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Regulating Prostitution: An Health Risk Approach

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Regulating Prostitution: An Health Risk Approach

Giovanni Immordino[*] and Francesco Flaviano Russo[**]

Abstract

We build an equilibrium model of prostitution where clients and sex workers choose to demand and supply sex under three legal regimes: prohibition, regulation and laissez-faire. The key feature is the endogenous evolution of the risk as a consequence of policy changes. We calibrate the model to empirical evidence from Italy and then compare the effect of different policies on the equilibrium quantity of prostitution and on the harm associated with it. A prohibition regime that makes it illegal to buy sex but not to sell it is more effective than the opposite regime in reducing quantity but less effective in reducing harm. Taxes are one inducement to go illegal and prevent some of the less risky individuals from joining the market, leaving it smaller but riskier. A licensing system that prevents some infected individuals from joining the legal market reduces the risk and is therefore associated with a sharp increase in quantity. While prohibition is preferable to minimize quantity, regulation is best to minimize harm.

JEL classification: L51, I18, O17, H21

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1 Introduction

Throughout history, prostitutes have been priestess, artists, role models, workers, sinners or outright criminals. There is perhaps no other human activity that engendered such a wide array of attitudes. Attitudes that translated and still translate into different legislations and policies.

In this paper we study the effects of different policies on the prostitution market. Our goal is to inform the debate on prostitution policy and to fill a gap in the economic literature.

We start with the observation that all policy approaches can be classified into one of three broad categories: prohibition, regulation and *laissez-faire*. Under prohibition, prostitution is illegal and the government enforces the law by spot checks resulting in fine or imprisonment. The United States (except Nevada), Russia, China and Iran are examples of this regime. Peculiar cases of prohibitionism are Sweden, Norway and Iceland, where it is illegal to buy but not to sell sex services. In a prohibition regime, the only policy instruments available to government are enforcement probability and sanctions. Under a regime of regulation, there is a legal market for prostitute services, but access is restricted by licensing. The sex workers who take part in the legal market normally have to pay taxes and comply with various health requirements. Some individuals, on both the demand and the supply side, will optimally choose not to comply with the regulation so an illegal market will typically coexist with the legal. This means that the government must repress the illegal market. This kind of regime is found in Germany, Austria, Turkey, Bolivia and Mexico, among others. It allows for a wider range of policy instruments: entry restrictions, taxes, enforcement against the illegal market and, in general, all sorts of behavioral restrictions on the individuals in the legal market. Under *laissez-faire*, prostitution is legal and unregulated and the government refrains from intervention. Italy, Denmark, Portugal, Israel, Costa Rica and Canada are examples of this policy approach.

To compare those different policy approaches, we set up an equilibrium model of prostitution where clients and sex workers simultaneously choose whether to demand and supply sex, given the government policies. They both differ along two dimensions: the first is the value of their residual life, which they put at risk when joining the prostitution market. The second is their infection status: some individuals are already infected with a Sexually Transmittable Infection (STI henceforth), others are not. We model two costs of demanding sex services for a customer:

the expected loss in case of STI infection and the social stigma in case he is identified as a customer, which can result, for instance, in a divorce. Similarly, we model three costs of supplying sex in the market: the expected loss in case of STI infection, the social stigma associated with being a sex worker and the expected loss in case of violent behavior, either from the customers or from the pimps.

A distinctive feature of the model is the endogeneity of the health risks associated with prostitution. The probability of infection with an STI when entering the market is the product of the probability of matching with an STI-infected individual and the exogenous transmission probability of the STI. The former quantity, in turn, is equal to the ratio of the number of infected individuals to the total number of individuals in the market (infected plus non-infected). Any policy will change the type of clients and sex workers who decide to enter the market, both in terms of infection status and in terms of lifetime earnings. A different composition of infected and non-infected endogenously changes the risks of the market, further affecting demand and supply, hence types, and so on. In a regulation regime, the policies will affect not only the choice whether to enter the market but also the choice of which market. Suppose, for instance, the government imposes screening on those who want to participate to the the market, in order to keep the STI-infected out. This means that some infected individuals will go into the illegal market, heightening the risk there. But, as becomes less risky the legal market, more individuals may join it and if they are non-infected, risk decreases still. In short, we take a rational-expectations approach, which accounts for some of the behavioral responses to prostitution policies documented in the epidemiological literature.

Despite its simple structure, the model cannot be solved in closed form. Nevertheless, we are able to find an important analytical result, namely that there will always be an illegal market for prostitution in case of a regulation regime. In particular, there is either an equilibrium where both a legal and an illegal market coexist or one where only an illegal market exists.

We proceed by calibrating the model on actual data on the Italian prostitution market, whose legislation forges a *laissez-faire* regime. We then use this benchmark to evaluate the effects of alternative policies. We choose Italy because we have more information and data, which helps us apply more discipline to the model. While we solve the model for one country, we nevertheless believe that most of the insights hold in general. We perform several robustness tests that confirm this intuition.

In assessing the impact of different policies, we focus on two social goals that are associated with distinct cultural approaches: quantity minimization and harm minimization. On the one hand, those who consider the exchange of sex for money to be intrinsically repugnant want to reduce the number of transactions, i.e. the total quantity.[1] But where this moral judgment of prostitution is absent, or milder, the policy objective is naturally the elimination of the side-effects, hence the reduction of the harm associated with the market. We do not take a position in this debate, we simply assess the effects of different policies on the basis of objective economic analysis.

First we compare prohibition with *laissez-faire.* Since prohibition regimes differ in choice of enforcement target, (clients, sex workers or both), we look separately at the different cases. This allows us to compare two opposite approaches to prohibition. One makes it illegal to purchase sex but not to sell it, as in Sweden. The second, of which the US is the most notable example, is characterized by a slack enforcement on clients, so that, *de facto*, the sex workers are the only ones subject to sanctions. We find that the Swedish approach is more effective than the American approach in reducing quantity and harm. However, if the stigma of being a sex worker is high, or if there is a high probability to face violence, there is less scope for a prohibition policy, as the main cost of joining the market is not due to the sanctions.

We then compare *laissez-faire* with regulation. We posit three different policy instruments: a tax on legal prostitution, enforcement against the illegal market, and a licensing system to keep infected sex workers out of the legal market. We show that taxation can be an effective policy if the social goal is to reduce quantity, but they increase harm. Taxes create an incentive to go illegal and prevent some of the less risky individuals from entering the legal market, leaving it smaller but riskier. The higher the stigma or the probability to face violence for the sex workers, the lower is the reduction in total quantity. Stepping up enforcement against the illegal market displaces part of the demand/supply to the legal market, so the illegal quantity decreases and the legal quantity increases as more individuals find it advantageous. Overall the behavior of total quantity is dominated by that of legal quantity and is therefore increasing. A licensing system to keep some infected sex workers out of the legal market reduces the risk and is therefore associated with an increase in quantity. But the risk effect predominates, so overall harm is decreasing.

[1] On the role played by repugnance and its consequences for transactions, see Roth (2007).

Lastly we compare regulation and prohibition, finding that prohibition is more effective in decreasing quantity only if a high expected sanction is feasible. Regulation is better to minimize harm[2]. Consistently with the previous findings, we also find that, the higher the stigma and the probability to face violence, the less advantageous is prohibition.

In their work on male participation in the market for female heterosexual prostitution services in the United Kingdom, Cameron and Collins (2003) find that the perception of a high risk of contracting HIV/AIDS has a strong negative impact on prostitute service usage. Their results show a strong support for the view of "the man who pays for sex as a rational economic actor." In accordance with these findings, in this work we take a rather narrow approach to model participation in the prostitution market. We consider the choice of rational individuals who maximize their utility taking into account a narrow set of costs and benefits, in the Law and Economics tradition that followed the work by G. Becker (1968). We ignore sociological, religious and, more broadly, cultural factors, related, for instance, to the relationship between sexes, to the role of women in society or to the perception of the male sexual identity. We also abstract from other important phenomenons such as human trafficking, slavery and women exploitation.

