008).

5.1 Determinants of registration

Determinants of registration

Table 2 presents the determinants of registration and includes observable characteristics that affect the decision to register with authorities but that are exogenous to registration. To choose the most relevant set of covariates, we rely on economic theory and on self-reported reasons given by clandestine FSWs for not registering and by official FSWs for registering with authorities (Smith and Todd, 2005).

The main reason against registration was discretion (44%); followed by the fact that their sex work activity was occasional (18%), the poor knowledge of the legal system (10%), or procrastination (4%). Hence a key determinant of registration is associated with the fear of FSW stigmatised by relatives. To account for this, we include whether the FSW's parents live in Dakar as this would increase the risk of being discovered by relatives. In addition, we include whether the FSW was introduced by another FSW assuming that those FSWs would be more likely to be aware of the registration policy than those who entered prostitution alone. It is assumed that FSWs who have other opportunities outside sex work may decide to do this activity only occasionally. We thus control for a set of variables that may be correlated with the FSW's opportunity cost such as educational level to account for outside work opportunities, but also age and beauty to account for the fact that younger or more attractive FSWs will be more willing to solicit clients in bars and night clubs and hence will have greater benefits in becoming official FSWs. We also control for divorce status and whether the FSW has children as this may be correlated with their economic vulnerability.

On the other hand, health concerns (62%) and police threats (36%) were the main reasons provided by legal FSWs for registering. In order to account for these factors we control for the following individual intrinsic attributes: risk aversion in the financial domain (elicited via an experimental economic game with real payments),[8] preference for the present, altruism (elicited via a dictator game with real payment) and self-reported fatalism. Moreover, we control for whether the FSW's household owns the house where she lives in. Contrary to the observed assets which are a mixed between the FSW wealth prior to her entry in the sex industry and the earnings she has accumulated, we believe that house ownership is a good exogenous proxy for household wealth.

The selected set of covariates appears to significantly explain the registration status. Table 2 shows that 12% of the variance in registration status is explained by the model. In particular, and as expected from the theoretical predictions, FSWs who face more economic and social vulnerability are more likely to register.

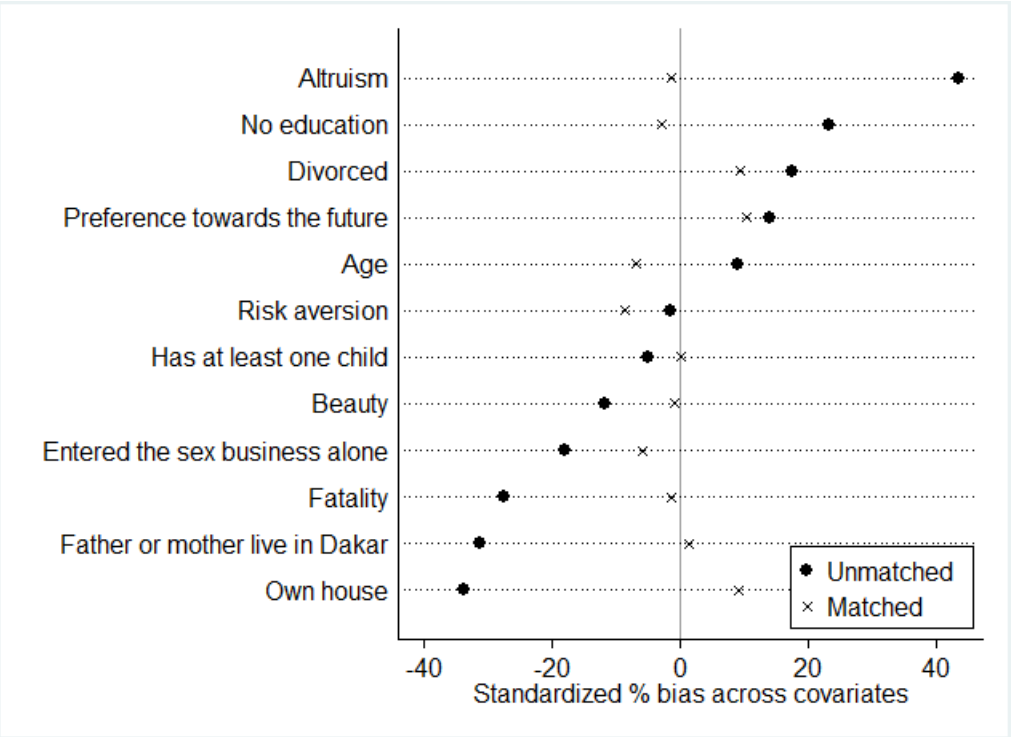
[8] Although risk aversion in money may not correlate with risk aversion in health, we expect that it will predict the decision of register through financial losses resulting from the fine.

Table 2: Determinants of registration

Variables	Coefficient	Robust SE
Age	0.000	0.002
Divorced	0.076*	0.044
No education	0.059	0.043
Has at least one child	-0.085	0.062
Father or mother live in Dakar	-0.118***	0.041
Preference towards the future	0.071	0.047
Altruism†	0.209***	0.042
Risk aversion	0.010	0.027
Beauty	-0.049	0.048
Enters the sex business alone	-0.085**	0.038
Fatality	-0.096**	0.041
Own house	-0.161***	0.049
Observations	*627*	
R^2	0.119	
VIF (max)/ (mean)	1.28/ 1.09	

Notes: † Binary variable which equals 1 if the women gave more than gave more than 40% of the money received in a dictator game to a street children association. VIF stands for variance inflation factors and is used to test multicollinearity of independent variables. * p<0.1; ** p<0.05; *** p<0.01.

