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A model of Senegalese FSWs

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Keywords: sex work, stigma, registration, impacts
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A model of Senegalese FSWs
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Abstract Sex workers supply sex acts out of bare necessity for survival. They are often stigmatised of their profession and worry about being known to others. Effectiveness of registration policies that intend to reduce harms of sexually transmitted infections may be reduced by such stigma. To understand the responses of sex workers to a registration policy, we develop a model of sex worker supply with stigma under a simple labour supply framework. We show that sex workers with lower asset levels decide to register and they supply more sex acts. In the extension of the base model, we consider effects of other earning opportunity, STD infection risks and their treatment possibilities, and presence of different client types (occasional and regular). Results of the base model are shown to be maintained.

1 Introduction

Many countries have been banning prostitution on moral and public health grounds. Such approach is broadly considered as criminalisation of prostitution. Criminalisation is considered to be less effective than policymakers intended, because a ban that criminalises offenders often does not reduce the demand for it due to lux enforcement, while illegalisation pushes the sex industry to underground that public health officials cannot easily approach. It is thus natural that harm reduction and more controled approach to prostitution is widely discussed both in policy and academic arena (Rekart, 2005).

Harm reduction imposes regulations and provide assistance to minimise harms (Ritter and Cameron, 2006). It is often proven to be effective to curve HIV infection under an injection drug user (IDU) context focused on needle syringe programs (Cook et al., 2016). Under the sex work context, it involves regulations on sex work and assistance to sex workers. To keep activities under the regulatory purview, it is essentially coupled with partial decriminalisation. In Senegal, brothels are illegal and criminalised. While decriminalisation does not penalise sex workers who comforms with medical checks and carrying cards, it does criminalise brothel owners/managers. Consequently, sex workers who intend to supply many sex acts need to solicit clients in more noticeable places.

There is a wide spectrum of regulations, from location, venues, hours, to registration and periodical testing of sexually transmitted diseases. Assistance includes free distribution of condoms, free medical and psychological counselling, and access to free medical care. There is, however, little research that indicates how the sex work will be affected by regulatory and assistance policies.

In this paper, we use Senegal as an example and model how a decriminalisation policy may affect the sex work supply. Senegal is a predominantly muslim country that decriminalised sex work in the 1960's and keeps the HIV prevalence rate to the second lowest level in Africa. The base of policy is registration: A sex worker must register at a public health facility to be issued a card, and is required to visit a clinic every month to check health conditions. If one fails to carry a valid card when soliciting a client, one faces a risk of an arrest and may be sentenced to a fine or a prison term. Not all the sex workers decide to register. There is a strong fear and stigma among the sex workers about being known by family members and friends about their sex work. The card is easily noticed by others about the sex work, and all sex workers show unwillingness to carry a card.

There are two types of location: Public and private. Public places include bars, clubs, and streets. Private places are mostly residences. Arguablly, in the public places, market size is bigger and

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clients are a mix of occasional and regulars. In contrast, in private places, market size is almost fixed and more regular clients are found. Sex workers in the private places often choose not to register, because they are less likely to be spotted by police and they have a higher risk of being seen by family members and friends. Sex workers in public places tend to register because they are more visible and easily noticed by police.

In the following sections, we will model the sex act supply in the spirit of traditional labour supply framework. We will show that low income induces sex workers to register, and take more clients.

2 A model

2.1 Facts and modeling ideas

In the descriptive statistics section of the companion paper (Ito et al., 2017), we have seen that the registered FSWs differ from nonregistered FSWs in the following aspects: Work at more visible location, take more clients, take more occasional clients, earn larger incomes, take more risks, and feel more stigmatised. In addition, Figure 1 shows that they are less educated, less likely to live with children or other family members. From these, we can see that one of the advantages of registration is a bigger market size. In fact, as in Table A1 in the below shows, nonregistered FSWs charge a higher prices on average to both occasional and regular clients, yet earn less incomes from them than registered FSWs (Figure 2). This suggests that they supply less amount of sex acts. We take this empirical regularity in our data to conjecture that registered FSWs are more in need of earning cash incomes, and they enjoy a smaller repercussion of their supply behaviour on prices in a big market rather than facing a downward sloping demand curve in a small market. We also note that the clients do not ask to show the registration card, so FSW registration status does not directly affect the terms of sex act transactions once the clients and FSWs started negotiation. Indeed, unlike Edlund and Korn (2002); Immordino and Russo (2015), we do not model the demand side or any strategic interactions to keep the model tractable. This is also in line with the facts that our focus on the decision making process of FSWs, not the market equilibria, and that our data only provide information of clients but not the potential clients which are necessary to empirically analyse client's self-selection process.

Table 1: Mean prices charged, by registration status and client type (tail 5% are trimmed)

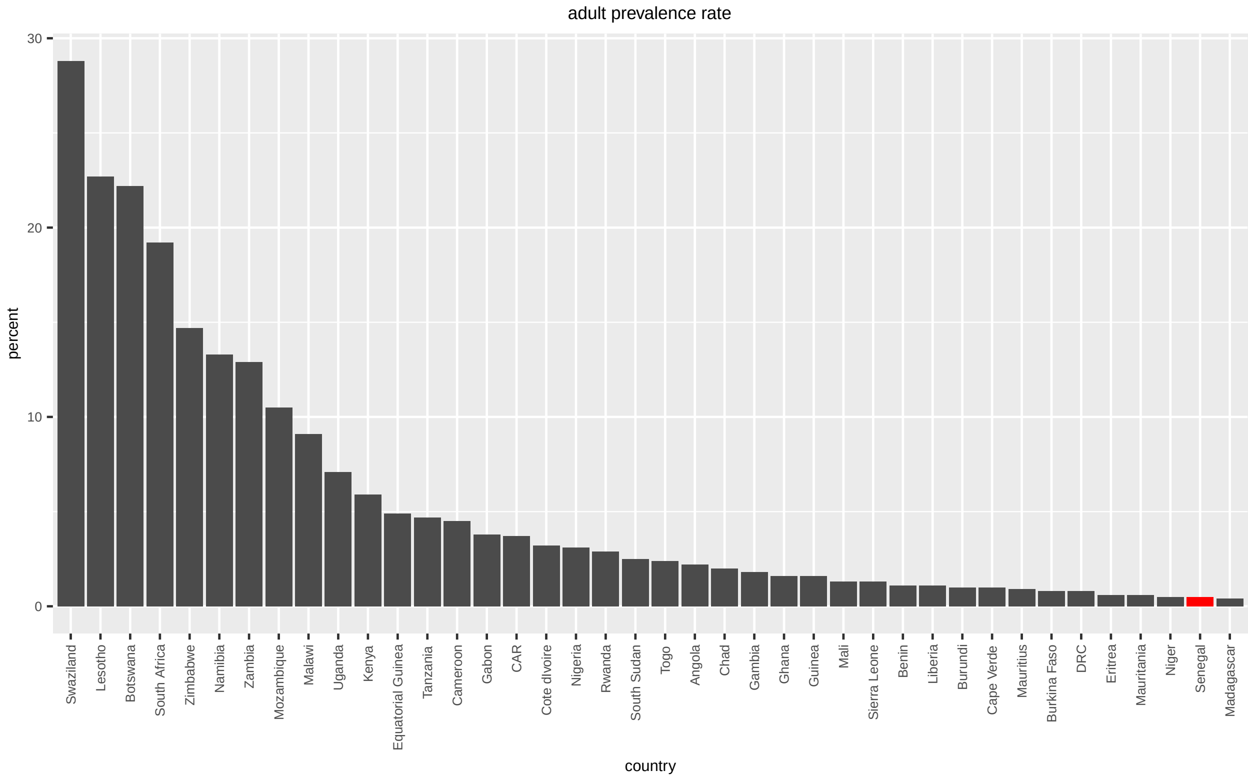
type	min	25%	median	75%	max	mean	std	n
registered, occasional	3500	6000	10000	17500	35000	12550.7	7559.2	227
registered, regular	4000	7000	12500	20000	45000	14787.5	9869.8	240
not registered, occasional	3500	7500	12500	17500	40000	14187.5	8702.7	168
not registered, regular	4000	7625	13125	20000	57500	16458.7	11154.6	266

Note: An occasional client refers to clients that came once or a few times but someone you don't know or you wouldn't recognize the face. A regular client is all other clients.

Source: Summarised from data collected by Lépine and Treibich.