A methodological note: in this paper we use the words "prostitute" and "sex worker" as synonyms, and we use them to denote the individuals that exchange sexual services for money. We do so since our paper focuses on the market for these services, and we do not consider cultural and sociological aspect of the phenomenon, which might attach more specific and different meanings to the two words.

Related Literature. There is a growing literature on the economics of prostitution but a lack of works that deal directly with policy analysis. The only three exceptions, to our knowledge, are Della Giusta, Di Tommaso and Strom (2009a), Gertler and Shah (2011) and the present paper. The former describes the effects of different policy approaches on the social stigma associated with buying and selling sexual services and its effects on equilibrium prices and quantities. Gertler and Shah (2011) discusses the effects of the enforcement of licensing on prostitution in Ecuador, finding that stricter enforcement against street prostitution is associated with decreased diffusion of STI

[2] Unfortunately we are unable to study a single model that encompasses, as special cases, each regime, to then find the overall optimal policy. The reason is that we do not have suitable data to assess the cost of different policy instruments. For instance, we would need to know the exact cost of increasing the enforcement against the illegal prostitution market or the cost of performing the health checks.

among sex workers, but stricter enforcement in the brothels is associated with higher infection rates.[3] The present paper, instead, considers the effects of enforcement, prevention and taxation within the same framework and explicitly models the individual choice between the legal and the illegal market. We also explicitly take account of the policy-engendered variation of risk.

In a companion paper (Immordino and Russo forthcoming in the Handbook of the Economics of Prostitution), we survey the effects of the different prostitution policies proposed by the above cited economic literature including by our own work.

Our work is also related to Becker et al. (2006), who considers the cost of reducing the consumption of a good by making its production illegal and punishing producers. That work compares the effectiveness of this prohibition approach with a tax on legal production that punishes only the producers who try to avoid the tax by illegal production. The authors show that the tax on a legal good could cause a greater fall in output and a larger increase in price than optimal enforcement against production when the good is illegal. We extend their analysis by explicitly modeling the choice, for clients and sex workers, between legal and illegal markets. We also show, in our quantitative exercise, that legalizing and taxing prostitution could reduce the total quantity by comparison with *laissez-faire* but not prohibition. However, legalization can be more effective than prohibition in reducing harm.

Other recent theoretical and empirical papers on prostitution have investigated the determinants of prices, demand and supply. For Edlund and Korn (2002) prostitution is a low-skilled, labor-intensive, female and well-paid occupation. They argue that an important opportunity cost of prostitution is forgone marriage, and that this cost explains the high wages. Cameron (2002) provides an explanation for the high wages in terms of compensation for social exclusion, risk, boredom and physical effort, distaste and loss of recreational sex pleasure. Rao et al. (2003) and Gertler et al. (2005) use microdata to quantify the risk compensation required by sex workers for not using condoms. They argue that prostitutes accept the extra risk basically because clients are willing to pay them well for it. Moffatt and Peters (2004) identify the factors affecting price in a regression framework for a sub-sector of the prostitution market in the United

[3] The reason is that enforcement in brothels raises the cost of being an unlicensed sex worker in a brothel with respect to complying with the license and with respect to participating in the street sector, where unprotected sex is more common and STI among clients more frequent; empirically, the migration towards the riskier street sector prevails.

Kingdom and estimate the earnings, both aggregate and individual. Cameron and Collins (2003), Della Giusta et al. (2009b) and Della Giusta et al. (2014) focus on the demand side, using UK microdata to identify the characteristics of the male clients that influence their demand for prostitution. Cameron et al. (1999) use principal component and regression analysis on data drawn from British advertisements to identify the characteristics of male escorts that make them more likely to offer particular services.

The rest of the paper is organized as follows. In Section 2 we set up the model and present our main analytical result. Section 3 describes the calibration of the model to the Italian data. Section 4 describes all the policy exercises, and Section 5 presents some extensions and robustness checks. Finally, Section 6 concludes. The proof of the Proposition can be found in Appendix A, the numerical algorithm used to find the equilibrium of the model is described in Appendix B, while the Italian prostitution law in succinctly described in Appendix C.

2 The model

A country is populated by risk-neutral individuals who choose to participate in the prostitution market according to subjective costs and benefits.[4] The benefits are the revenue for the sex worker and a "gratification" for the client. The costs for the sex worker are the stigma associated with being identified as a sex worker, the risk of facing violent behavior and the risk of contracting an infection, all of which entail a loss in terms of the present discounted value of the outside earning opportunity (from now on lifetime earnings).[5] The costs for the client are the price, the stigma of being identified as a client and the risk of infection. We assume heterogeneity of individuals along the two characteristics: value of lifetime earnings and infection status. The greater the value of the lifetime earnings one puts at stake when engaging in the prostitution market, the lower the demand and the supply.[6]

To simplify the analysis, we consider a single standardized transaction, a specific sex "act",

[4] In a previous version of the paper we studied the case of risk averse individuals. The results were qualitatively similar (see our working paper Immordino and Russo, 2012).

[5] In other words what the individual could gain in the labor market excluding the earnings from prostitution.

[6] Although we model prostitution as a voluntary choice, we acknowledge the important distinction between forced prostitution – in particular the prostitution of trafficked women – and voluntary prostitution. On this see Carol Vance (2011).

abstracting from the choice between different acts. The risk of contracting an STI differs for different acts and, for the same act, according to use of a condom. Different risks will determine, in equilibrium, different prices and a different subset of the populations of actual clients and sex workers. However, while our model is representative of a market for a specific prostitution service, the different types of services and the risks can be understood through the comparative statics of our results with respect to some parameters of the model.

Our modeling of the health risk centers on the HIV virus, even though there are five other major STIs: syphilis, herpes (HSV2), chlamydia, gonorrhea and hepatitis B. We choose to abstract from the direct disability caused by the first four of these because it is minor, especially in a developed country like Italy: they are all resolved within a few days and they generally do not lead to major complications. We also abstract from hepatitis B, but not on the basis of disability and complications, which unfortunately are quite substantial, but because of the existence of a safe and effective vaccine.

We start (Section 2.1) considering a country with no prostitution policy, a regime that we label *laissez-faire*. Then we introduce prohibition (Section 2.2) and finally the more complicated regulation regime, where two markets can coexist (Section 2.3). We discuss the numerical solution in the next sections.

2.1 Laissez-faire

Under *laissez-faire* (LF) prostitution is legal and unregulated and the government does not intervene.[7]

The utility for a sex worker who participates in the market (l) under the *laissez-faire* regime is the following:

$$U_{LF}(l;\gamma,u) = \begin{cases} q + u(1-\alpha-s^{sw}) \text{ if } \gamma = 1 \\ (1-\pi^{sw})(q+u(1-s^{sw})) + \pi^{sw}(q+u(1-\alpha-s^{sw})) \text{ if } \gamma = 0 \end{cases} \tag{1}$$

where $\gamma = \{0,1\}$ indicates the infection status (not infected $\gamma = 0$, infected $\gamma = 1$). π^{sw} is the probability of getting the HIV virus, which leads to a loss of a fraction $\alpha < 1$ of lifetime earnings

[7]Typically *laissez-faire* is coupled with a ban on soliciting and procurement, but we abstract from this here.

$u \in [0, \bar{u}]$ and distributed according to the cdf F_u, whose pdf is f_u. The cost s^{sw} includes both the stigma of being a identified as a sex worker and the expected cost of facing a violent behavior by clients and/or pimps. The fraction of infected sex workers is β^{sw} and q is the revenue. Finally, we assume that u and γ are independently distributed.