Figure 3: Balance of covariates

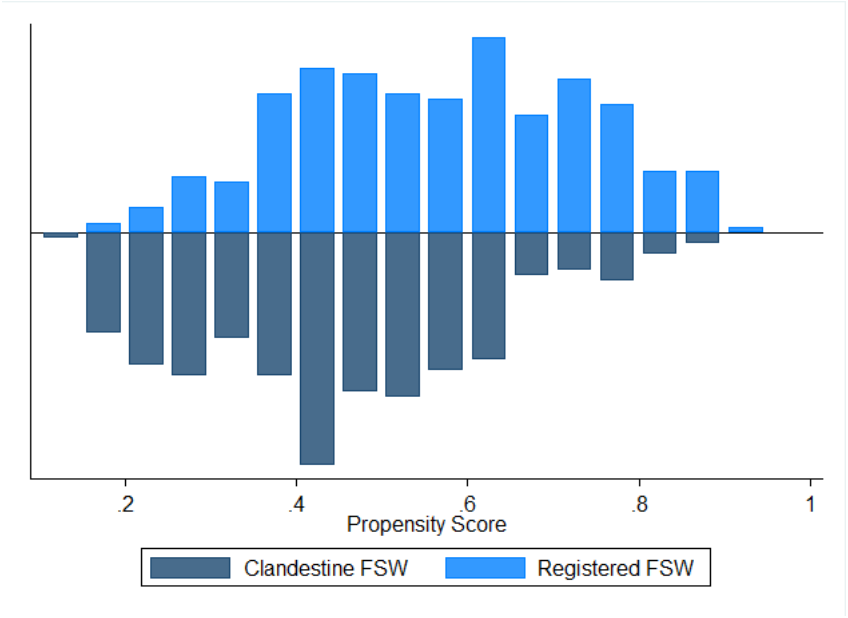


In order to test if the matching procedure is able to reduce the bias between registered and non-registered FSWs along the set of covariates, we compare the standardized percentage bias before and after matching. As shown in Figure 3, the standardized percentage biases are considerably reduced, going from up to 43% before matching to less than 10% for all covariates.

Overlap

Figure 4 brings evidence that the overlap condition is fulfilled by representing the densities of the distribution of the estimated propensity score for registered and non-registered FSWs. In fact, less than one percent of observations in our sample are off support.

Figure 4: Common support



5.2 Effects of the policy

Tables 3 and 4 report the average treatment effect on the treated (ATT).

5.2.1 Effect on health

Overall the net effect of registration on health is positive. We find that registered FSWs are 11 percentage points (23%) less likely to have been sick or injured in the past four weeks. They also are 6 percentage points (38%) less likely to have suffered from lower abdominal pain in the past 30 days. However, no difference in self-reported HIV status, elicited via subjective expectations, is found.

5.2.2 Effect on wellbeing

Overall the net effect of registration on wellbeing is negative. Registered FSWs are 8 and 7 percentage points (29% and 36%) more likely to declare that they are unhappy and unsatisfied with their life in general, respectively. Finally, registered FSWs appear to have a lower self-esteem since they are 9 percentage points (95%) more likely to strongly disagree with the statement *"Overall I am satisfied with myself"*. Despite assuming that registration may have a deterring effect on self-image, we do not find that registration leads to a greater expectation of being in sex work in three years of time.

5.2.3 Effects on earning

Registration leads to a change in the place of sex work. Registered FSWs are 34 percentage points (133%) more likely to work in bars or nightclubs and this translates into a greater activity: registered FSWs have on average 2.7 (51%) more clients a week and greater earnings. We find that registered FSWs earn CFAF 62,793 (USD 107) or 61% more than clandestine FSWs. This difference in earnings is only explained by a greater intensity of their sex work activity rather than by a higher price charged per sex act. Indeed, there is no difference in the price charged by registered and non-registered FSWs during the last sex act with both regular clients and occasional ones. In addition, the increase in earnings allows to increase savings level, we find that registered FSWs save 24,332 (USD 41) more than clandestine FSWs.

5.2.4 Unintended effects

Change in risk taking

Based on information gathered regarding the circumstances of the last paid sexual intercourse, it appears that the differences in sex work environment also translate into riskier sexual behaviours. More precisely, legal FSWs are 15 percentage points (42%) more likely to have had an occasional client as the last client, 6 percentage points (132%) more likely to have consumed

alcohol prior the sex act and 13 percentage points (137%) more likely to have had sex with an intoxicated client, which may explain that registration leads to a higher likelihood of experiencing violence from a client. No difference in condom use or anal sex is detected between registered FSWs and clandestine FSWs, maybe because of the poor variability in those variables (98% of FSWs declare having used a condom and not having performed anal sex during last sex act). However, registered FSWs were 5 percentage points (141%) more likely to have had a sex act with several clients at the same time during last sex act. The result indicate that because of the accrued contact with the police, registered FSWs are also more likely to have experienced violence from a police officer in the past 12 months. However, they are also more likely to report clients' violence to the police.

Social support

Greater competition between registered FSWs translates into lower psychological support from peers. Overall, registered FSWs are less satisfied as far as friendship and social network are concerned. We find that registered FSWs are 15 and 12 percentage points (26% in both cases) less likely to report to know a FSW who will reassure her when they need it and from whom she can borrow money respectively. This rivalry between sex workers is also detected when comparing the difference in the amount registered FSWs agree to give to street children and to a peer sex worker: registered FSWs give 54 FCFA more (41%) to street children than to a peer sex worker in a dictator game than unregistered FSWs. This unintended effect may provide another explanation for the negative effect of registration on wellbeing.

As a matter of fact, the effects of the registration program appear to be stronger when excluding from the analysis registered FSWs who did not go their health visit in the past month.

Table 3: Registration policy impacts - Final outcomes

Outcomes	# ***treated***	# ***controls***	**ATT**	**SE**	**sign.**	**Mean of matched controls**
Physical health						
Has been sick or injured in the past 4 weeks	*318*	*308*	-0.109	0.043	**	0.483
Had lower abdominal pain in the past month	*317*	*308*	-0.055	0.031	*	0.143
Wellbeing						
Is not happy	*318*	*308*	0.077	0.041	*	0.266
Is not satisfied at all in general	317	308	0.074	0.037	**	0.207
Strongly disagree with "Overall I am satisfied with myself"	318	308	0.090	0.028	***	0.095

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
ATT stands for Average Treatment effect on the Treated. Results of the Gaussian Kernel matching on the common support with replacement and 1,000 replications are presented here.