2.2 A setup

A FSW is endowed with an asset $A \in \mathbb{R}$, lives with n children, and faces a unit price $w > 0$ for a sex act. We assume that n is exogenously given. She chooses the number of acts a to maximise her utility. There is a probability $\Pr[k = 1] = \delta^D \in (0, 1)$ of being known by someone close that she is working as a FSW, an event denoted as $k = 1$. This probability is assumed to be increasing in both a and n, and further assume that it is differentiable up to second order and the cross derivative is nonnegative. She feels stigma $g = g(A), g' > 0$ of working as a FSW once she is found by someone close. We assume that stigma is increasing in the asset level A based on the presumption that, the wealthier one gets, the more worried of the bad reputations stemming from engaging in a commercial sex work, or A is positively related to social class. So this may also be termed as extrinsic stigma, as



Source: Data from UNAIDS 1990-2015.

Figure 1 Adult HIV prevalence rate estimates

Source: Data collected by Lépine and Treibich.

Figure 2 FSW earning by registration status and age we call it so later.[*3] We also assume:

$$u'(c) > 0,\ u''(c) \leqslant 0\ \forall c \in \mathbb{R}_{++}.$$

Her utility is given by

$$U = u(c) - \delta^D(a|n)g(A).$$

So her problem is

$$\max_{\{a\}} \quad u(c) - \delta^D(a|n)g(A) \qquad \text{s.t.} \quad wa + A = c \tag{p0}$$

Assuming an interior solution, FOC is:

$$F \equiv u'\left(wa^{*D} + A\right)w - \delta^{D'}(a^{*D}|n)g(A) = 0. \tag{1}$$

We assume the second order condition for a maximum is satisfied.[*4] This relationship in (1) is depicted in the Figure 3 as an intersection e^1 between u' and $\frac{\delta^{D'}g}{\bar{w}}$. She chooses a to equate the increase in marginal consumptive utility and the increase in expected marginal costs of stigma. The value of realised utility U^1 is depicted in the lower half of the figure, and it reaches its maximum at a^{1*}. It can be argued, and we will assume so hereafter, that registration $D = 1$ as a FSW at the government increases the probability of being known from $\delta^0(a|n)$ to $\delta^1(a|n)$ for all a and n, $\delta^1(a|n) > \delta^0(a|n)$. Because $g(A) > 0$, the optimal acts a^{1*} decreases from a^{0*} and, as long as $\delta^0(a^{0*}|n) \leqslant \delta^1(a^{1*}|n)$, so does the maximised utility from $V^0 = u(wa^{0*} + A) - \delta^0(a^{0*}|n)g(A)$ to $V^1 = u(wa^{1*} + A) - \delta^1(a^{1*}|n)g(A)$, so she will not register.

Let us consider the effects of A and n. We can show that $da^{*D}/dA \leqslant 0, da^{*D}/dn \leqslant 0$.[*5] A represents an asset to be consumed. But this also captures the consumption needs by other family members, or some form of tax on sex work earnings. When a FSW has more number of dependents, then we can express it as a low value or as a negative value of A which limits the consumption for oneself. In a way, A also represents the preferences which considers other member's consumption as if one's own.[*6] A negative A can also be considered as a lump sum tax on FSW earnings. A also works to magnify the fear of being known.

2.3 Registration

It takes some penalty of nonregistered status $D = 0$ or benefits of registered status $D = 1$ to induce registration given the increased chance $\delta^1 > \delta^0$ of being known under registration than non-registration. Registration can bring three benefits: First, one can access a bigger market to take more

[*3] We can allow stigma to be nonzero even when not being found out. I normalise this baseline stigma level to zero for simplicity. We can also allow for stigma to be variable with a by letting $b_1 a + b_2 Ak$. It does not change results qualitatively. I set $b_1 = 0$ for simplicity.

[*4]
$$u''w^2 - \delta^{D''}g(A) < 0 \quad \text{at } a = a^{D*}$$

The sufficient condition for SOC $\delta^{D''} \geqslant 0$ is satisfied at small values of δ^D for a commonly used density, such as logistic distribution at $\delta^D \leqslant 1/2$.

[*5] By totally differentiating FOC (1), we have

$$\frac{da^*}{dA} = -\frac{u''w - \delta^{D'}g'}{u''w^2 - \delta^{D''}g} \leqslant 0, \quad \frac{da^*}{dn} = \frac{\delta^D_{an}g}{u''w^2 - \delta^{D''}g} \leqslant 0, \quad \text{if } \delta^{D''} \geqslant 0,$$

$\delta^{D''} \geqslant 0$ is implied in the second order condition as we assumed in *4.

[*6] One can extend this to incorporate other-regarding preference by changing it to $u(c, z)$ where $u(\cdot, z)$ measures the other-regarding utility and the budget is changed to $wa + A = c + z$.

clients. This corresponds to the finding in our data that registered FSWs do not take clients in the obscure corners of the town but in the public places such as streets, bars, clubs, and hotels. In some respect, FOC in (1) is analogous to the textbook monopolist behaviour in which the monopolist must take declining marginal revenues and increasing marginal costs into account. In our case, the FSW must take declining marginal utility stemming from declining marginal revenue (and concave utility), while contrasting it to the marginal costs of being known. We will follow the analogy of price takers to contrast the registered status with the nonregistered, and assume w is fixed in the registered FSW market. Second, she will be able to use the health care services at a lower cost. This reflects the characteristics of the actual regime in place in Senegal and other countries which adopt the harm reduction approach. Our data also confirms that registered FSWs acknowledge the health care cost advantages. Third, registered FSWs will not be arrested by the police. Again, this is another characteristics of the regime in place which is also given by the registered FSWs as the benefits of registration. We will consider the first two aspects in the following.

Let us assume that under $D = 0$, one faces a smaller market such that $w = w(a)$ with $w' < 0$. On the contrary, under $D = 1$, one becomes a price taker and $w = \bar{w}$ for $\forall a \in \mathbb{R}_+$. Then, the Lagrangian under $D = 0$ is

$$\mathcal{L}^0 = u(c) - \delta^0(a)g(A) + \lambda^0[w(a)a + A - c]$$

while under $D = 1$ is

$$\mathcal{L}^1 = u(c) - \delta^1(a)g(A) + \lambda^1[\bar{w}a + A - c]$$

Assume the following:

Assumption 2.1 1.

$$w(0) = \bar{w}$$

2.

$$\delta^1(0) = \delta^0(0).$$

3.

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

1 is a normalisation assumption to make the comparison between two problems easier. One can relax it and allow $w(a) = \bar{w} + z$ for $a, z > 0$ small and maintain $a^1 \geqslant a^0$ in the equlibrium, which may be more consistent with our data. 2 is another normalisation assumption which may be justified on the ground that a zero sex act would not reveal anything. Again, this can be relaxed and may not be necessary for A small as they will choose $a^D > 0$. 3 is a sufficient condition for the nonregistered status to induce a greater expected marginal stigma by a. This may be justified with a smooth density, as there is a discrete jump from $\delta^0(a)$ to $\delta^1(a)$, it requires δ^0 to increase more rapidly than δ^1. Note this holds if $d^2\delta^D/da^2 = 0$.[*7]

Assuming $a > 0$, FOCs are

$$\mathcal{L}^0_c = u' - \lambda^0 = 0, \qquad \mathcal{L}^0_a = -\delta^{0'}(a)g + \lambda^0[w(a) + w'(a)a] = 0,$$
$$\mathcal{L}^1_c = u' - \lambda^1 = 0, \qquad \mathcal{L}^1_a = -\delta^{1'}(a)g + \lambda^1[\bar{w}] = 0.$$

[*7] 3 may look like a strong assumption but as $\delta^1(a)$ jumps more as a becomes positive, we have $\delta^1(a) > \delta^0(a)$ for all $a \in \mathbb{R}_+$. Then we can expect $\delta^{0'}$ to be larger as $\delta^0(a)$ catches up on $\delta^1(a)$, or $\delta^{1'}(a)$ can stay lower than $\delta^{0'}(a)$. However, it is a too strong assumption for our purpose because we only need $\delta^{0'} - \delta^{1'}$ to be in pace with $w'a$, or $\frac{d\left(\frac{\delta^{0'}}{w+w'a} - \frac{\delta^{1'}}{\bar{w}}\right)}{da} \geqslant 0$. In fact, our results hold if we assume $w^0 = \zeta w^1$ for $\zeta \in [0, 1]$ which holds if FSWs have to pay a part of wage to the law enforcement to deter arrests.