An individual who chooses not to engage in prostitution (0) has the following utility function:[8]

$$U(0;\gamma,u) = \begin{cases} u(1-\alpha) \text{ if } \gamma = 1 \\ u \text{ if } \gamma = 0. \end{cases} \tag{2}$$

An individual supplies prostitution if $U_{LF}(l;\gamma,u) \geq U(0;\gamma,u)$, i.e. if the expected value of market participation is greater than the outside option. Non-infected individuals will supply prostitution if their lifetime earnings is lower than the following threshold:

$$u \leq \widetilde{u}_{\gamma=0} = \frac{q}{\alpha\pi^{sw} + s^{sw}}. \tag{3}$$

Instead, for infected individuals, the threshold is

$$u \leq \widetilde{u}_{\gamma=1} = \frac{q}{s^{sw}}. \tag{4}$$

The total supply of prostitution therefore is increasing in the revenue q, while it is decreasing in the expected loss in case of infection $\alpha\pi^{sw}$ and in the cost s^{sw} (stigma plus violent behavior):

$$S_{LF} = \beta^{sw} F_u(\widetilde{u}_{\gamma=1}) + (1-\beta^{sw}) F_u(\widetilde{u}_{\gamma=0}). \tag{5}$$

The utility of the client of a sex worker is:

$$V_{LF}(l;\gamma,\omega) = \begin{cases} k + \omega(1-\alpha-s^c) - q \text{ if } \gamma = 1 \\ (1-\pi^c)(k+\omega(1-s^c)-q) + \pi^c(k+\omega(1-\alpha-s^c)-q) \text{ if } \gamma = 0 \end{cases} \tag{6}$$

where k is the gratification from sex, s^c is the stigma of being a client and π^c is the risk of

[8] In this work we abstract from any externality that prostitution could cause to people who are not in the market. Moreover, we are also implicitly assuming that the funding of public policies has a negligible effect on utilities. Not considering that the revenue from taxation could be used to finance other policies creates a bias against regulation.

contracting HIV. β^c is the fraction of infected clients. $\omega \in [0, \bar{\omega}]$ is the client's lifetime earning distributed according to the cdf F_ω, whose pdf is f_ω. Again we assume that ω is distributed independently from γ.

Individuals who do not buy prostitution services simply have utility

$$V(0; \gamma, \omega) = \begin{cases} \omega(1-\alpha) \text{ if } \gamma = 1 \\ \omega \text{ if } \gamma = 0. \end{cases} \tag{7}$$

Non-infected clients will demand sex if $V_{LF}(l; 0, \omega) \geq V(0; 0, \omega)$, that is, if their lifetime earnings are lower than a threshold:

$$\omega \leq \widetilde{\omega}_{\gamma=0} = \frac{k-q}{\alpha\pi^c + s^c}. \tag{8}$$

For infected clients the threshold is

$$\omega \leq \widetilde{\omega}_{\gamma=1} = \frac{k-q}{s^c}. \tag{9}$$

The total demand for prostitution therefore is increasing in the gratification from sex k, while it is decreasing in the revenue q, in the expected loss in case of infection $\alpha\pi^c$ and in the stigma s^c:

$$D_{LF} = \beta^c F_\omega(\widetilde{\omega}_{\gamma=1}) + (1-\beta^c) F_\omega(\widetilde{\omega}_{\gamma=0}). \tag{10}$$

Finally notice that both supply and demand are increasing in the fraction of infected individuals, β^{sw} and β^c.

The key feature of the model is the endogenous determination of the infection risk. The health risk for a sex worker π^{sw} is equal to the probability of being matched with an infected client, which is equal to the ratio of infected to total clients, times the per-act probability of contagion $\tilde{\pi}$. We have:

$$\pi^{sw}_{LF} = \tilde{\pi}\,\frac{\beta^c F_\omega(\widetilde{\omega}_{\gamma=1})}{D_{LF}}. \tag{11}$$

Similarly the health risk for a client is

$$\pi^{c}_{LF} = \tilde{\pi}\,\frac{\beta^{sw} F_u(\widetilde{u}_{\gamma=1})}{S_{LF}}. \tag{12}$$

Finally we define the harm associated with the market equilibrium as the mass of individuals who experience the health shock, that is,

$$H_{LF} = (\pi^{sw} + \pi^{c})Q_{LF}. \tag{13}$$

In other words, harm is the product of multiplying the probabilities of contracting HIV for sex workers and clients by the equilibrium quantity.

Definition. A rational-expectations equilibrium (REE) in *laissez-faire* is a price q_{LF}, a quantity Q_{LF} and a vector of probabilities $(\pi^{sw}_{LF}, \pi^{c}_{LF})$ such that:

(1) demand equals supply, i.e., $D_{LF} = S_{LF}$;

(2) the probabilities of contracting HIV (11) and (12) are consistent with the fraction of infected individuals participating in the market given the exogenous transmission probability $\tilde{\pi}$.

2.2 Prohibition

The prohibition regime (P) consists of a unique illegal market (i) for prostitution, where the only public intervention is the enforcement of sanctions against those who engage in the market.

The utility of a sex worker who engages in the (illegal) market is the following:

$$U_P(i;\gamma,u) = \begin{cases} (1-f)(q^i + u(1-\alpha-s^{sw})) + f(q^i + u(1-\alpha-s^{sw}-F^{sw})) \text{ if } \gamma = 1 \\ (1-f)(q^i + u(1-\alpha\pi^{sw}-s^{sw})) + f((q^i + u(1-\alpha\pi^{sw}-s^{sw}-F^{sw})) \text{ if } \gamma = 0 \end{cases} \tag{14}$$

where q^i is the price of a transaction, f is the probability of being caught and F^{sw} is the sanction for a sex worker modeled as a fraction of the lifetime income.

The utility of a client is instead the following:

$$V_P(i;\gamma,\omega) = \begin{cases} (1-f)(k + \omega(1-\alpha-s^{c}) - q^i)) + f(k + \omega(1-\alpha-s^{c}-F^{c}) - q^i) \text{ if } \gamma = 1 \\ (1-f)(k + \omega(1-s^{c}-F^{c}) - q^i) + f(k + \omega(1-\alpha\pi^{c}-s^{c}-F^{c}) - q^i) \text{ if } \gamma = 0 \end{cases} \tag{15}$$

where F^c is the sanction for a client.

Individuals who do not buy or sell prostitution services have utilities equal to those under *laissez-faire*, i.e., $V(0;\gamma,\omega)$ and $U(0;\gamma,u)$.

Going through the same steps as in *laissez-faire* we find the total supply and demand of prostitution:[9]

$$S_P = \beta^{sw} F_u \left(\frac{q^i}{fF^{sw} + s^{sw}} \right) + (1-\beta^{sw}) F_u \left(\frac{q^i}{\alpha\pi^{sw} + fF^{sw} + s^{sw}} \right) \tag{16}$$

and

$$D_P = \beta^c F_\omega \left(\frac{k - q^i}{fF^c + s^c} \right) + (1-\beta^c) F_\omega \left(\frac{k - q^i}{\alpha\pi^c + fF^c + s^c} \right). \tag{17}$$

Notice that, differently from the *laissez-faire* regime, besides the health risk and the stigma now there is also a legal risk of supplying and demanding prostitution. An increase in the legal risk fF has the effect of decreasing both supply and demand.

Finally harm is simply

$$H_P = (\pi_P^{sw} + \pi_P^c) Q_P. \tag{18}$$

Definition. For any given policy $\wp_P = (F^c, F^{sw}, f)$, a rational-expectations equilibrium (REE) in the prohibition regime is a price q_P^i a quantity Q_P and a vector of probabilities (π_P^{sw}, π_P^c) such that:

(1) demand equals supply, i.e., $D_P = S_P$;

(2) the probabilities of contracting HIV are consistent with the fraction of infected individuals participating in the market given the exogenous transmission probability $\tilde{\pi}$:

$$\pi_P^{sw} = \tilde{\pi} \, \frac{\beta^c F_\omega \left(\frac{k - q^i}{fF^c + s^c} \right)}{D_P} \qquad \text{and} \qquad \pi_P^c = \tilde{\pi} \, \frac{\beta^{sw} F_u \left(\frac{q^i}{fF^{sw} + s^{sw}} \right)}{S_P}. \tag{19}$$

[9]The new thresholds are obtained from $U_P(i;\gamma,u) = U(0;\gamma,u)$ and $V_P(i;\gamma,\omega) = V(0;\gamma,\omega)$ both for infected and non-infected individuals.

2.3 Regulation

Under regulation (R), there exists a legal market (l) for prostitution services, but access is restricted by licenses and permits; the sex workers typically pay taxes and fulfill some health requirements. The very existence of these restrictions implies that an illegal market will exist alongside the legal one. The presence of an illegal market implies that enforcement is necessary to compliance with the regulations. The illegal market consists of two categories of individuals: those who cannot obtain the license because they are HIV-positive and those who do not want to join the legal market even if they could obtain a license. They may be sex workers who want to evade the tax or workers and clients who find the price-risk combination more attractive in the illegal market.