Table 4: Registration policy impacts - Intermediate outcomes

Outcomes	# treated	# controls	ATT	SE	sign.	Mean of matched controls
Prevention						
Received free condoms	316	301	0.369	0.039	***	0.508
Is affiliated to a STD centre	317	306	0.364	0.039	***	0.566
Went to a health centre in the last month	318	308	0.560	0.036	***	0.289
Had a HIV screening in the past year	318	308	0.237	0.033	***	0.707
Sought care last STI	154	110	0.025	0.075	NS	0.760
Sought care last illness	301	305	0.055	0.041	NS	0.716
Unhealthy behaviours						
Cigarette expenses in the last 7 days	315	308	560	325	*	850
Alcohol expenses in the last 7 days	316	307	1300	413	***	289
Sex work environment						
Number of clients per week	315	308	2.665	0.517	***	5.215
Attracts usually clients in bars or night clubs	318	308	0.338	0.040	***	0.254
Last client was an occasional client	315	305	0.153	0.043	***	0.368
Had alcohol before last sex act	312	303	0.062	0.024	**	0.047
Last client consumed alcohol	310	304	0.125	0.033	***	0.091
Multiple clients relationship during last sex act	285	295	0.051	0.022	**	0.036
Used a condom during last sex act	265	294	0.016	0.016	NS	0.968
Anal intercourse during last sex act	315	305	0.019	0.013	NS	0.013
Fellatio during last sex act	315	305	0.015	0.021	NS	0.054
Is not satisfied at all with sex work	315	308	0.102	0.044	**	0.393
In the past year:						
Suffered from violence of an occasional client	186	168	0.101	0.052	*	0.238
Suffered from police violence	242	308	0.047	0.024	*	0.044
Fear police						
In the past year:						
If suffered from client violence						
went to report it to the police	42	26	0.192	0.094	**	0.117
Earnings and savings						
Monthly earnings from sex work (FCFA)	316	308	62,793	114,77	***	103,552
Savings in the past month (FCFA)	319	320	24,332	5,923	***	3,534
Leaving prostitution						
Is sure that she will no longer						
be a sex worker in 3 years	283	276	-0.066	0.044	NS	0.405
Social network						
Rivalry	318	308	54	24	**	132
Altruism towards other sexworker	323	320	2	19	NS	147
Life satisfaction with friends	306	302	-0.255	0.080	***	2.624
Has at least one FSW to go to be reassured	296	304	-0.146	0.047	***	0.558
Has at least one FSW to borrow money to	296	304	-0.122	0.046	***	0.467
Stigma						
Family knows about her sex work activity	312	304	0.080	0.041	**	0.244
Life satisfaction with family	318	307	-0.219	0.075	***	2.710
Self-image						
Strongly disagree with:						
"I feel that I have a number of good qualities"	317	308	0.014	0.008	*	0.005
"I feel that I am a person of worth"	318	306	0.016	0.008	**	0.003
"I take a positive attitude toward myself"	316	307	0.017	0.010	*	0.005

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. NS stands for "not significant".
ATT stands for Average Treatment effect on the Treated. Results of the Gaussian Kernel matching on the common support with replacement and 1,000 replications are presented here.

5.3 Sensitivity analysis

In order to tackle the unobserved confounder bias, we conduct the sensitivity analysis suggested by Ichino et al. (2008) to test whether the results obtained with the propensity score matching are robust to the violation of the conditional independence assumption.

More precisely, we implement the sensitivity exercise for different outcomes of interest, namely STI symptoms and low self-esteem. One may think of several unobserved variables that are likely to simultaneously influence the selection into the program and either the physical health or the wellbeing of FSWs. In particular, one may argue that intra-familial sexual abuse during childhood may, on the one hand, explain the family breakdown and therefore can be positively correlated to the decision to register (selection effect, $\Lambda > 1$). On the other hand, it may also explain the difficulties to socialise with peers and the low self-esteem (outcome effect, $\Gamma > 1$). Hence, the omission of this variable would mean that the estimated effect of registration on wellbeing is overestimated. When turning to physical health outcomes, the individual's preference for health is one of the main potential confounders since this characteristic is likely to be positively correlated with registration ($\Lambda > 1$) and negatively correlated with the likelihood of being sick ($\Gamma < 1$). Its inclusion is likely to reduce the size of the ATT.

Two different exercises are implement in this sensitivity analysis.

In a first step, we simulate an unobserved variable which would have similar selection and outcome effects as important observed variables. Observed covariates with the greatest selection and outcome effects are reported in Table 5. We find that any unobserved variable with similar treatment and selection effects as the covariates already introduced in the propensity score matching will not confound our results.

In a second step, we investigate how the unobserved variable should look like in order to kill the effects obtained with the propensity matching score. To do so, we simulate all possible distributions of U. Figure 7 shows all simulated selection and outcome effects. Table 5 displays some examples of outcome and selection effects for which our main results disappear. Finally, Figure 5 presents the results of the sensitivity analysis. When considering the effect found on the STI symptom, for this result to be statistically insignificant, the potential confounder should lead to an outcome effect and a selection effect that is 2 and 3 times greater respectively than what we observe in the distribution of the covariates. As for killing the impact of the program on low self-esteem, the outcome and selection effects should be almost 3 and 5 times bigger respectively. The robustness of the results obtained in the main analysis are confirmed graphically in Figure 5 where we can note that the ATT and significance levels shrink only for

relatively important levels of selection and outcome effects.

Table 5: Sensitivity analysis

	outcome effect Γ	**selection effect** Λ	**ATT**	**SE**
Outcome: *Had lower abdominal pain in the past month*				
PSM result	-	-	*-0.055*	*0.031*
Confounder-like				
Divorced	0.922	1.653	-0.054	0.005
Preference towards the future	0.700	1.488	-0.054	0.004
Has at least one child	1.609	0.908	-0.055	0.002
Entered the business alone	1.196	0.695	-0.055	0.005
Own house	1.020	0.428	-0.056	0.007
Killer confounder				
U= preference for health	0.432	4.790	-0.024	0.015
U	1.126	0.045	-0.050	0.031
Outcome: *Strongly disagree with "Overall I am satisfied with myself"*				
PSM result	-	-	*0.090*	*0.028*
Confounder-like				
No education	1.417	1.736	0.088	0.005
Father or mother live in Dakar	0.762	0.531	0.088	0.005
Fatality	0.247	0.565	0.075	0.008
Own house	0.915	0.427	0.089	0.006
Killer confounder				
U = sexual abuse	4.323	8.846	0.034	0.022
U	0.023	0.371	0.027	0.017

Notes: All covariates are binary variables.