The Lagrange multipliers are given by

$$\lambda^0 = \frac{\delta^{0\prime} g}{w(a) + w'(a)a}, \quad \lambda^1 = \frac{\delta^{1\prime} g}{\bar{w}}.$$

Denote the value function under D as $V^D(A)$. Then the slope of the value function is given by $\lambda^D - \delta^{D*} g'$ using the envelope theorem and, under the assumptions we have made, we know that $\lambda^0 > \lambda^1 > 0$ at all $A \in \mathbb{R}$. For a small A, we assume the following:

Assumption 2.2 For a small enough A, the following inequality holds:

$$V^0(A) = u\left\{w\left(a^0\right)a^0 + A\right\} - \delta^0\left(a^0\right)g(A) < u\left\{\bar{w}a^1 + A\right\} - \delta^1\left(a^1\right)g(A) = V^1(A).$$

Equivalently, this is to assume that stigma when being known by someone close $g(A)$ is small enough for a small A to satisfy the following inequality: An extra utility obtained by working in a bigger market is larger than the increase in difference of expected stigma of being known.[*8]

$$\left\{\delta^1\left(a^1\right) - \delta^0\left(a^0\right)\right\} g(A) < u\left(\bar{w}a^1 + A\right) - u\left\{w\left(a^0\right)a^0 + A\right\}.$$

We note that

$$\left\{\delta^1\left(a^1\right) - \delta^0\left(a^0\right)\right\} g(A) > 0$$

and

$$u\left(c^1\right) - u\left(c^0\right) \geqslant 0.$$

hence $V^1 - V^0 \gtrless 0$. So (2.2) assumes that, for a small A, $\left\{\delta^1\left(a^1\right) - \delta^0\left(a^0\right)\right\} g(A)$ is small and $u\left(c^1\right) - u\left(c^0\right)$ dominates. Then we can show that there exists $\underline{A}$ such that $A < \underline{A}$ implies $V^1(A) > V^0(A)$ so registration is superior.

The optimal a^{0*} is given by the intersection e^0 in the Figure 3. The optimal a^{1*} under registration is given by e^1. In the left figure, $V^0(a^{0*}) > V^1(a^{1*})$ so nonregistration is optimal. The converse is true for the right figure. The switch from $D = 1$ to $D = 0$ is induced by the increased level of A. The realised utility is depicted in the lower panel of the Figure 3, and its value is maximised at a^{*D}. Under the assumption 2.2, the maximal level of utility is greater for V^0 under the large A case in the left figure and V^1 under the small A case in the right panel. In Figure 4, we show this dependency of D^* on A which induces the heterogenous response in registration, explained by the relative positions of the value functions $V^0(A), V^1(A)$ over A.

One can also infer about the mental status of the registered FSWs relative to nonregistered FSWs. As a increases under $D = 1$ and registration is accompanied with a jump in δ, the probability of being known δ^1 increases both discretely and continuously from δ^0, hence the expected extrinsic stigma $\delta^1 g$ increases for a given A. On average, the registered FSWs will feel more stigmatised despite their larger earnings.

One can also incorporate *intrinsic* stigma deriving from the commercial sex act itself. This can be distinct from the extrinsic stigma of being known as a FSW which is derived in an external, social context. The intrinsic stigma may be argued to be more strongly rooted to the feeling of self esteem than the extrinsic stigma. Let us continue to denote the extrinsic stigma as g and denote the intrinsic stigma as ξ which we assume to be increasing $\xi'(a) > 0$ for all a. Then the utility is modified as

$$U = u(wa + A) - \delta^D(a)g(A) - \xi(a).$$

[*8] In other words, there exists a large enough $\underline{\delta} > 0$ such that $\delta^1\left(a^1\right) - \delta^0\left(a^0\right) > \underline{\delta}$, and/or small enough $\underline{w} > 0$ such that $\bar{w}a^1 - w\left(a^0\right)a^0 < \underline{w}$ that allows the inequality in (2.2) to hold.

Figure 3 A large A case (left) and a small A case (right)

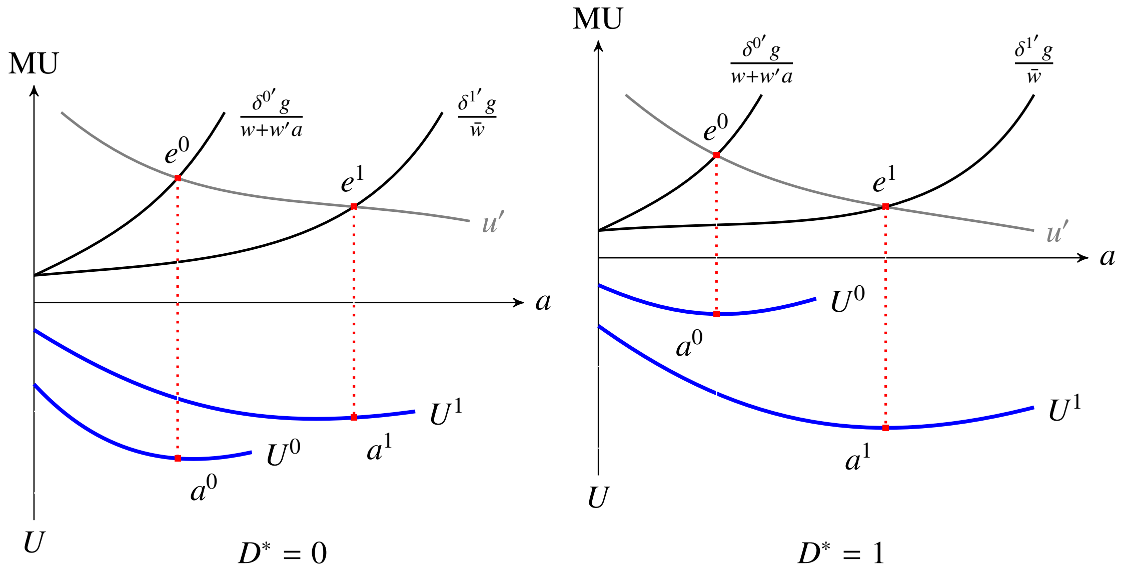
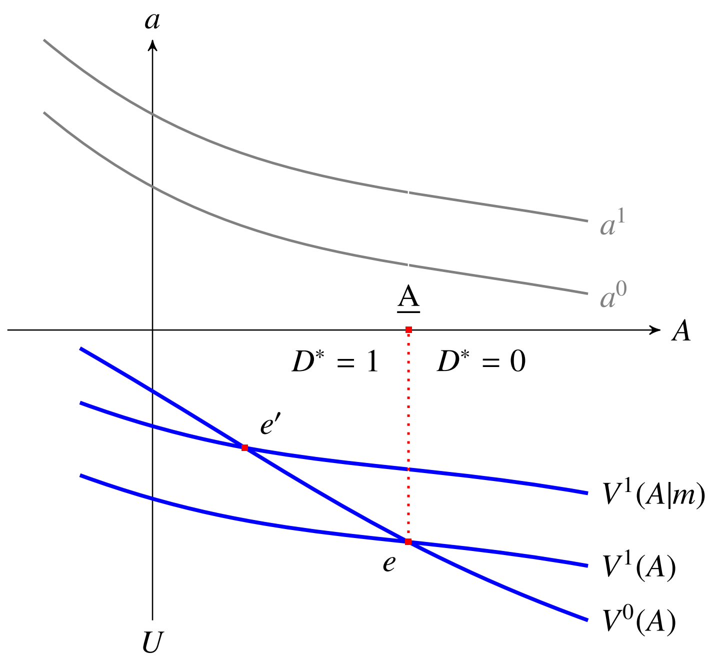


Figure 4 Registration decision over A



This adds an extra marginal psychological cost to a thus decreases a relative to the case in which we do not consider the intrinsic stigma. Upon registration, a increases and so does the intrinsic stigma.

We summarise these results in the following proposition:

Proposition 2.1 Under the assumptions 2.1, 2.2:

1. $a^1 \geqslant a^0$ for all A.
2. The decision to register D switches from 1 to 0 as A becomes large. That is, $V^1(A) > V^0(A)$ for $A \leqslant \underline{A}$ and $V^1(A) < V^0(A)$ for $A > \underline{A}$.
3. Expected extrinsic stigma is larger for registered FSWs relative to nonregistered FSWs, $\delta^1 g >$

$\delta^0 g$ for a given A.