We model the stringency of the licensing system with its effectiveness at keeping infected individuals outside the legal market. Specifically, we consider a fraction $\xi_{sw} < 1$ of infected sex workers that are screened for STI and, thus barred from the legal market.[10] In a system with infrequent tests and license renewals, some individuals may contract an STI between tests and participate in the market. A system with frequent tests and renewals is more effective in excluding infected individuals. Someone who is denied the license can choose only between the illegal market and non-participation.[11] The utility of a sex worker and a client in the legal market are:

$$U_R(l;\gamma,u) = \begin{cases} q^l(1-t) + u(1-\alpha-s^{sw}) \text{ if } \gamma = 1 \\ (1-\pi_l^{sw})(q^l(1-t) + u(1-s^{sw})) + \pi_l^{sw}(q^l(1-t) + u(1-\alpha-s^{sw})) \text{ if } \gamma = 0 \end{cases} \tag{20}$$

[10] We do not explicitly model an out-of-pocket cost for the sex workers associated with the licensing system. We assume that the direct cost of the medical exams is paid by the government and that the forgone revenue associated with compliance is compensated directly by the government (in order to model these costs, we would need data to associate the stringency of the licensing system both with the forgone revenue and with the fraction of infected individuals excluded from the legal market, data we do not have). For the same reason, we do not model the reduction in STI transmission probabilities associated with the exclusion of individuals infected with STI other than HIV. Indeed, several medical studies indicate that the transmission probability of HIV is much higher in the case of infection with other STIs. Thus screening will make the legal sector safer not only because of the smaller probability of matching with an HIV infected but also because of the smaller transmission probability in case of matching.

[11] In a previous version of the paper we studied the possibility of a licensing system also for clients, akin to the regulation of firearms sales or to the regulation of Opium sales described by Van Ours (1995). In this system, the customers, in order to legally purchase prostitution, must possess and periodically renew a licence. The comparative static results were qualitatively similar.

and

$$V_R(l;\gamma,\omega) = \begin{cases} k - q^l + \omega(1-\alpha-s^c) \text{ if } \gamma = 1 \\ (1-\pi_l^c)(k - q^l + \omega(1-s^c)) + \pi_l^c(k - q^l + \omega(1-\alpha-s^c)) \text{ if } \gamma = 0. \end{cases} \tag{21}$$

where t is the tax paid by the sex workers on their earnings. Since, under regulation, two markets can coexist (see the next proposition), we denote the price of a transaction in the legal market by q^l to distinguish it from the illegal market. The utilities of clients and workers in the illegal market are the same as under the prohibition regime, i.e. $V_R(i;\gamma,\omega) = V_P(i;\gamma,\omega)$ and $U_R(i;\gamma,u) = U_P(i;\gamma,u)$. Similarly, the utilities of individuals who do not participate in either market are equal to those under *laissez-faire*, $V(0;\gamma,\omega)$ and $U(0;\gamma,u)$.

A non-infected sex worker will supply prostitution in the legal market if the expected value of participation in the legal market is larger than the expected value of participation in the illegal and larger than the outside option of not supplying. Then, it is immediate to show that those who supply in the legal market have the following outside opportunities:

$$u < u^{l/o}_{\gamma=0} = \frac{q^l(1-t)}{\alpha\pi_l^{sw} + s^{sw}} \qquad \text{and} \qquad u \geq u^{l/i}_{\gamma=0} = \frac{q^i - q^l(1-t)}{\alpha(\pi_i^{sw} - \pi_l^{sw}) + fF^{sw}} \tag{22}$$

where individuals with $u^{l/o}$ and $u^{l/i}$ are indifferent, respectively, between supplying in the legal market and not supplying and between supplying in the legal and illegal market. Similarly, there will be supply in the illegal market if the expected value of participation is larger than the value of participation in the legal market and larger than the outside option, i.e. for

$$u < u^{l/i}_{\gamma=0} \qquad \text{and} \qquad u < u^{i/o}_{\gamma=0} = \frac{q^i}{\alpha\pi_i^{sw} + fF^{sw} + s^{sw}} \tag{23}$$

where the individual $u^{i/o}$ is indifferent between supplying in the illegal market and not supplying. There will be no participation to the prostitution market if $u \geq u^{l/o}_{\gamma=0}$ and $u \geq u^{i/o}_{\gamma=0}$.

Going through the same steps as for the non-infected we find that for infected sex worker who are not screened (a fraction $1-\xi^{sw}$) the corresponding thresholds are:

$$u^{l/o}_{\gamma=1} = \frac{ql(1-t)}{s^{sw}}, \qquad u^{l/i}_{\gamma=1} = \frac{q^i - q^l(1-t)}{fF^{sw}} \qquad \text{and} \qquad u^{i/o}_{\gamma=1} = \frac{q^i}{fF^{sw} + s^{sw}}. \tag{24}$$

Screened sex workers (a fraction ξ^{sw}) either supply in the illegal market if $u < u^{i/0}_{\gamma=1}$ or stay out of the market.

Notice that, with respect to the previous regimes, the supply of prostitution is now negatively affected by the tax rate t. Moreover, for non-infected individuals, the choice between supplying in the legal and illegal market is affected by the endogenous difference in health risks between the two markets, i.e., $(\pi^{sw}_i - \pi^{sw}_l)$.

A non-infected client will pay for sex services in the legal market if the value of doing so is larger than the value of buying those services in the illegal market and larger than the value of not buying them:

$$\omega < \omega^{l/o}_{\gamma=0} = \frac{k - q^l}{\alpha\pi^c_l + s^c} \qquad \text{and} \qquad \omega \geq \omega^{l/i}_{\gamma=0} = \frac{q^l - q^i}{\alpha(\pi^c_i - \pi^c_l) + fF^c} \tag{25}$$

where again $\omega^{l/o}$ and $\omega^{l/i}$ are individuals who are indifferent between, respectively, buying in the legal market and not buying and buying in the legal or illegal market. A client will instead purchase in the illegal market if

$$\omega < \omega^{l/i}_{\gamma=0} \qquad \text{and} \qquad \omega < \omega^{i/o}_{\gamma=0} = \frac{k - q^i}{\alpha\pi^c_i + fF^c + s^c} \tag{26}$$

where $\omega^{i/o}$ is the client indifferent between purchasing in the illegal market or not purchasing. There will be no purchase of sex services from the individuals for whom $\omega \geq \omega^{l/o}_{\gamma=0}$ and $\omega \geq \omega^{i/o}_{\gamma=0}$.

Going through the same steps as for the non-infected we find that for infected clients the thresholds are:

$$\omega^{l/o}_{\gamma=1} = \frac{k - q^l}{s^c}, \qquad \omega^{l/i}_{\gamma=1} = \frac{q^l - q^i}{fF^c} \qquad \text{and} \qquad \omega^{i/o}_{\gamma=1} = \frac{k - q^i}{fF^c + s^c}. \tag{27}$$

Again, for non-infected individuals, the choice between demanding in the legal and illegal market is affected by the endogenous difference in health risk, $(\pi^c_i - \pi^c_l)$.

The next proposition allows us to greatly simplify the study of the market equilibria:

Proposition. There is either an equilibrium where both a legal and an illegal market coexist or one where only an illegal market exists.

proof: See Appendix A.