500 replications have been performed for the sensitivity analysis.

Figure 5: Killer confounders simulations

Figure 5a. Had a lower abdominal pain in the past 4 weeks

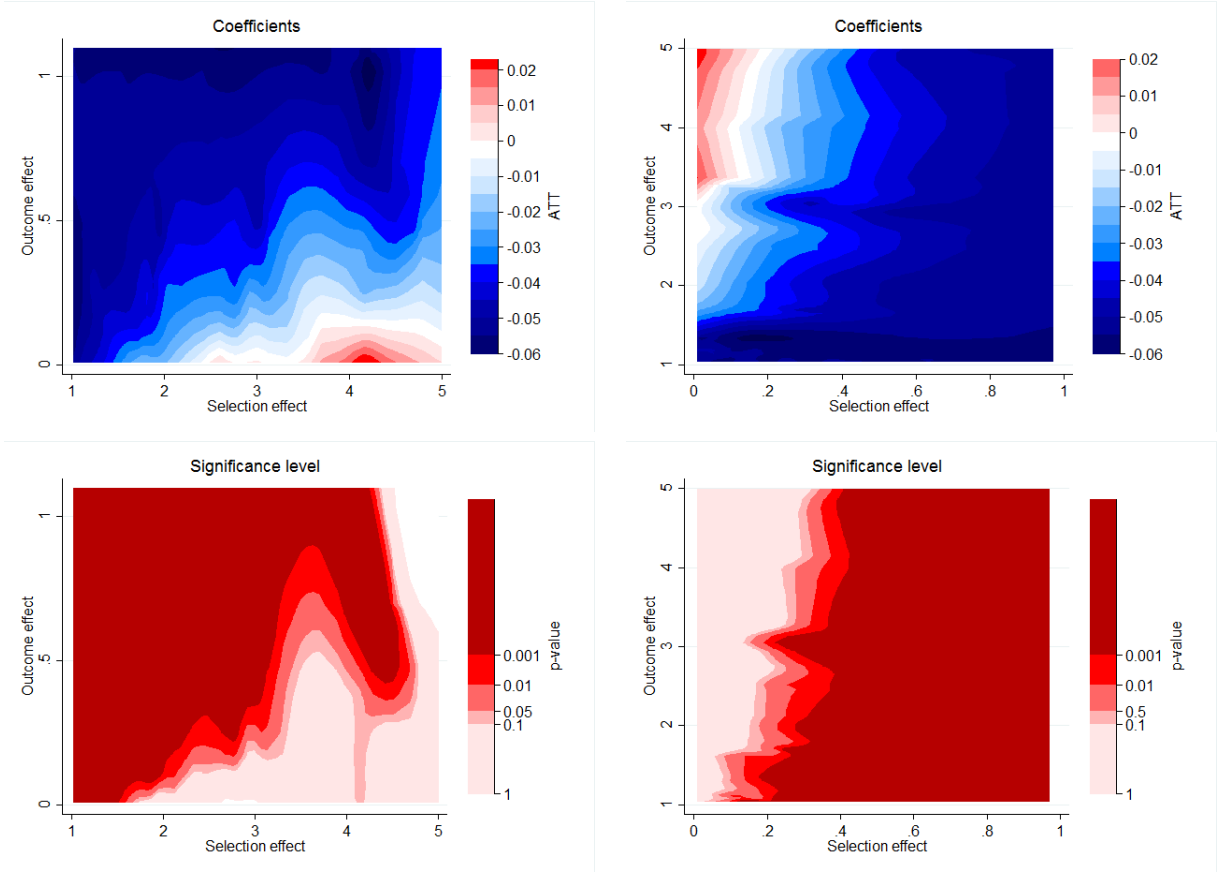
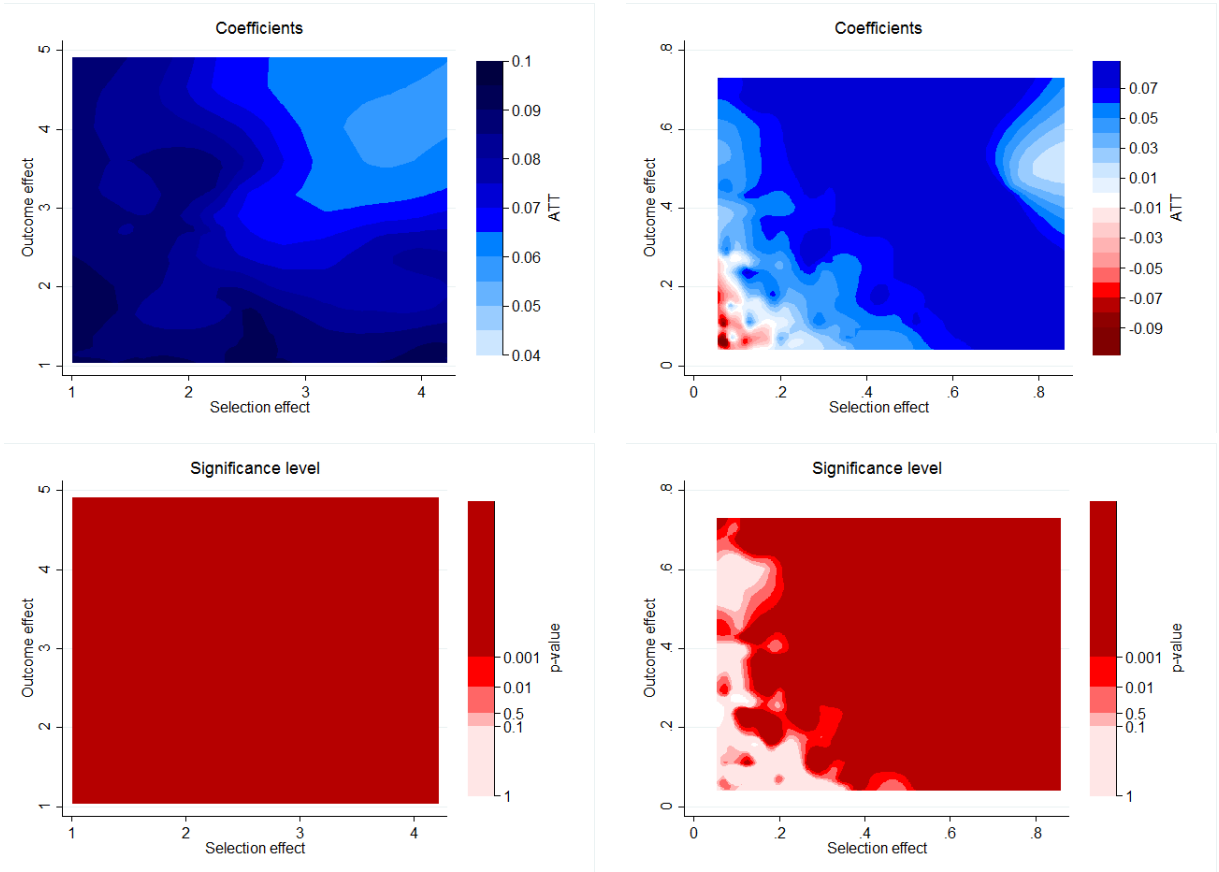