4. Registration induces larger intrinsic stigma $\xi\left(a^1\right) > \xi\left(a^0\right)$.

We can include other fixed costs m of registration that is not related to number of acts (e.g., being asked to report regularly) as another source of heterogeneity in D. The smaller the m, the later the switch from $D = 1$ to $D = 0$ as A increases. As m can be different among FSWs, it introduces heterogeneity in the registration decision. Formally, there can be two ways to modify the utility. First is to subtract costs directly:

$$U = u(c) - \delta^D(a)g - mD, \quad m > 0. \tag{2}$$

Introduction of registration cost shifts the value function of registered FSW to shift vertically in Figure 4. This does not affect a^{D*}.

The second way is:

$$U = u(c - mD) - \delta^D(a)g, \quad m > 0. \tag{3}$$

This shifts up u' in Figure 3 for $D = 1$, so it increases a^1. Despite the increased activity level, it reduces the realised utility value so U^1 shifts toward zero just as in the first modification in Figure 4.

In either way of cost considerations, $V^1(A)$ shifts toward zero. This induces the relatively poor FSWs not to register as m becomes large. An increase in fixed costs of registration poses a problem in controlling STI among FSWs as the fraction of registered FSW becomes smaller.

Let us consider a reduction of registration cost. First, we see that the utility cost of registration in (2) does not affect a^D for given D. However, it increases $\underline{A}$ which prompts some FSWs to register. This increases a for the switched FSWs, hence the net effect on the total number of sex acts is positive. Second, the reduced pecuniary costs in (3) have more nuanced impacts. Ir reduces a^1 in the intensive margin while also induces the marginal nonregistered FSWs to switch from $D = 0$ to 1. By switching, they increase a, so the extensive margin of sex acts of registered FSWs increases. As a result, the combined effects on the total number of acts are ambiguous. In both cases, there will be substitution of sex acts from the nonregistered to the registered.

Although we have not incorporated STI in the analysis, it is worth mentioning the impacts of reduced registration costs on STI control. In (2), even if the sex act by registered FSWs is less risky, the increased total sex acts can undermine the control on STI. In (3), it reduces the total nonregistered sex acts which may be helpful in STI control, yet the change in total registered sex acts is ambiguous, hence it is not certain if it helps to curve STI.

In terms of FSW welfare, the substitution in both cases should make the FSWs better off when we do not consider the health damages of infection, because the reduction in costs should be beneficial for existing registered FSWs and the switch to register is voluntary. If we consider the health damages, then the reduction in costs may harm the FSWs if it increases the chance of infection. Impacts on health need to be considered in an extension that incorporates the health utility explicitly into the analysis.

Proposition 2.2 Under the same set of assumptions:

1. Greater the cost of registration, lower the $\underline{A}$.
2. When m is a utility cost, a reduced m:
   a. Increases a^1 in extensive margins.
   b. Increases the total number of acts.
   c. Increases average A and increased number of acts among the registered FSWs.
3. When m is a pecuniary cost, a reduced m:
   a. Decreases a^1 in the intensive margin yet increases in the extensive margin.

b. Impacts on total number of acts are ambiguous.
c. Increases average A among the registered FSWs.

4. A reduced m induces substitution of sex acts from the nonregistered and registered.

3 Extensions

3.1 Other incomes

Let us consider that FSWs have an earning opportunity other than sex work. To do so, let us redefine the sex acts in terms of hours used in sex work. Assume that an FSW is endowed with one unit of time, and supply a fraction $l \in [0, 1]$ of time endowment to sex work. It will give sex work earning of $w(l)l$ with $w' > 0$ for all l. The remaining fraction $1 - l$ is used for other earning opportunity whose earning is denoted by $\theta_i h(1 - l)$ with $h' > 0, h \leqslant 0$ for all $l \in [0, 1]$ and $\theta_i \in [\underline{\theta}, \bar{\theta}]$ is a positive valued, productivity term.

The maximisation problem is then:

$$\begin{aligned} \max_{\{l\}} \quad & u(c) - \delta^D(l)g(A) \\ \text{s.t.} \quad & w(l)l + \theta_i h(1 - l) + A = c \end{aligned} \tag{p0}$$

Corresponding Lagrangian is

$$\mathcal{L}^D = u(c) - \delta^D(l)g(A) + \lambda^D \left[w(l)l + \theta_i h(1 - l) + A - c \right].$$

Assuming $l > 0$, FOC is

$$F \equiv u' \cdot (w' l + w - \theta_i h') - \delta^{D'} g(A) = 0. \tag{4}$$

We assume the following:

Assumption 3.1

$$\lim_{l \to 0} \{w'(l)l + w(l) - \theta_i h'(1 - l)\} > 0.$$

This ensures that the marginal pecuniary returns to sex act is positive at the limit, so everyone can become a FSW when A and/or θ_i is small. We further assume the SOC is satisfied.[*9] We assume the following inequality to hold for a small A, an assumption analogous to 2.2:

Assumption 3.2 For a small enough A, the following inequality holds:

$$\begin{aligned} V^0(A) &= u\left\{w\left(l^0\right)l^0 + A + \theta_i h\left(1 - l^0\right)\right\} + v_0 - \delta^0\left(l^0\right)g(A) \\ &< u\left\{\bar{w}l^1 + A + \theta_i h\left(1 - l^1\right)\right\} - \delta^1\left(l^1\right)g(A) = V^1(A). \end{aligned}$$

[*9] At $a = a^{D*}$,

$$w'' \leqslant 0, \quad h'' \leqslant 0, \quad \delta^{D''} \geqslant 0,$$

hence

$$u'' \cdot (w' l + w - \theta_i h')^2 + u' \cdot (w'' l + 2w' + \theta_i h'') - \delta^{D''} g(A) < 0.$$

Note that F_l =SOC, $F_A = u'' - \delta^{D'} g' \leqslant 0$, $F_{\theta_i} = u''h - u'h' \leqslant 0$, so

$$\frac{dl^{D*}}{d\theta_i} = -\frac{F_{\theta_i}}{F_l} \leqslant 0.$$

Using the Envelope theorem, we can see

$$\frac{dV^{D*}}{d\theta_i} = \frac{d\mathcal{L}^{D*}}{d\theta_i} = u'h > 0.$$

Given that $u'(c^1) \leqslant u'(c^0)$ or $c^1 \geqslant c^0$ and $l^1 \geqslant l^0$, we see that

$$u'\left(c^1\right)h\left(1-l^1\right) < u'\left(c^0\right)h\left(1-l^0\right),$$

so when θ_i increases, the upward shift of value function is greater for V^0 than V^1 for a given A. This reduces the relative merit of registration. This follows because a θ_i increase will reduce $\underline{A}$ as the V^0 shift is larger than the V^1 shift. The consumption under nonregistration is smaller, hence the same multiplicative increase on other earnings gives a larger impact on (indirect) utility.

With the same reason, for two FSWs i, j with $\theta_i > \theta_j$ and same A, we have $l_i^{D*} < l_j^{D*}$ for $D = 0, 1$. In addition, we can see that $\underline{A}_i < \underline{A}_j$, so even with the same A, it is possible to have $D_i = 0$ and $D_j = 1$. If we consider θ_i as the human capital, the less educated who earns less in other activities tends to register more.

Proposition 3.1 Under the assumptions 2.1, 2.3, 2.4:

1. With a given asset level A, greater the θ_i, smaller the supply of sex acts l.
2. Greater the θ_i, smaller the threshold asset level $\underline{A}$.
3. FSWs with different marginal returns $\theta_i > \theta_j$ have the threshold asset levels $\underline{A}_i > \underline{A}_j$ for $i \neq j$.

3.2 Health

One natural extension of the base model is to incorporate health. Let us consider the health capital h which gives the utility $v(h_0)$. We assume that a FSW is endowed with health capital of $h_0 > 0$. For simplicity of exposition, let us assume that health utility is linear in health[*10] and write health utility as $v_0 = v(h_0)$, $v_1 = v(h_1)$.