The previous proposition has shown that there will always be an illegal market for prostitution. In the rest of this section we focus on the equilibrium where an illegal market coexists with a legal one. The case where only an illegal market exist is identical to the case of prohibition. To define demand and supply notice that, as shown in the proof of the previous proposition, when the two markets coexist we have $u^{l/o} \geq u^{i/o} \geq u^{l/i}$ and $\omega^{l/o} \geq \omega^{i/o} \geq \omega^{l/i}$. Then, individuals with the highest outside opportunities $(1 - F_u(u^{l/o}))$ will avoid prostitution, those with intermediate opportunities will supply in the legal market $(F_u(u^{l/o}) - F_u(u^{l/i}))$, and those with the worst opportunities will supply in the illegal market $(F_u(u^{l/i}))$. Since the same is true for the demand we are now ready to define the demand of prostitution in the legal and illegal market as:

$$D_R^l = \beta^c(F_\omega(\omega_{\gamma=1}^{l/o}) - F_\omega(\omega_{\gamma=1}^{l/i})) + (1 - \beta^c)(F_\omega(\omega_{\gamma=0}^{l/o}) - F_\omega(\omega_{\gamma=0}^{l/i}) \tag{28}$$

and

$$D_R^i = \beta^c F_\omega(\omega_{\gamma=1}^{l/i}) + (1 - \beta^c)F_\omega(\omega_{\gamma=0}^{l/i}). \tag{29}$$

Similarly, we define the supply of prostitution services in legal and illegal markets as:

$$S_R^l = \beta^{sw}\,(1 - \xi^{sw})\,(F_u(u_{\gamma=1}^{l/o}) - F_u(u_{\gamma=1}^{l/i})) + (1 - \beta^{sw})(F_u(u_{\gamma=0}^{l/o}) - F_u(u_{\gamma=0}^{l/i})), \tag{30}$$

and

$$S_R^i = \beta^{sw}\xi^{sw}F_u(u_{\gamma=1}^{i/o}) + \beta^{sw}(1 - \xi^{sw})F_u(u_{\gamma=1}^{l/i}) + (1 - \beta^{sw})F_u(u_{\gamma=0}^{l/i}). \tag{31}$$

Notice that unlike the *laissez-faire* and prohibition regimes, the licensing system allows only a fraction of infected individuals $\beta^{sw}\,(1 - \xi^{sw})$ to enter the legal market. This increases supply in the illegal market by the fraction of infected individuals who are barred $\beta^{sw}\xi^{sw}$ and who prefer the illegal market to not participating, i.e. those with $u \leq u^{i/o}$ (those with $u^{l/o} \geq u > u^{i/o}$ facing the choice between not participating and joining the illegal market prefer to stay out). The total harm associated with this regime is the total mass of individuals who experience the health shock in either the legal or the illegal market, i.e.

$$H_R^l = (\pi_l^{sw} + \pi_l^c)Q_R^l \qquad H_R^i = (\pi_i^{sw} + \pi_i^c)Q_R^i. \tag{32}$$

Definition. For any given policy $\wp_R = (F^c, F^{sw}, f, t, \xi^{sw})$, a rational-expectations equilibrium (REE) in the regulation regime is a pair of prices (q_R^l, q_R^i), a pair of quantities (Q_R^l, Q_R^i) and a vector of probabilities $(\pi_l^{sw}, \pi_i^{sw}, \pi_l^c, \pi_i^c)$ such that:

(1) demand equals supply both in the legal and in the illegal market, i.e., $D_R^l = S_R^l$ and $D_R^i = S_R^i$;

(2) the probabilities of contracting HIV are consistent with the fraction of infected individuals participating in the markets given the exogenous transmission probability $\tilde{\pi}$:

$$\begin{aligned}
\pi_l^{sw} &= \tilde{\pi}\,\frac{\beta^c(F_\omega(\omega_{\gamma=1}^{l/o}) - F_\omega(\omega_{\gamma=1}^{l/i}))}{D_R^l}, \\
\pi_l^c &= \tilde{\pi}\,\frac{\beta^{sw}\,(1-\xi^{sw})\,(F_u(u_{\gamma=1}^{l/o}) - F_u(u_{\gamma=1}^{l/i}))}{S_R^l}, \\
\pi_i^{sw} &= \tilde{\pi}\,\frac{\beta^c F_\omega(\omega_{\gamma=1}^{l/i})}{D_R^i}, \\
\pi_i^c &= \tilde{\pi}\,\frac{\beta^{sw}(1-\xi^{sw})F_u(u_{\gamma=1}^{l/i}) + \beta^{sw}\xi_{sw}F_u(u_{\gamma=1}^{i/o})}{S_R^i}.
\end{aligned} \tag{33}$$

3 The Italian benchmark: parameters and calibration

In this section we resort to a numerical algorithm to study the effect of different policies on the prostitution market and to compare different legal regimes.

In short, we code a double grid search procedure over the vector of probabilities and over the pair of legal and illegal prices. We stop when we find prices that clear both markets and such that the probabilities are consistent with the equilibrium quantities given the epidemiological transmission probability of HIV. The details are quite tedious, since we have to take account of the kinks in both the demand and the supply schedules (see Appendix B for more details).

The first step in the numerical analysis is calibrating the model to actual data on prostitution in Italy, which we use as a benchmark to evaluate the effects of alternative policies. Since prostitution is not illegal in Italy, and since it is also unregulated (see Appendix C for more details), we take *laissez-faire* as our benchmark regime and calibrate the model accordingly. The benchmark parametrization refers to an act of sexual intercourse with a condom (see Section 5 for a brief discussion of the no condom case). There are two main reasons for this choice. First, this is the most common transaction in the prostitution market; and second the economic and epidemiological literature has focused significantly on the role of condoms in determining the probability of transmission of STI and prices in sex markets (see for instance Rao et al. 2003 and Gertler et al. 2005).

We assume that the distribution of lifetime earnings for the sex workers u follows a triangular distribution in $[0, \bar{u}]$ with peak at 0. The pdf of this distributions is the following:

$$f_u(y) = \frac{2(\bar{u} - y)}{\bar{u}^2} \qquad 0 \leq y \leq \bar{u}. \tag{34}$$

Basically the probability mass is linearly decreasing at rate $2/(\bar{u}^2)$ over the entire support, from $2/\bar{u}$ (associated with 0) to 0 (associated with $\bar{u}$). Our assumptions have two main advantages: first, we capture the skewed distribution of lifetime earnings in the population, consistent with the evidence for Italy provided by the Italian National Institute of Statistics (ISTAT); second, the choice of a linearly decreasing probability and a bounded support for u results in a distribution that is fully described by a single parameter, which facilitates the calibration exercise.

Similarly, the distribution of lifetime earnings for clients ω follows a triangular distribution in the interval $[0, \bar{\omega}]$ with peak at 0. With this assumption we capture the highly skewed nature of the actual distribution of income in the population in a way which is, again, tractable and parsimonious. The pdf of ω is:

$$f_\omega(y) = \frac{2(\bar{\omega} - y)}{\bar{\omega}^2} \qquad 0 \leq y \leq \bar{\omega}. \tag{35}$$

From the information reported by the "Gruppo Abele", a non-profit organization that helps street prostitutes, which refers to a series of surveys and field studies conducted from 2000 to 2008, we learn that Italian sex workers are mostly female immigrants whose earning potential is much less than that of Italian males, who make up the bulk of their clients.[12] Thus in our simulation we use Italian males data for the clients and female immigrants data for the sex workers.

[12]The data are available at: http://www.gruppoabele.org/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/255

We set the average income of Italian males $E[\omega]$ according to the information provided by ISTAT. The average income of an Italian family in 2003 was 26521 euros if the average is taken over all families. If the main income earner is the male, however, the average increases to 29350 euros. We roughly split in half this last figure to have the average income of an individual that we set to 14500 euros. We denote this average income as y. According to ISTAT data, the ratio of the average income of immigrants women to the average income of Italian men is 0.52.[13] Consistently, we assume $E[u] = 0.52 * E[\omega]$, so that $\bar{u} = 0.52\,\bar{\omega}$.

We use data from the UNAIDS for the percentage of HIV-infected individuals in the populations of clients (Italian males): the percentage of adults with the HIV virus in Italy is 0.3%. Using the absolute numbers of Italian females with HIV (reported by UNAIDS) and some demographic information, we computed the percentage of infected male adults as 0.4%. Thus $\beta^c = 0.004$.