Figure 5b. Strongly disagree with "Overall I am satisfied with myself"



Notes: Figures 5a. and 5b. report the results of the "threatening" simulations presented in Figures 7c. and 7f. respectively.

5.4 Robustness checks

Propensity score matching is widely used in the literature in order to assess the causal effect of a programme on a set of outcomes of interest, circumventing the existing biases induced by the voluntary selection into the programme. Yet, the consistency of the propensity score relies on correct specification and balancing property. We presented hereinafter, two alternative methods to preprocessing data to avoid these caveats; namely entropy balancing to achieve balance in covariates beyond the mean and a super learner to improve specification of the estimation of propensity scores.

5.4.1 Improving covariates balance using entropy balancing

Matching techniques aim at reducing the imbalance between the treatment and the control groups with respect to some covariates related both to the probability of being treated and the outcomes of interest. Through trial and error, applied researchers attempt to find the set of covariates that reach the right balance. This procedure may take some time and may not rule out the possibility that the introduction of some variables may increase the imbalance regarding other observed confounders. Hainmueller (2012) introduced entropy balancing, a data preprocessing procedure that directly focuses on covariate balancing and is able to ensure balancing not only on the first moment of the distribution but also on any specified moment. One can then force the distribution of all covariates considered to look very similar in the treatment and in the reweighted control groups, simulating a randomised experiment.

We implement entropy balancing so that the three first moments of the distribution of each covariate used to estimate the propensity score is identical for registered and non-registered FSWs. Table 6 shows the differences between the two groups before and after implementing the entropy balancing procedure. Weights generated by this procedure are then used to estimate the causal effect of registration on the outcomes of interest, which lead to similar results as the ones obtained with propensity score matching (see Table 9).

Table 6: Balancing of covariates

	Means			**Variances**			**Skewness**		
	Controls			Controls			Controls		
Covariates	Pre	Post	Treated	Pre	Post	Treated	Pre	Post	Treated
Age	36.06	36.81	36.81	82.49	75.01	75.01	0.301	0.284	0.284
Divorced	0.670	0.745	0.745	0.222	0.191	0.190	-0.723	-1.126	-1.126
No education	0.227	0.330	0.330	0.176	0.222	0.222	1.307	0.722	0.722
Has at least one child	0.896	0.881	0.881	0.093	0.106	0.106	-2.602	-2.346	-2.346
Father/ mother live in Dakar	0.625	0.472	0.472	0.235	0.250	0.250	-0.515	0.113	0.113
Preference towards the future	0.178	0.233	0.233	0.147	0.179	0.179	1.684	1.265	1.265
Altruism (more than 400 FCFA)	0.197	0.387	0.387	0.159	0.238	0.238	1.520	0.465	0.465
Risk aversion	0.725	0.709	0.709	0.571	0.587	0.587	0.755	0.775	0.775
Beauty	0.799	0.745	0.745	0.161	0.190	0.190	-1.495	-1.126	-1.126
Entered the sex business alone	0.576	0.487	0.487	0.245	0.251	0.251	-0.308	0.050	0.050
Fatality	0.702	0.572	0.572	0.210	0.246	0.246	-0.885	-0.293	-0.292
Own house	0.269	0.135	0.135	0.197	0.117	0.117	1.044	2.132	2.133

5.4.2 Improving specification of the propensity score using a super learner

While it is common practice to use logistic regression to estimate propensity score, there is evidence that propensity score model misspecification may affect the balance of covariates and lead to biases in treatment estimation (Drake, 1993). Machine learning methods can be used for propensity score estimation in order to choose the optimal regression algorithm among a set of candidates (Pirracchio et al., 2014). We implement the method proposed by van der Laan et al. (2007) so that a weighted linear combination of the candidate learners associated with a high performance is used as a super learner estimator. To achieve this, we include 15 different models in the super learner library (see Table 7). Analyses were performed using R statistical software. Table 7 displays the composition of the super learner estimator. Figure 6 shows the common support based on the super learner propensity score estimation. We can note that the overlap is reduced compared to previously (see Figure 4). Despite having a lower number of units on support (563 vs. 626), ATTs based on the scores estimated with a super learner remains of comparable magnitude (see Table 9) than the ones obtained using a logistic regression.