Through a sex acts, there is a probability $\pi(d = 1|a) = \pi(a) \in [0, 1]$ that she will be infected with an STD, an event denoted as $d = \{0, 1\}$, with $\pi' > 0$ for all $a \in \mathbb{R}_{++}$. If infected, the health capital will be reduced to $v_1 < v_0$. For simplicity, we assume that a FSW chooses a first and finds out the infection status after completing a acts, rather than sequentially, confirming the status one act after another. This is consistent with the situation where FSWs get checked up only occasionally, such as once in a month as required under the Senegalese regulation regime.

We also assume the STD is a curable disease that the damaged health can be recovered if treated, or a manageable disease like HIV/AIDS that may not affect the health condition severely if treated according to a standard regimen. We therefore assume that the health capital recovers to βv_0 if treated, with the cure rate $\beta \in [0, 1]$. β measures the extent of treatment effectiveness. Denote $\bar{\pi}^D(a) = 1-\pi^D(a), \bar{v} = v_0 - v_1$, then the expected health utility is given as $\pi^D\{(1-D)v_1 + D\beta v_0\} + \bar{\pi}^D v_0 = v_0 - \pi^D\{(1-D\beta)\bar{v} + D(1-\beta)v_1\}$. Her problem becomes:

$$\begin{aligned} \max_{\{a\}} \quad & u(c) + v_0 - \pi^D(a)\{(1-D\beta)\bar{v} + D(1-\beta)v_1\} - \delta^D(a)g(A) \\ \text{s.t.} \quad & wa + A = c \end{aligned} \tag{p2}$$

[*10] This can be relaxed at the cost of more tedious algebra.

Corresponding Lagrangian is

$$\mathcal{L}^D = u(c) + v_0 - \pi^D(a)\{(1-D\beta)\bar{v} + D(1-\beta)v_1\} - \delta^D(a)g(A) - \lambda^D[wa + A - c].$$

FOC is:

$$F \equiv u' \cdot (w'a + w) - \pi^{D'} \cdot \{(1-D\beta)\bar{v} + D(1-\beta)v_1\} - \delta^{D'}(a)g(A) = 0$$

Again, we assume SOC to hold so $F_a < 0$. We can see that $F_A \leqslant 0, F_\beta \geqslant 0, F_{\bar{v}} \leqslant 0$. Then

$$\frac{da^{D*}}{dA} \leqslant 0, \quad \frac{da^{D*}}{d\beta} \geqslant 0, \quad \frac{da^{D*}}{d\bar{v}} \leqslant 0.$$

The second of these comparative static results shows the moral hazard induced by the treatment possibility, and the third shows the negative response to an increased health loss. As in the previous sections, we assume the following:

Assumption 3.3 For a small enough A, the following inequality holds:

$$\begin{aligned} V^0(A) &= u\left(c^{0*}\right) + v_0 - \pi^0\left(a^{0*}\right)\bar{v} - \delta^0\left(a^{0*}\right)g(A) \\ &< u\left(c^{1*}\right) + \left\{1 - \pi^1\left(a^{1*}\right)(1-\beta)\right\}v_0 - \delta^1\left(a^{1*}\right)g(A) = V^1(A) \end{aligned}$$

This is to assume that β is close to 1 or $\bar{v}$ is large. 2.5 is also more likely to hold if $\pi^0\left(a^0\right) > \pi^1\left(a^1\right)$ at large a^0, a^1, which holds if STI prevention is more effective with the registered FSWs. As A becomes large and a^D decreases, so does $\pi^D\left(a^D\right)$ which makes $\pi^D\left(a^D\right)$ terms to become ignorably small in 2.5, hence $V^1 < V^0$ results.

We can show

$$\frac{dV^1}{d\beta} > 0, \quad \frac{dV^0}{d\bar{v}} < 0, \ \frac{dV^1}{d\bar{v}} = 0,$$

hence both an increase in β and $\bar{v}$ increase $\underline{A}$. We also note that

$$\lambda^0 = \frac{\pi^{0'}\left(a^{0*}\right)\bar{v} + \delta^{0'}\left(a^{0*}\right)g}{w'a^0 + w}, \quad \lambda^1 = \frac{\pi^{1'}\left(a^{1*}\right)(1-\beta)v_0 + \delta^{1'}\left(a^{1*}\right)g}{\bar{w}},$$

and $\lambda^0 > \lambda^1$ is likely if $\pi^{0'}(a^{0*}) \geqslant \pi^{1'}(a^{1*})$, $(1-\beta)v_0 \leqslant \bar{v}$ and $\delta^{0'}(a) \geqslant \delta^{1'}(a)$ in assumptions 2.1. The first condition holds if the marginal infection prevention effort is no smaller for the registered relative to the nonregistered FSWs: use of condoms, risk implications of venue and client choice, risk implication of sex acts under intoxication, and choice of sex acts contents. This, however, is not true in our data as we have observed in the descriptive statistic section that the registered FSWs tend to engage in riskier acts more often, and we need to resort to other conditions for $\lambda^0 > \lambda^1$ to hold. The second condition can be rewritten as $\beta v_0 \geqslant v_1$, which states that the treatment cure rate β needs to be no smaller than no treatment.

Proposition 3.2 Under the assumptions 2.1, 2.5:

1. If an increase in infection probability by each additional act is no larger for the registered, or $\pi^{0'}(a) \geqslant \pi^{1'}(a)$, with minimal treatment effectiveness $\beta v_0 \geqslant v_1$, $a^1 > a^0$.
2. Greater the cure rate β, greater the a^1.
3. Greater the damage $\bar{v}$, smaller the a^0.
4. An increase in β or $\bar{v}$ increases $\underline{A}$, hence delay the switch to $D = 0$ as A increases.

1 implies that number of sex acts continues to be larger with registered FSWs, even if the treatment is only minimally effective, as long as an additional act is equally risky between registered and nonregistered FSWs. The statement holds if the marginal infection prevention effort is the same between the registered and nonregistered FSWs. Since our data shows $a^1 > a^0$ holds in general, which implies $\lambda^0 > \lambda^1$, one can conjecture that β in our data is relatively close to unity.

When the health checks and treatments regularly provided under registration is efffective, an increased activity level may not necessarily increase the remaining incidence, defined as incidence after the registered FSWs have received a treatment, of STI at any given time. If the effectiveness of treatment is sufficiently high, the increased activity level after registration can decrease the remaining incidence of STI. This is what we find in our collected data. Together with $a_1 > a^0$ and the model we constructed, we conjecture that the treatment is more than minimally effective (β relatively close to unity).

2 predicts the moral hazard among the registered FSWs. Registered FSWs will increase a^1 in response to an increase in the cure rate β. At the extreme of perfect cure rate $\beta = 1$, STI will not affect the sex act supply and the supply behaviour will be reduced to our baseline case. 3 is a mirror image response by nonregistered FSWs that the prospect of severer health damage reduces a^0 when the treatment is not available.

4 shows that the prospect of health damage and its treatment for registered FSWs make registration more attractive. The relative merit of treatment under registration is expected to induce FSWs to register.

One notes that both the increased treatment effectiveness and increased damage size lead to increased registration. Both of these induce substitution of sex acts from a^0 to a^1, which may be beneficial for STI control. Effects on the total number of sex acts are different, however. An increase in β increases total sex acts, while the increase in $\bar{v}$ decreases it. These have implications on STI incidence. If β increases, a^1 in both extensive and intensive margins increase, thereby dampen the impacts of improved treatment effectiveness. When $\bar{v}$ increases, a^1 decreases in intensive margin yet increase in the extensive margin both under treatment provided by the government, thereby dampening the impacts of increased health damage. To see the impacts of relative merit more explicitly, we will consider the differences in the quality and costs of medical care between D status in the below.