For the percentage of HIV-infected individuals in the population of sex workers we consider the average reported by the "Istituto Superiore di Sanitá" (2004) that indicates an average HIV prevalence among immigrants sex workers between 1.8% and 2.5%, computed averaging over different studies (D'Anutuono et al. 1999, Smacchia et al. 1998, Beltrame et al. 2001, Giuliani et al. 2004). We found two more studies on the subject, D'Antuono et al. 2001, which reports a 1.6% incidence, and Gruppo Abele, which reports a 5% incidence among African born sex workers and a negligible incidence among Eastern European born which averaging, delivers a 2.5% incidence. Thus we end up with a final range of values between 1.6% and 2.5%. We choose a 2% incidence as a benchmark, but we consider the robustness of the results to a higher incidence.

For the transmission probabilities we draw on the medical literature. Gray et al. (2001) and Waver et al. (2005) report a probability of between 0.01% and 0.2% depending on HIV subtype, based on epidemiological studies conducted using different methodologies and on different populations. We posit a benchmark value of 0.1%. However, these values refer to transmission probability without condom. Weller and Davis-Beaty (2001), in their survey, indicate that systematic condom use reduces the risk of HIV infection by 80%, with studies indicating values as low as 60% and as high as 96%. Thus we set our benchmark (per-act) transmission probability with condom at $\tilde{\pi} = 0.2 * 0.001 = 0.0002$.

The next step entails computing the loss α associated with HIV infection. We compute $1 - \alpha$

[13] "Redditi delle Famiglie con Stranieri ", freely available at http://www.istat.it/it/archivio/48675.

as the ratio between the present discounted value of life in case of HIV infection and in case of no infection. We first compute the value of life without HIV infection. According to surveys by Gruppo Abele, clients' average age is 40.[14] ISTAT put life expectancy at birth of about 80 years, which means that the average client expects to live 40 more years. If r is the interest rate and y the yearly income, then the lifetime residual income without infection is $y^0 = \sum_{t=0}^{40} y/(1+r)^t$. For instance, considering an interest rate of 3%, an average residual life of 40 years and 14,500 euros average income we obtain a permanent income of 341,000 euros.

However, the value of life is greater than lifetime earnings. The classic reference on this issue is Viscusi (1993) who in a review of 27 studies reports a value of life between 1.4 and 28 times higher than the annual income. We denote by λ the multiplier that transforms lifetime earnings in to value of life, choosing the average value of 15 for the benchmark model simulation. Thus the "value of life" is $Y^0 = \lambda y^0 = 15 * 341(k)$.

Second, we need to evaluate the losses due to the infection. We follow Gertler et al.(2005), who assign a disability weight of 0.135 to the HIV infection before the development of AIDS, when the symptoms are mild, and of 0.505 to the years after the outbreak of the disease, when the quality of life declines drastically. King et al. (2003) report a median duration of life after infection (from development of HIV to death) as high as 15 years (180 months) when treated with the latest-generation Highly-Active-Anti-Retroviral (HAART) drugs. According to Zwahlen and Egger (2006), the duration of life for individuals with AIDS (from development of acute infection to death) is between 10 and 22 months in developed countries depending on the HIV virus subtype, a figure that includes the treatment with HAART medications. We choose the average value of 16 months. These data, combined with those in King et al. (2003), imply that the average time between HIV infection and the onset of AIDS is 164 months. We are now ready to calculate the value of life for an HIV-infected individual:

$$Y^{HIV} = \lambda y_m \left[\sum_{t=0}^{164} \frac{(1-0.135)}{(1+r_m)^t} + \sum_{t=165}^{180} \frac{(1-0.505)}{(1+r_m)^t} \right], \tag{36}$$

where y_m and r_m are the monthly equivalent of the yearly income y and of the interest rate r.

[14] This is similar to the average age of the male population as reported by ISTAT, which is 43, including those younger than 14 or older than 65, whom we do not consider as potential clients. But since they account for, respectively, 14% and 20% of the overall population, it is likely that the true average age of potential clients is indeed close to 40.

According to our definition the value of life for an infected individual Y^{HIV} is a fraction $(1-\alpha)$ of the value of life of a healthy individual Y^0. The loss α can then be easily computed from $1 - Y^{HIV}/Y^0$ which yields $\alpha = 0.57$. The interesting feature of this computation is that it does not depend either on λ or on the income y_m, since both cancel out in the computation of the ratio. This makes the parametrization more robust.

While our evaluation of the losses uses data from reliable medical studies, the estimates may nevertheless appear high. Indeed, new and more powerful therapies are constantly being developed, lengthening residual life and mitigating the disability.[15] Thus the benchmark parametrization may well overestimate the loss due to HIV infection. Given the lack of more recent data on market prices, we are unable to calibrate the model for recent years, were, given the newly available therapies, the risk is much lower. Therefore, we take an alternative approach and we alter the final value of α, i.e. the fraction of lifetime income lost in case of infection. In Section 5, we consider a loss that is half the benchmark value, to test the model robustness. This could be the result of a longer period before the onset of acute AIDS, of a longer lifespan with or without acute infection, of better management of the symptoms either before or after the acute infection, or of a combination of these factors.

The most problematic parameters are the costs s^c and s^{sw} and the gratification from sex k. The cost s^c is the stigma for the customer, which is the product of the probability of being identified as a customer and the loss of reputation that follows. The cost s^{sw} for the sex workers includes both the stigma, which is again the product of the probability of being identified and the loss, but also the expected cost of being subjected to violent behavior, either by clients, pimps or both. Since there is no obvious way to quantify these costs, in the next section, we discuss how the results change for different values of s^c and s^{sw}. In particular, we present our results for three different scenarios: low costs for both customers and sex workers, high costs for both and, perhaps more realistically, high costs for sex workers and low costs for customers. For illustrative purposes, we choose two specific values of those costs that make them less important than the health risk in case of the low value and more important in case of the high value. This allows us to analyze the effect of the policy on the model equilibrium when the health risk is the most important concern but

[15] For instance, Lakdawalla et al. (2006) argue that HIV is now treated much more effectively. In addition, the study by Hogg et al. (2008) indicates a life expectancy of Anti-Retroviral treated HIV infected individuals equal to two thirds of the uninfected.

also when the stigma or the probability of facing violence is the most important concern, either for the sex workers or for both the customer and the sex worker. To check for robustness, we also considered the less realistic case of high costs for the customers and low costs for the sex workers, which delivered results that are closer to the model with low costs for both.

As for the gratification k, since there is no evident real-world counterpart for it, we decided to calibrate it so that the equilibrium price delivered by the model is equal to what we observe in the data. For the average price of the sex transaction we use a 2003 study by EURISPES (Istituto di Studi Politici Economici e Sociali), a private research institute specialized in opinion polls and surveys.[16] The average price for street prostitution is 15 euros for Africans and 25 euros for Eastern European sex workers; for sex in apartments, 35 and 45 euros respectively. We use a reference price of 28 euros, the rounded average of the foregoing taking into account the relative proportions of Africans and Eastern Europeans and of street and apartment-based transactions.[17] Since we were unable to find more recent price data, we set all the model parameters using information dated circa 2003, even if, in some cases, we have more recent information.

4 Results and policy analysis

In this section we evaluate the effects of alternative policies on the equilibrium quantity of prostitution and on the related harm. We limit ourselves to the comparative statics of alternative policies and we compare different regimes pairwise: first we simulate the prohibition regime, comparing two different approaches to prohibition, then compare regulation and *laissez-faire,* and conclude by comparing regulation and prohibition.

4.1 Prohibition

Here we compare prohibition with *laissez-faire* and at the same time compare several approaches to prohibition: sanctioning clients only, sanctioning sex workers only, and sanctioning both. The

[16] "Aperto per ferie - Indagine sul mercato del sesso a pagamento" August 2003. Available at: http://www.eurispes.it/

[17] The distinction between street-level prostitution and closed places has been addressed in the literature. It is also closely related to questions of social distance between the public, sex workers, and potential clients. See for instance Cunningham and Kendall (2011) or Kotsadam and Jakobson (2011).

first approach is that taken, among others, in Sweden, where it is illegal to purchase sexual services but not to sell them.[18] An instance of the second approach is the US, where prostitutes bear most of the sanctions.[19]

We start from the case of low costs s^c and s^{sw}, summarized in Figure 1. All the quantities are expressed in units of the corresponding quantities under *laissez-faire*. In all cases we set the enforcement probability at 2%. This choice is just for illustrative purposes (but see below for more details).