Table 7: Composition of the Super Learner

Models	Risk	Coefficient
Stepwise regression with interactions	0.2425	0.2248
Logistic regression	0.2340	0.0000
Generalised additive model	0.2343	0.0000
Random forest	0.2375	0.0482
Polynomial spline regression	0.2425	0.0000
Neural network	0.2537	0.0360
Stepwise regression	0.2393	0.0000
Bayesian generalised linear model	0.2338	0.2786
Classification and regression routines	0.2371	0.0116
Classification and regression trees (CART): recursive partitioning	0.2512	0.0000
Bootstrapped aggregated CART	0.2346	0.0000
Gradient boosting	0.2315	0.1508
Support vector machine	0.2381	0.2500
Generalised linear model with penalised maximum likelihood	0.2334	0.0000
Multivariate adaptive regression splines	0.2406	0.0000

Notes: A low risk indicates a greater performance of the model. The coefficients indicate how much weight the super learner puts on each model in the weighted-average.

Figure 6: Common support based on Super Learner weights

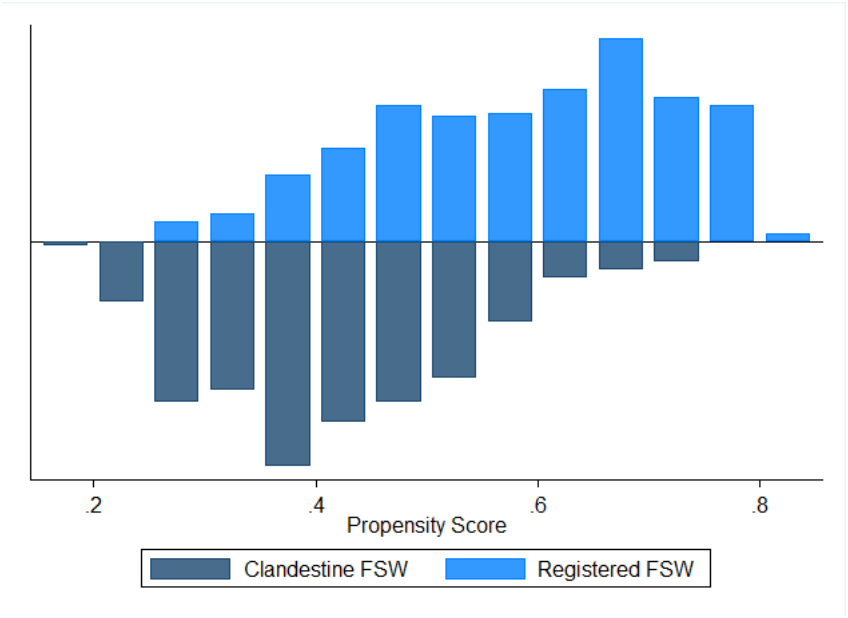


Table 8: Robustness checks - Final outcomes

	PSM		**Entropy balancing**		**Super Learner**	
Outcomes	*ATT*	*sign.*	Coeff.	sign.	ATT	sign.
Observations	T=318	C=308			T=280	C=283
Physical health						
Has been sick or injured in the past 4 weeks	-0.109	**	-0.120	***	-0.133	**
Had lower abdominal pain in the past month	-0.055	*	-0.060	*	-0.047	NS
Wellbeing						
Is not happy	0.077	*	0.086	**	0.074	NS
Is not satisfied at all in general	0.074	**	0.074	*	0.022	NS
Strongly disagree with "Overall I am satisfied with myself"	0.090	***	0.093	***	0.087	***

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. NS stands for "not significant".

Results in italic come from Table 3. ATT stands for Average Treatment effect on the Treated.

Results of the Gaussian Kernel matching on the common support with replacement and 1,000 replications are presented for Super Learner.

T and C indicate the number of treated and control observations respectively.

Super Learner propensity score is a weighted linear combination of candidates presented in Table 7.

Table 9: Robustness checks - Intermediate outcomes

	PSM		**Entropy balancing**		**Super Learner**	
Outcomes	*ATT*	*sign.*	Coeff.	sign.	ATT	sign.
Observations	T=318	C=308			T=280	C=283
Prevention						
Received free condoms	0.369	***	0.373	***	0.324	***
Is affiliated to a STD centre	0.364	***	0.358	***	0.347	***
Went to a health centre in the last month	0.560	***	0.554	***	0.543	***
Had a HIV screening in the past year	0.237	***	0.221	***	0.240	***
Sought care last STI	0.025	NS	-0.041	NS	-0.045	NS
Sought care last illness	0.055	NS	0.065	NS	0.058	NS
Unhealthy behaviours						
Cigarette expenses in the last 7 days	560	*	483	NS	704	**
Alcohol expenses in the last 7 days	1300	***	1335	***	1498	***
Sex work environment						
Number of clients per week	2.665	***	2.617	***	2.408	***
Attracts usually clients in bars or night clubs	0.338	***	0.320	***	0.362	***
Last client was an occasional client	0.153	***	0.151	***	0.179	***
Had alcohol before last sex act	0.062	**	0.064	***	0.061	*
Last client consumed alcohol	0.125	***	0.118	***	0.135	***
Multiple clients relationship during last sex act	0.051	**	0.050	**	0.052	*
Used a condom during last sex act	0.016	NS	0.019	NS	0.003	NS
Anal intercourse during last sex act	0.019	NS	0.023	**	0.025	**
Fellatio during last sex act	0.015	NS	0.019	NS	0.024	NS
Is not satisfied at all with sex work	0.102	**	0.087	*	0.035	NS
In the past year:						
Suffered from violence of an occasional client	0.101	*	0.063	NS	0.115	*
Suffered from police violence	0.047	*	0.068	***	0.032	NS
Fear police						
In the past year:						
If suffered from client violence went to report it to the police	0.192	**	0.103	NS	0.055	NS
Earnings and savings						
Monthly earnings from sex work (FCFA)	62793	***	56792	***	61930	***
Savings in the past month (FCFA)	24332	***	25232	***	27559	***
Leaving prostitution						
Is sure that she will no longer be a sex worker in 3 years	-0.066	NS	-0.082	*	-0.065	NS
Social network						
Rivalry	54	**	46	NS	-3	NS
Altruism towards other sexworker	2	NS	-1	NS	-1	NS
Life satisfaction with friends	-0.255	***	-0.262	***	-0.224	***
Has at least one FSW to go to be reassured	-0.146	***	-0.144	***	-0.145	*
Has at least one FSW to borrow money to	-0.122	***	-0.124	***	-0.135	**
Stigma						
Family knows about her sex work activity	0.080	**	0.069	NS	0.080	NS
Life satisfaction with family	-0.219	***	-0.225	***	-0.178	**
Self-image						
Strongly disagree with:						
"I feel that I have a number of good qualities"	0.014	*	0.016	*	0.009	NS
"I feel that I am a person of worth"	0.016	**	0.016	**	0.018	*
"I take a positive attitude toward myself"	0.017	*	0.017	*	0.018	**

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. NS stands for "not significant".