Assume that the cure rate under $D = 0$ is $\gamma \leqslant \beta$ and there is a medical cost $e \geqslant 0$. Denote c_0 as consumption without treatment, c_1 as consumption with treatment. Noting $\bar{\pi}\{u(c_0) + v_0\} + \pi\{u(c_1) + (1 - D)\gamma v_0 + D\beta v_0\} = \pi u(c_1) + \bar{\pi} u(c_0) + [1 - \{1 - \gamma + D(\gamma - \beta)\}] v_0$, the problem is:

$$\begin{aligned} \max_{\{a\}} \quad & \bar{\pi}^D(a)u(c_0) + \pi^D(a)u(c_1) + \left[1 - \pi^D(a)\{1 - \gamma + D(\gamma - \beta)\}\right] v_0 - \delta^D(a)g \\ \text{s.t.} \quad & wa + A = c_0 \\ & wa + A = c_1 + (1 - D)e \end{aligned} \tag{p4}$$

This specification implies $\bar{u}^0 = u\left(c_0^0\right) - u\left(c_1^0\right) > u\left(c_0^1\right) - u\left(c_1^1\right) = u\left(c_0^1\right) - u\left(c_0^1\right) = 0 = \bar{u}^1$. As in the previous sections, we assume the following:

Assumption 3.4 For a small enough A, the following inequality holds:

$$\begin{aligned} V^0(A) &= \bar{\pi}^0\left(a^{0*}\right)u\left(c_0^{0*}\right) + \pi^0\left(a^{0*}\right)u\left(c_1^{0*}\right) + \left[1 - \pi^0\left(a^{0*}\right)(1 - \gamma)\right]v_0 - \delta^0\left(a^{0*}\right)g(A) \\ &< \bar{\pi}^1\left(a^{1*}\right)u\left(c_0^{1*}\right) + \pi^1\left(a^{1*}\right)u\left(c_1^{1*}\right) + \left[1 - \pi^1\left(a^{1*}\right)(1 - \beta)\right]v_0 - \delta^1\left(a^{1*}\right)g(A) = V^1(A) \end{aligned}$$

c_d^D denotes the consumption under infection status d and registration status D.

This is likely to hold when $\beta > \gamma$, or when the expected consumptive utility is greater for the registered at low A, $\mathcal{E}[u(c^1)] > \mathcal{E}[u(c^0)]$.[*11] Again, as A becomes large and a^D decreases, so does

[*11] This can be due to $\pi^0\left(a^{0*}\right) \geqslant \pi^1\left(a^{1*}\right)$ in theory, but, in the case of our data, the greater risk taking among the registered

$\pi^D\left(a^D\right)$ which makes $\pi^D\left(a^D\right)$ terms to become ignorably small in 2.5, hence $V^1 < V^0$ results.

Denoting $\bar{u}^D = u(c_1^D) - u(c_0^D)$, her FOC is:

$$F \equiv \pi^{D'}\left[\bar{u}^D - \{1-\gamma+D(\gamma-\beta)\}v_0\right] - \delta^{D'}g + \left\{\pi^D u'(c_1) + \bar{\pi}^D u'(c_0)\right\}(w'a+w) = 0. \quad (5)$$

We assume SOC for a maximum to hold. Note that $F_\beta = \pi^{1'}v_0 > 0$, we have $\frac{da^{1*}}{d\beta} = -\frac{F_\beta}{F_a} > 0$ as before.

Given $\bar{u}^0 > \bar{u}^1 = 0, \beta \geqslant \gamma$, and assumptions 2.1, 2.6:

$$\mathcal{E}[u'|D=0] = \frac{\pi^{0'}\left\{\bar{u}^0 + (1-\gamma)v_0\right\} + \delta^{0'}g}{w'a+w} \geqslant \frac{\pi^{1'}(1-\beta)v_0 + \delta^{1'}g}{\bar{w}} = \mathcal{E}[u'|D=1] = u_0'|D=1,$$

which requires $\pi^{0'}(a^{0*}) \geqslant \pi^{1'}(a^{1*})$ for sufficiency, which we assume to hold, although this inequality is likely to hold without it given $\beta \geqslant \gamma$, $\bar{u}^0 > 0$ and $\bar{w} > w'a + w$. These show the condition for $a^1 \geqslant a^0$. Then we see that $c_1^1 = c_0^1 \geqslant c_0^0 > c_1^0$, so under a small asset A, $D = 1$ is preferred. Again, as A increases, a decreases, $\pi^D(a)$ approaches to zero, $g(A)$ increases, and FSWs will eventually switch to $D = 0$.

We can see that $F_\gamma = \pi^{0'}v_0 > 0$, $F_e = \pi^{0'}u_1' - \pi^0 u_1'' > 0$ hence

$$\frac{da^{0*}}{d\gamma} = -\frac{F_\gamma}{F_a} > 0, \quad \frac{da^{0*}}{de} = -\frac{F_e}{F_a} > 0,$$

so just as with the registered FSWs, treatment effectiveness induces more sex acts hence moral hazard, and treatmet cost induces nonregistered FSWs to supply more sex acts to cover for possible medical expenses.

To see the changes in treatment effectiveness on registration decision, we consider an infinitesimal increase in β and γ. This shifts V^0, V^1 away from zero, and their shifts are given by

$$\frac{\partial V^0}{\partial\gamma} = \pi^0\left(a^{0*}\right)v_0, \quad \frac{\partial V^1}{\partial\beta} = \pi^1\left(a^{1*}\right)v_0.$$

The relative extent of shifts depends on the relative infection probabilities $\pi^0\left(a^{0*}\right), \pi^1\left(a^{1*}\right)$. Hence a marginal improvement in treatment effectiveness leads to $\underline{A}$ to increase if $\pi^1\left(a^{1*}\right) \geqslant \pi^0\left(a^{0*}\right)$. One also notes that this extent of shfits is not uniform across A or a^D. As a lower A corresponds to a larger a^D, the shifts are larger for smaller A's. This implies that the slopes of value functions flatten as they shift upward in response to an increase in β and γ. This is likely to increase $\underline{A}$.

Given the differences in treatment effectiveness and its cost benefits under $D = 1$, it is possible a FSW chooses to register yet works in a smaller market that is subject to a downward sloping demand curve. Then her problem is:

$$\begin{aligned} \max_{\{a\}} \quad & u(c) + \left[1 - \pi^1(a)(1-\beta)\right]v_0 - \delta^{1,s}(a)g \\ \text{s.t.} \quad & w(a)a + A = c \end{aligned} \quad \text{(p5)}$$

FOC is:

$$F \equiv u' \cdot (w'a+w) - \pi^{1'}(1-\beta)v_0 - \delta^{1,s'}g = 0.$$

The corresponding Lagrangian multiplier $\lambda^{1,s}$, whose superscript indicates $D = 1$ yet works in a small market, is

$$\lambda^{1,s} = \frac{\pi^{1'}(1-\beta)v_0 + \delta^{1,s'}g}{w'a+w}.$$

FSWs shown in the descriptive statistics section suggests that it is more likely due to $c_0^{1*} > c_0^{0*}, c_1^{1*} > c_1^{0*}$.

Provided that $\pi^{0'}(a^{0*}) \geqslant \pi^{1'}(a^{1*})$, we see $\lambda^{0,s} = \frac{\pi^{0'}\{\bar{u}^0+(1-\gamma)v_0\}+\delta^{0'}g}{w'a+w} > \lambda^{1,s}$ hence it increases a, or $a^{1,s} > a^{0,s}$ and $V^{1,s}(A) > V^{0,s}(A)$, so nonregistration is strictly inferior if working in a small market under the current setting. This implies that all FSWs choose to register, but that does not imply that all FSWs work in a large, publicly visible market. This seemingly surprising result is a natural consequence of the policy that subsidises sex acts and risk taking. This can be seen more explicitly in the following inequality:

$$\begin{aligned} V^{1,s} &= u(c) + \left[1 - \pi^1\left(a^{1,s}\right)(1-\beta)\right] v_0 - \delta^{1,s}\left(a^{1,s}\right) g(A) \\ &\geqslant \bar{\pi}^0\left(a^{0,s}\right) u\left(c_0^{0,s}\right) + \pi^0\left(a^{0,s}\right) u\left(c_1^{0,s}\right) + \left[1 - \pi^0\left(a^{0,s}\right)(1-\gamma)\right] v_0 - \delta^0\left(a^{0,s}\right) g(A) = V^{0,s}(A). \end{aligned}$$

Given $u(c) > \mathcal{E}\left[u\left(c^{0,s}\right)\right]$, this is likely to hold either one or all of the following hold: $\beta - \gamma$ is large, $\pi^0\left(a^{0,s}\right) \geqslant \pi^1\left(a^{1,s}\right)$, $\delta^0\left(a^{0,s}\right) - \delta^{1,s}\left(a^{1,s}\right)$ is nonnegative. If working in a small market allows us to assume the detection probability $\delta^{1,s} = \delta^0$, as it happens when FSWs do not have to carry an obvious ID card, then it is even more likely the inequality to hold. On the other hand, this inequality needs to reconcile with the fact that there are nonregistered FSWs. One way to do so is to incorporate registration costs m as we considered in the previous subsection.