Stricter enforcement decreases the equilibrium quantity since it raises the cost of participation. Infected individuals are less sensitive to the enforcement risk, having a lower lifetime value, and so are less responsive than the non-infected. Since the non-infected leave the market more rapidly, we have greater equilibrium risk and a higher price. Overall, prohibition creates a smaller and riskier prostitution market. Figure 1 also shows that enforcement targeted at clients is the most effective since clients have more to loose because of their larger set of outside options (recall from the previous section that $\bar{u} = 0.52\,\bar{\omega}$).

If s^c and s^{sw} are both high, the effect of the policy is qualitatively similar, but quantitatively very small, almost negligible. If the stigma, or the probability of facing violence, are the main component in the decision of joining the market, sanctions and enforcement do not make much of a difference: the total fraction of individuals that participates to the market is already small because the costs of entering the market are already high. In other words, there is also less scope for a prohibition policy.

In the more realistic case of high costs for the sex workers and low costs for customers (Figure 2), the results are again qualitatively similar but quantitatively smaller. Compared to the benchmark case, where 20 days in jail drive a 25% reduction in the total quantity, now the same sanction delivers a modest 8% reduction.

In case of different expected sanctions (fF), the effects described by Figure 1 are qualitatively similar but quantitatively different. For the same value of the sanctions, the higher the enforcement level the faster the demand decrease and the risk increase and, therefore, the more effective is the

[18]The Act Prohibiting the Purchase of Sexual Services, Brottsbalken [BrB] [Criminal Code] 6:11 (Swed.)

[19]For example Heiges (2009) reports that "[...] in the Chicago district with the highest concentration of prostitution-related arrests, persons in prostitution accounted for 89% of arrests in 2002, while purchasers represented only 10% ".

prohibition regime at reducing quantity. For instance, if enforcement were 4% instead of 2%, the total quantity decrease for a symmetric fine would be, on average, 15% higher.

Overall we conclude that prohibition is better than *laissez-faire* for quantity reduction but less effective in reducing harm. Moreover, a prohibition regime that makes it illegal to buy sex but not to sell it is more effective than the opposite regime at reducing quantity. The higher the stigma and the higher the probability that the sex workers will face violence, the lower the gains that a prohibition regime can achieve.

4.2 Regulation: Taxing a legal market

Figure 3 summarizes the comparative statics of the equilibrium quantities for different tax rates under regulation. We start again with the case of low costs s^c and s^{sw}. To make the choice between the legal and the illegal market meaningful, we need to specify a non-zero enforcement probability and a non-zero fine. The pictures are drawn assuming a 2% enforcement probability and a sanction equal to half a week in jail. As in the previous paragraph, this choice is made only for illustrative purposes. Prevention is set to zero. All the quantities are expressed in units of the corresponding quantities under *laissez-faire*.

Under *laissez-faire*, prostitution is supplied in the legal market only. Introducing taxes for the sex workers raises the cost of supplying in the legal market. The effect is the displacement of part of the supply and demand to the illegal market. Moreover, the lower the value of the expected sanction, the faster the displacement towards the illegal sector. The non-infected individuals with the greatest outside opportunity drop out of the market altogether. Some of the infected individuals with high outside opportunity also drop out of the market like the non infected, but they are more sensitive to tax and price increase than the non-infected and, therefore, they leave the legal market more rapidly ($u^{l/0}_{\gamma=0}$ is less responsive than $u^{l/0}_{\gamma=1}$ to tax and price increases and the pdf of u has a constant derivative over the support. Similarly for $\omega^{l/0}_{\gamma=0}$ and $\omega^{l/0}_{\gamma=1}$). This decreases the health risk in the legal market. However the legal quantity is going down, which means that the denominator of the endogenous probabilities decreases, which increases the equilibrium health risk. This last effect prevails and, overall, the health risk in the legal market increases for both customers and sex workers. Some of the infected and non-infected individuals switch to the illegal market, and the infected switch at a faster rate, which increases the health risk in the illegal market. Since the illegal quantity increases, the denominator of the endogenous probability goes up, which decreases the health risk. Overall the first effect prevails and the illegal risk is increasing in taxes. We find that the legal market is smaller and riskier, while the illegal is larger and riskier. We also found a Laffer curve for the Government revenue, which is first increasing and then decreasing in the tax rate (graph not reported).

In case of high costs s^c and s^{sw} the displacement towards the illegal market induced by taxes is faster, and the legal market disappears completely even for modest tax rates. When the fixed cost of joining the market is high, imposing an additional cost drives a faster exit from the market both for infected and non infected individuals. The solution with an illegal market only is characterized by higher health risks and by a slightly lower total quantity than in the *laissez-faire* scenario with no taxes. In the more realistic case of high costs for the sex workers only (Figure 4), the displacement is again faster than the benchmark, with a modest 6% tax rate for which the illegal market becomes bigger than the legal and the legal market that disappears around a 25% tax rate, as opposed to an almost double value in the benchmark model. Another difference is that the net effect of total quantity is much smaller in this scenario, with the illegal quantity increase that compensates the legal market decrease and, for high tax rates, more than compensates. The health risks are also increasing in both markets, although the pattern is non linear due to the effects at the numerator and at the denominator of the endogenous probabilities. Finally notice that, because of the high costs, only sex workers with the least outside opportunities are left in the market so that supply is now more rigid and prices are decreasing.

We conclude that taxation is an effective policy to decrease the quantity of prostitution but not to reduce harm. Taxes create an incentive to go illegal and keep some of the less risky individuals out of the market, leaving it smaller but riskier. The more important the costs s^c and s^{sw}, the faster the increase in the illegal quantity and, therefore, the smaller the effect of taxes on total quantity. Therefore taxes are not a sensible policy in case the stigma and the probability of facing violence for the sex workers is very high, as they increase harm without reducing quantity.

4.3 Regulation: Enforcement

Figure 5 summarizes the comparative static results for different enforcement probabilities in case of low costs s^c and s^{sw}. For illustrative purposes, we assume a tax rate of 30%, a half-week equivalent sanction and no preventive policies. A positive tax rate is needed for the choice between the legal and the illegal market to be meaningful; and the 30% rate is realistic for Italy. All the graphs start at an enforcement rate of 0.5% since below that level there is only an illegal market and the point is to show the comparative statics when the two markets coexist.

Stepping up enforcement against the illegal market displaces part of the demand/supply to the legal market, so the illegal quantity decreases and the legal quantity increases as more individuals find it advantageous.[20] Overall the behavior of total quantity is dominated by that of legal quantity and is therefore increasing. Also the quantity effect prevails for harm, which is increasing in the legal sector and decreasing in the illegal (graph not reported). Government revenue is increasing since, for a constant tax rate, legal quantity is increasing (graph not reported). This means that the policy can be self-financing: part of the extra resources needed for the government to achieve a higher enforcement probability can be procured out of the extra revenue generated. We cannot make more precise statements since we do not know the exact increase in expenditure needed to increase the enforcement probability by one percentage point.

In case of high costs s^c and s^{sw} there is a a coexistence of the two markets only for small values of the tax rate (the higher s^c and s^{sw} the smaller must be the tax rate). In this case, the effects of enforcement are very similar. The only difference is a smaller effect on total quantity. If instead only an illegal market prevails (for larger tax rates), the comparative statics is as in Section 4.1. The case of high costs for sex workers only (Figure 6) delivers similar results, with again a small effect on total quantity. Both results are due to the high fixed costs, which reduce the scope of an enforcement policy.

4.4 Regulation: The licensing system

We now consider the effects of one specific preventive policy, namely a licensing system for sex workers subject to passing periodic health checks. The purpose of the policy is to bar infected

[20] For very high enforcement probabilities there is no supply in the illegal market. Further increases in enforcement beyond this level have no effect on the equilibrium.

individuals from the market and thus reduce the risk for the participants.

As is explained in Section 2.3, we model the licensing system as a reduction in the fraction of infected individuals who have the choice of participating in the legal market. If an infected individual is screened, he cannot enter the legal market and, so can only turn to the illegal market or abstain. Stricter licensing systems, requiring more frequent screenings, are more effective in reducing the number of infected persons in the market. Figure 7 summarizes the results in case of low costs s^c and s^{sw}. For illustrative purposes, we assume a 30% tax rate, 2% enforcement probability and a fine equivalent to half a week in jail.