Results in italic come from Table 4. ATT stands for Average Treatment effect on the Treated.

Results of the Gaussian Kernel matching on the common support with replacement and 1,000 replications are presented for Super Learner.

T and C indicate the number of treated and control observations respectively.

Super Learner propensity score is a weighted linear combination of candidates presented in Table 7.

6 Discussion

We analysed the effect of the registration policy for sex workers in Senegal. Our results show that this policy is effective in controlling the spread of STIs and HIV by targeting high-risk populations with preventive services. However, our results also highlight that this policy has a detrimental effect on FSWs' wellbeing. We show that this result is attributable to greater internal and external stigma resulting from registration and to some unintended effects of registration, namely greater risk-taking in sex acts and lower social support from peers. Registered sex workers are therefore more exposed than non-registered sex workers to the violence of the sex business, which induces negative psychological effects due to the physical and emotional wearing sides of this activity. Despite showing a negative effect of the registration policy on violence experienced by FSWs, the results also suggest that among those FSWs, registered FSWs were more likely to report violence to the police.

The results suggest that regulating sex work in a context where FSWs are highly stigmatised can have a perverse effect on FSWs' wellbeing and suggest that decriminalising or legalising sex work is not sufficient to reduce stigma. Hence, sex work regulation should be accompanied by awareness campaign aiming at reducing stigma toward FSWs. In addition, a change in the registration policy is required in order to reduce the risk associated with the possession of the registration card. Overall, interventions are required in order to leverage registration. This can be achieved by the implementations of a mix of interventions aiming at reducing the costs of registration and increasing the perceived benefits. Leveraging registration is likely to be highly effective in order to reduce the spread of STI and HIV in the country, however the stigma attached to this policy is counterproductive to HIV prevention efforts and reinforce the urgent need to reframe registration in ways that better meet FSWs preferences.

Those conclusions are based on data collected from registered and non-registered FSWs in Dakar. While our results may not be generalisable to the whole population of clandestine FSWs, the selection of the clandestine that have strong links with NGOs in our sample is pertinent for the purpose of the study. First, it is probably an explanation for the good common support obtained using propensity score matching. Secondly, if one was implementing interventions to encourage registration, one could not reach out the most isolated clandestine girls. Hence, the effect of the registration policy presented in the study is likely to represent the one we could expect if we were encouraging registration of clandestine FSWs in Dakar.

The main limitation of the paper is that it only investigates the effect of registration on the current pool of sex workers and falls short to investigate the effect of the policy at the market level. In fact, the effect of registration on market size and on the type of sex workers

entering the market is unknown. If regulation was attracting a lot more FSWs and riskier ones on the sex market, the policy could lead to more infections in the general population even though the transmission of STI and HIV is contained in the current pool of sex workers. The effect of decriminalisation and registration hence relies strongly on context specificity (e.g quality of care, STI/HIV prevalence) and on the behavioural response of sex workers and clients.

7 Conclusion

Few countries worldwide have opted for the regulation of prostitution and mandatory medical screening in order to control the spread of STI and HIV. We show that in Senegal, the only country on the African continent that chose this route, the registration scheme of sex workers is associated with greater demand for HIV/STI prevention services and improved health. However, we show that this policy also has some detrimental effects on psychological and social wellbeing that would require further attention from policy makers.

8 Appendices

8.1 Concavity of the maximisation problem

Second order condition (SOC) for the maximum under (p1) is given as below:

$$u'' \cdot (w^{R'} a^R + w^R)^2 + u' \cdot (2w^{R'} + w^{R''} a^R) - \{\delta^{R''}(a)s(A) + \tau''(a) + (1-R)r''(a)m\} \leq 0$$

The SOC holds if marginal income is nonincreasing ($w^{R''} \leqslant 0$) which holds for non-Giffen goods, and probability δ^R is convex at a^R ($\delta^{R''}(a^R) \geqslant 0$) and $\tau''(a^0)$ is convex at a^0, both of which hold for a smooth, bell-shaped density at $a^R \leqslant \mu_{a^R}$. For $a^R > \mu_{a^R}$, it is possible that, given that $\delta^R(a), r(a)$ are already high enough, the marginal increase in probability can become smaller as one increases a, which is the case for bell-shaped density functions with an infinite support. However, this induces the FSWs to supply as much sex acts as possible, which is clearly unrealistic. So we assume the following for SOC to hold:
Assumption 2.2:

$$\delta^{R''}(a)s(A) + \tau''(a) + (1-R)r''(a)m \geqslant 0.$$

Assumption 2.2 is a sufficient condition for the second-order condition for the maximum to hold at a large a. For $a^R > \mu_{a^R}$, we have negative marginal density and it is necessary to assume the marginal increase of internal stigma is large enough to ensure the SOC to hold. The convexity assumption of internal stigma is consistent with our data in which more active FSWs report more psychological problems.

8.2 Assumption 2.1′

Assumption 2.1′ holds if Assumption 2.1 holds, in fact, it is weaker than Assumption 2.1, because $\pi'(a)(1-\beta^1) \leqslant \pi'(a)(1-\beta^0)$ and $1-\alpha \geqslant 0$. The prospect of infection risk gives the registration a further advantage relative to unregistration in choosing a, which causes relative supply of sex acts to be even greater under registration, although the levels of supply are lower than in the absence of infection risk.