So far, we have assumed that an STD-positive FSW will choose to get treated by spending e. However, it is possible that they choose not to get treated if the resultant consumption c_1 is small enough to forgo the prospect of getting healthier. Denote the treatment as $t = \{0, 1\}$. Then her utility is given by:

$$\begin{aligned} U(A|d = 1, t = 1) &= u\left(wa^{0*} + A - e\right) + \gamma v_0 - \delta^0\left(a^{0*}\right) g, \\ U(A|d = 1, t = 0) &= u\left(wa^{0*} + A\right) + v_1 - \delta^0\left(a^{0*}\right) g, \end{aligned}$$

and when she makes such a choice, we must have:

$$U(A|d = 1, t = 0) - U(A|d = 1, t = 1) = \bar{u}^0 - (\gamma v_0 - v_1) > 0, \tag{6}$$

with $\bar{u}^0 = u\left(wa^{0*} + A\right) - u\left(wa^{0*} + A - e\right) > 0$. (6) holds if e is large enough relative to $wa + A$ that makes $\bar{u}$ large and/or γ is small. This may hold if the medical services are costly or have limited effectiveness in the area where nonregistered FSWs reside.

We note that the prospect of infection leaves a nonregistered FSW worse off in the *ex ante* sense, before finding out the infection status, for two mutually exclusive reasons: Health disutility of infection if left untreated and the uncertainty in consumptive utility if treated. Provided that there is a probability that a STD-positive FSW does not get a treatment, the average physical health is worse for nonregistered FSWs relative to the registered FSWs even if $\beta = \gamma$.

Proposition 3.3 Under the assumptions 2.1, 2.6:

1. If an increase in infection probability by each additional act is no larger for the registered, or $\pi^{0'}(a) \geqslant \pi^{1'}(a)$, with a treatment effectiveness difference $\beta \geqslant \gamma$, $a^1 > a^0$.
2. Greater the cure rate γ, greater the a^0.
3. Greater the treatment expense e, greater the a^0.
4. A marginal improvement in treatment effectiveness leads $\underline{A}$ to increase if $\pi^1\left(a^{1*}\right) \geqslant \pi^0\left(a^{0*}\right)$, hence delays the switch to $D = 0$ as A increases. The contrary is true for $\pi^1\left(a^{1*}\right) \leqslant \pi^0\left(a^{0*}\right)$.
5. A nonregistered FSW may not choose to get treated for infection if $\bar{u} - (\gamma v_0 - v_1) > 0$, or when the treatment cost e is large enough relative to $wa + A$ that makes $\bar{u}$ large and/or when γ is small.
6. Nonregistration is strictly inferior in the absence of registration costs.

3.3 Client types

It is worth noting that a FSW has some control over the choice of clients. With a given price, it is conceivable that not all the clients receive the same acceptance. This choice can be prompted by the appearance or the knowledge of the client. Consider that there are two types of clients, occasional o and regular r. An occasional client is typically a total stranger that the FSW does not have any knowledge about. A regular client is an individual who shows up repeatedly, with an intention to be matched with a specific FSW. We assume that the regular clients have a lower risk of carrying STD virus, otherwise he will fall out of favour and will not retain his "a regular" status. In contrast, an occasional client has an elevated level of infection risk. To be concrete, we assume that the aggregate impact of sex acts with occasional and regular clients on $\pi(\grave{a})$ is given by:

$$\grave{a} = a_r + ma_o, \quad m \geqslant 1,$$

where a_r is the number of sex acts with the regular clients, a_o is the total number of sex acts with the occasional clients, and m is an elevated risk factor. Analogously, we also assume that an aggregate impact on $\delta(\tilde{a})$ as

$$\tilde{a} = a_r + \tilde{m}a_o, \quad \tilde{m} \geqslant 1.$$

$\tilde{m} \geqslant 1$ is justified in the following way. In the event of being known by someone close, regular clients can be subtle in negotiating and reaching an agreement while occasional clients have to show, in an understandable manner to at least one FSW, an intention that he is looking for a sex act. This makes having an occasional client more visible to others about the commercial sex work. We assume that a FSW cannot price discriminate between the occasional and regular clients, although this can be relaxed at the cost of more tedious conditions.

Then her problem is

$$\begin{aligned} \max_{\{a_o,a_r\}} \quad & u(c) + \left[1 - \pi^D(a)\{1-\gamma+D(\gamma-\beta)\}\right] v_0 - \delta^D(\tilde{a})g(A) \\ \text{s.t.} \quad & w(a_r+a_o)(a_r+a_o) + A = c \\ & \grave{a} = a_r + ma_o \\ & \tilde{a} = a_r + \tilde{m}a_o \\ & a_r \in [0, \bar{a}_r] \end{aligned} \tag{p6}$$

Corresponding Lagrangian is:

$$\mathcal{L} = u(c) + \left[1 - \pi^D(a)\{1-\gamma+D(\gamma-\beta)\}\right] v_0 - \delta^D(\tilde{a})g + \lambda[w(a_r+a_o)(a_r+a_o) + A - c] + \mu[\bar{a}_r - a_r].$$

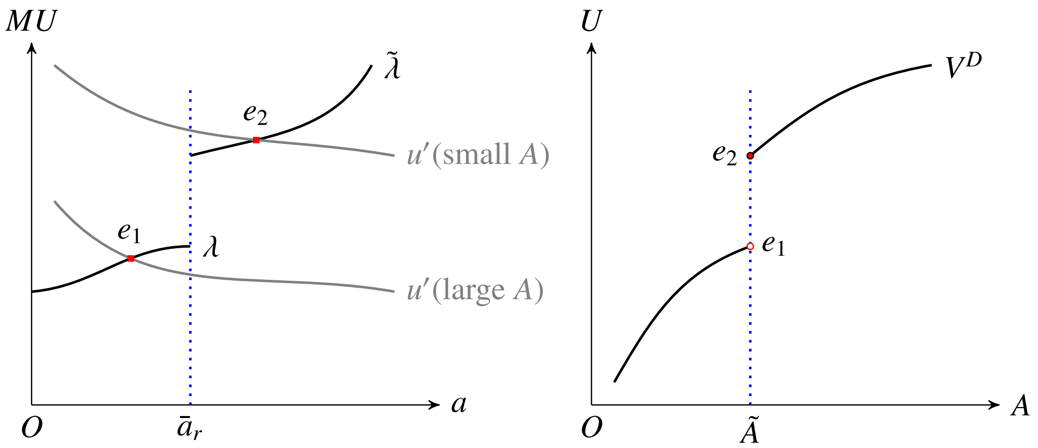
KT-FOCs are, assuming $c, a_r > 0$, budget is used up:

$$\begin{aligned} &\mathcal{L}_{a_r} \equiv \lambda(w'a_r + w) - \pi^{D'}\{1-\gamma+D(\gamma-\beta)\} v_0 - \delta^{D'}g(A) - \mu = 0. \\ &\mathcal{L}_{a_o} \equiv \lambda(w'a_o + w) - m\pi^{D'}\{1-\gamma+D(\gamma-\beta)\} v_0 - \tilde{m}\delta^{D'}g(A) \leqslant 0, \quad a_o \geqslant 0, \quad a_o\mathcal{L}_{a_o} = 0. \\ &\mathcal{L}_c \equiv u' - \lambda = 0. \\ &\mathcal{L}_\lambda \equiv w_r(a_r)a_r + w(a_r+a_o)(a_r+a_o) + A - c = 0. \\ &\mathcal{L}_\mu \equiv \bar{a}_r - a_r \geqslant 0, \qquad \mu \geqslant 0, \quad \mu\mathcal{L}_\mu = 0. \end{aligned}$$

Denote the corresponding multiplier as λ when $a_r < \bar{a}_r$, and $\tilde{\lambda}$ when the reserve of regulars is used up $a_r = \bar{a}_r$. Then, given $w(a_r)a_r + w(a_r) > w'(\bar{a}_r + a_o)(\bar{a}_r + a_o) + w(\bar{a}_r + a_o)$ and $\mu > 0$,

$$\lambda(a_r, 0|A) = \frac{\pi^{D'}\{1-\gamma+D(\gamma-\beta)\} v_0 + \delta^{D'}g(A)}{w'(a_r)a_r + w(a_r)} < \frac{\pi^{D'}\{1-\gamma+D(\gamma-\beta)\} v_0 + \delta^{D'}g(A) + \mu}{w'(\bar{a}_r+a_o)a_o + w(\bar{a}_r+a_o)} = \tilde{\lambda}(\bar{a}_r, a_0|A).$$