8.3 Comparative statistics with health

A FSW under registration status R now solves the following maximisation program:

$$\begin{aligned} \max_{\{a^R\}} \quad & u(c^R) - \delta^R(a^R)s(A) - \tau(a^R) - (1-R)r(a^R)m - \pi(a^R)(1-\beta^R)I \\ s.t. \quad & w^R(a^R)a^R + A = c^R \end{aligned} \tag{p2}$$

The first order condition (FOC) for (p2) is:

$$F \equiv u' \cdot (w^{R'} a^R + w^R) - \delta^{R'}(a^R) s(A) - \tau'(a^R) - (1-R) r'(a^R) m - \pi'(a^R)(1-\beta^R) I = 0. \quad (14)$$

Compared to the FOC (2) in the absence of infection risks, there is an extra negative term $-\pi'(a^R)(1-\beta^R)I$ which makes a^R to be smaller.

Again, to ensure the solution is the maximum, we modify Assumption 2.2 as Assumption 2.2′. Assumption 2.3′ holds for a larger A than in equation (3), so we can find $\underline{\mathrm{A}}_I$ in an analogous way as in Proposition 2.1, only that $\underline{\mathrm{A}}_I \geqslant \underline{\mathrm{A}}$ because the expected infection damage is larger for the non-registered FSWs.

We can derive how the number of acts a^R varies with wealth A, with the probability of being cured β^R and with the size of STI damage when left untreated I.

$$\begin{aligned} \frac{da^R}{dA} &= -\frac{u'' \cdot (w^{R'} a^R + w^R) - \delta^{R'}(a^R) s'(A)}{F_a} \leqslant 0, \\ \frac{da^R}{d\beta^R} &= -\frac{\pi^{R'}(a^R) I}{F_a} \geqslant 0, \\ \frac{da^R}{dI} &= \frac{\pi^{R'}(a^R)(1-\beta^R)}{F_a} \leqslant 0. \end{aligned} \quad (15)$$

Again, a FSW decides to register if her maximised utility under registration V^1 is greater than under illegality V^0:

$$\begin{aligned} V^0 &= u(c^0) - \delta^0(a^0) s(A) - \tau(a^0) - r(a^0) m - \pi(a^0)(1-\beta^0) I \\ &< u(c^1) - \delta^1(a^1) s(A) - \tau(a^1) - \pi(a^1)(1-\beta^1) I = V^1. \end{aligned} \quad (16)$$

In other words, a FSW would register if the increase in consumptive utility, decrease in health risks, and averted expected penalty amount is greater than the increased external and internal stigma costs. This holds for a larger A than in equation (3), so we can find $\underline{\mathrm{A}}$ in an analogous way as in Proposition 2.1.

8.4 Simulations for the sensitivity analysis

Figure 7: Simulations

Had a lower abdominal pain in the past 4 weeks

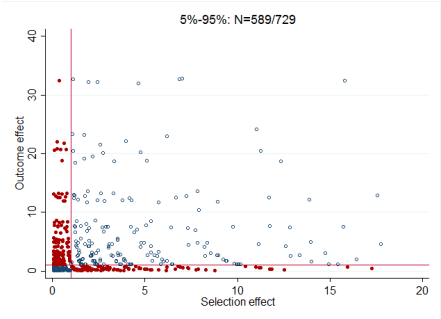


Figure 7a.

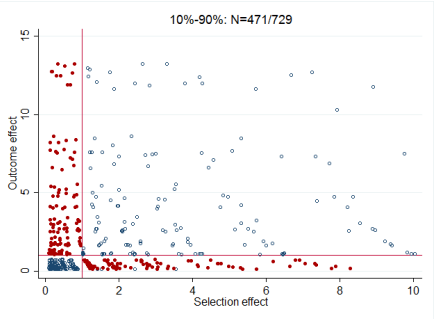


Figure 7b.

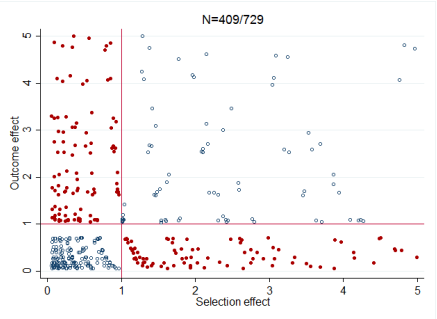


Figure 7c.

Strongly disagree with "Overall I am satisfied with myself"

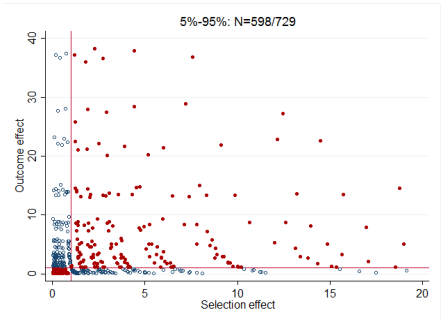


Figure 7d.

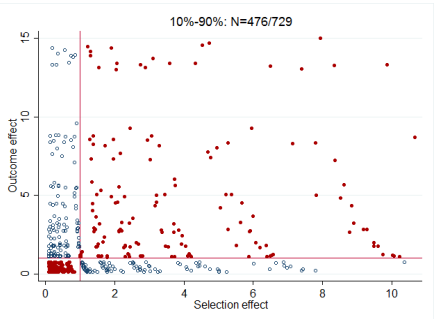


Figure 7e.

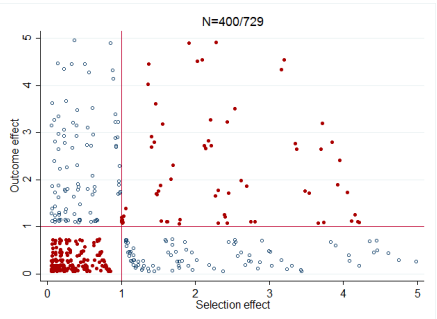


Figure 7f.

Notes: In Figures 7a. and 7d., we excluded simulations inducing either an outcome effect or a selection effect below below the 5^{th} percentile or above the 95^{th} percentile of their respective distributions.
Red dots refer to the simulations likely to threaten our results.
Figures 5a. and 5b. report the results of the "threatening" simulations presented in Figures 7c. and 7f. respectively.

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