Figure 5 Discontinuity in λ and value function



This indicates that the marginal cost curve jumps upward at $a = \bar{a}_r$. The choice of a is depicted in Figure 5 for two FSWs, namely, a person with a small asset and a person with a large asset. A FSW with a large enough asset will choose $a_r < \bar{a}_r$, so the intersection is with λ, while a FSW with a small asset finds it optimal to supply beyond $\bar{a}_r$ hence $a_o > 0$, thus the intersection is with $\tilde{\lambda}$. When a FSW takes occasional clients, we have

$$\tilde{\lambda}(\bar{a}_r, a_o|A) = \frac{m\pi^{D'}(a_r + \gamma a_o)\{1 - \gamma + D(\gamma - \beta)\} v_0 + \tilde{m}\delta^{D'}(a_r + \tilde{\gamma} a_o) g(A)}{w'(\bar{a}_r + a_o)a_o + w(\bar{a}_r + a_o)}. \tag{7}$$

When $m = \tilde{m}$, we have $\tilde{\lambda}(\bar{a}_r, a_0) = m\omega\lambda(a_r, 0) > \lambda(a_r, 0)$ where $\omega = \frac{w'(a_r)a_r + w(a_r)}{w'(\bar{a}_r + a_o)a_o + w(\bar{a}_r + a_o)} > 1$.[*12]

Assumption 3.5 For a small enough A, the following inequality holds:

$$\begin{aligned} V^0(A) &= u(c^0) + \left[1 - \pi^0(\grave{a}^0)(1-\gamma)\right] v_0 - \delta^0(\tilde{a}) g(A) \\ &< u(c^1) + \left[1 - \pi^1(\grave{a}^1)(1-\beta)\right] v_0 - \delta^1(\tilde{a}) g(A) = V^1(A) \end{aligned}$$

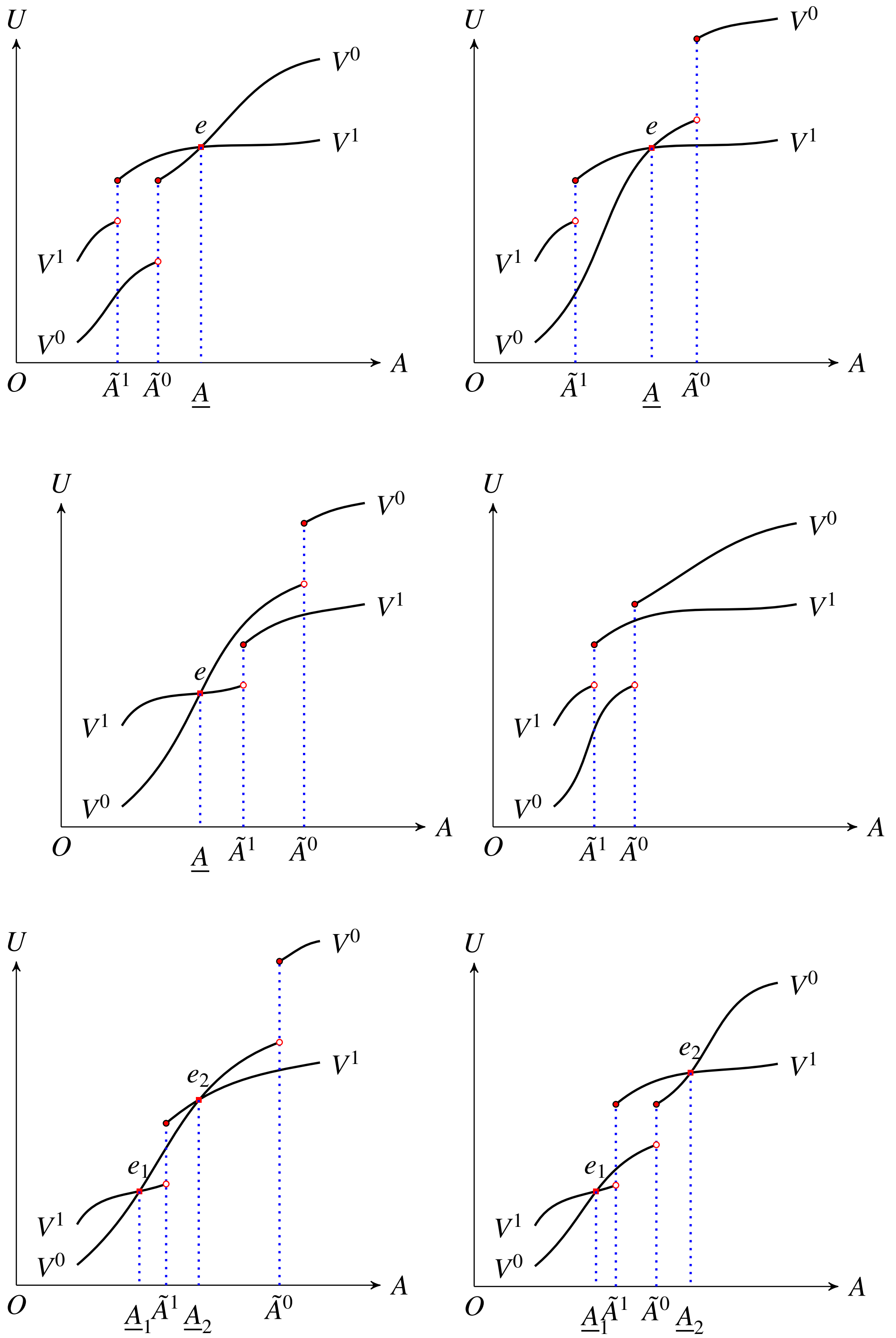
From the previous discussions that the optimal a can be written as a decreasing function of A, one can show there is a threshold asset level $\tilde{A}$ that only FSWs with $A < \tilde{A}$ would take occasional clients. Hence the poorer FSWs are more likely than the non-poor FSWs to take clients beyond $\bar{a}_r$ and accept o, despite the elevated level of infection and exposure risks. This means that the value functions under $D = 0, 1$ show a jump at $\tilde{A}^D$, because both δ^D, π^D jump discretely upward once a_o becomes strictly positive. We can see that $\tilde{A}^1 \leqslant \tilde{A}^0$ because the wage is smaller with $D = 0$ at the optimum. If we continue to assume $\beta \geqslant \gamma$, then the jump is larger for V^1 than V^0.

Proposition 3.4 Under the assumptions 2.1, 3.1:

1. There is a threshold asset level $\tilde{A}$ such that a FSW with $A \geqslant \tilde{A}$ only takes regular clients, given the upperbound of the number $\bar{a}_r$ of regular clients.

[*12] It is possible that there is no intersection because λ and $\tilde{\lambda}$ are discontinuous at $a = \bar{a}_r$ and u' curve can pass through the range of discontinuity. Should this be the case, the FSW chooses $a_r = \bar{a}_r, a_0 = 0$ for all A that satisfy $\lambda(\bar{a}_r, 0|A) < u'\{w(\bar{a}_r)\bar{a}_r + A\} < \tilde{\lambda}(\bar{a}_r, 0|A)$ where $\tilde{\lambda}(\bar{a}_r, a_o|A)$ is given in (7).

Figure 6 A variety of registration decisions



2. There can be multiple switches due to the jumps created by $\bar{a}_r$.

In the last panel of Figure 6, a sex worker starts with being registered, switches to non-registered, switch back to registered, and then end with non-registered as asset level rises.

4 Concluding remarks

In this paper, we modeled decision processes of a sex worker under a variety of conditions. We consider sex act supply as risky labour supply. The foremost risk we consider is a risk of being known by others that one is working as a sex worker. Sex act supply is determined while balancing the marginal income gains against the marginal social costs of being known. Probability of being known is greater if registered with the government. In the base model, we show poorer FSWs choose to get registered and supply more sex acts. We also showed that there is a threshold asset level that a FSW with a larger asset decides not to register.

In the extension of the base model, we considered effects of other earning opportunity, of STD infection risks and their treatment possibilities, and of presence of different client types (occasional and regular). The basic results of the base model are maitained and registration increases the number of sex act supplies. Under the heterogeneity in client types, we derived that there can be multiple asset level thresholds because a limited number of regular clients induces jumps in FSW value functions.

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