More severe screenings of sex workers imply a larger fraction of infected individuals in the illegal market and a smaller fraction in the legal market. The health risk in the legal market is decreasing, which increases the demand and the price. In turn, higher price and lower health risk induce a higher supply in the legal market from the non-infected, which fosters the quantity increase and the health risk decrease. In the illegal market there is an increase in both the supply and the demand from the infected who are barred from the legal market. The health risk is therefore higher, which fosters the quantity decrease. Overall total quantity is increasing, which means that the increase in legal more than offsets the decrease in illegal quantity. The legal market is less risky, while the illegal is riskier. The overall harm is decreasing (graph not reported). Government revenue is increasing since, for the same tax level, there is a bigger legal market (graph not reported).

The higher the expected sanction, the higher the increase in legal quantity in response to stricter licensing systems. In case of high costs s^c and s^{sw} the effects are qualitatively similar, but quantitatively much smaller. In particular, the total quantity increase is very small and so are the corresponding health risk effects. In case of a high cost for sex workers only (Figure 8), the effects are in between, with a non negligible but convex effect on total quantity, and which determines an increase in total quantity only for very effective prevention schemes. The health risk in the illegal market grows less rapidly in this scenario since the relocation of infected individuals towards the illegal market is slower.

We conclude that a licensing system is an effective policy if the purpose is harm reduction in the legal sector. The drawbacks of the licensing system are the creation of an illegal market, which is riskier the stricter the licensing system, and that of an increase in total quantity. Thus it is not an effective policy if the social goal is to minimize quantity.

4.5 Regulation Versus Prohibition

We conclude by comparing regulation and prohibition. We proceed in the spirit of Becker et al. (2006), since we compare the effectiveness of prohibition with that of a tax on legal production that punishes only producers who try to dodge the tax through illegal production. They show that taxing a legal good (regulation) could reduce output and raise prices more than enforcement against illegal production (prohibition).

In Figure 9, to compare regimes, we consider the effect of preventive policies (exactly as in the previous section but this time) normalizing everything in units of the corresponding quantities under a prohibition regime, with enforcement equal to 2% (upper panels) and 6% (lower panels). The sanction is equal to half a week in jail (upper panel) and two weeks in jail (lower panel). In both cases, we set the tax rate to 30% and the costs s^c ad s^{sw} are small. Our quantitative exercise shows that prohibition is better if the social goal is to reduce quantity only if it is possible to have a very high expected sanction (lower panel). Regulation is best if the goal is harm reduction and the more so the higher the expected sanction.

In addition, the higher the importance of stigma and violence (see Figure 10 for the case of high costs for sex workers and low costs for customers), the less effective is the prohibition regime at decreasing quantity, mostly because quantity is already very low. Therefore the higher stigma and violence, the higher the sanctions and enforcement needed for the prohibition regime to be effective in reducing quantity. In all cases, regulation is better at decreasing harm.

5 Extensions and more robustness

5.1 Endogenous stigma

The stigma for both clients and sex workers is likely to be endogenous, both to the policy and to the equilibrium quantity (see Della giusta et al. 2009b). For instance, in a prohibition regime, the stigma is likely to be higher than in a *laissez-faire* or regulation regime, where prostitution is considered an occupation like many others. In addition, it is likely that, the higher the fraction of individuals that participates to the market, the lower the stigma. In this section we discuss how our results might change if we took into account these two additional mechanisms. In both cases, we consider the endogeneity of the cost s^c, which is entirely due to stigma, and of the component of s^{sw} that is due to stigma.

If the stigma is endogenous with respect to the market outcome, the effects on quantity of any policy are magnified. In prohibition, for instance, a higher sanction decreases quantity, which in turns increases the stigma, further reducing quantity, and so on. In a regulation regime, an increase in taxes decreases total quantity, which increases the stigma, further reducing quantity and so on. In case of a stricter licensing system, the legal quantity increases because the legal risk decreases, reducing stigma and further increasing quantity.

In case of endogeneity to the policy, the comparative statics is not affected, since it is studied under the same policy regime. What changes is the comparison across regimes. If the stigma is higher under prohibition, the quantity is likely to be even lower under prohibition than under *laissez-faire* and regulation. Therefore prohibition might be a better regime for quantity reduction even for moderately high expected sanctions. The risk, conversely, is likely to be higher, since infected are less sensitive to the stigma than non-infected (s^{sw} and F^{sw} affect the thresholds in the same fashion, and so do s^c and F^c) and, therefore, leave the market less rapidly. Therefore, prohibition is still the best policy to reduce quantity but not the best to reduce harm, and the more so the more the stigma is influenced by the policy regime and by the market outcome.

5.2 Sex transactions without condom

Different types of prostitution services are characterized by different client utilities k and by different per-act transmission probabilities $\tilde{\pi}$. In the previous sections, we considered the comparative statics for the case of sex act with condom. In this section we briefly discuss how the comparative static results change if we focus attention on a sex act without condom. Arguably, both the per-act transmission probability $\tilde{\pi}$ and the client's utility k are higher in this market of sex without condom. To analyze the comparative statics, we then recalibrate the model under the different per act transmission probability, which is now equal to 0.001 according to the evidence (see Section 3 for details). Using data from Gruppo Abele, we have an average price of 150 euros for a transaction without condom. We then calibrate k so that the equilibrium price in the model is equal to the observed value of 150 euros. Overall, the comparative statics are qualitatively similar.

The main difference is that, with a much higher transmission probability, the equilibrium effects on risk due to the different shares of infected and non-infected in the total quantity matter much less. In particular, this implies that the licensing system has only a very small impact on equilibrium quantities, and the legal quantity can also be decreasing for stricter prevention policies.

5.3 More robustness

In this section we consider the robustness of the policy analysis with respect to the fraction of infected customers and sex workers in the populations (β^c and β^{sw}) and with respect to the loss in case of HIV infection (α). In all exercises we calibrated the parameter k so that the model delivered, as the equilibrium price, the empirically observed average price of a transaction with condom equal to 28 euros.

With respect to β^c and β^{sw} we consider the robustness to higher values. In particular, we did the comparative statics for $\widetilde{\beta}_c = 2 * \beta^c$ and $\widetilde{\beta}_{sw} = 2 * \beta^{sw}$, for both benchmark model specifications with (symmetric) high and low s. We found very similar results, both qualitatively and quantitatively. With respect to the loss due to HIV infection α, since newer and more effective cures are continuously developed, we considered the robustness to lower values. As explained in Section 3, a lower value of α can be the result of a longer expected lifetime span in case of HIV infection, of a better management of the symptoms, or of a combination of the two. To perform a rather extreme test, we considered the robustness of our comparative static to $\widetilde{\alpha} = \alpha/2$, i.e. we halved the loss in case of HIV infection. We find that lower expected loss is associated with higher equilibrium quantities and, since more non-infected individuals are active in the market, the equilibrium risks are both smaller and less sensitive to policy. However, the comparative statics is very similar both qualitatively and quantitatively.

6 Conclusion

Our goal is to inform the policy debate on prostitution. We have shown that a prohibition regime is optimal if the government objective is to reduce the quantity of prostitution exchanged in the market only for high expected sanctions, while a regulation regime is optimal if the goal is harm reduction. However, if a very repressive prohibition regime is considered as undesirable, for instance because it can impose a great burden on the legal system, then a regulation regime can be optimal even for quantity reduction. Either way, we showed that the *laissez-faire* regime is not a sensible choice. This is as far as we can go without taking a stand about which social goal should be pursued.

The scope of our analysis is nevertheless limited. The main reason is that we took a rather narrow and partial perspective on prostitution. Our model included only a small set of determinants of its demand and supply, namely the market price, the risk of infection with an STI, the stigma and the probability, for the sex workers, to face violent behavior from customers and or pimps. We did not consider sociological, religious and cultural factors that are most likely important factors behind the prostitution market. We also abstracted from issues related to human trafficking and slavery, which are often associated to prostitution. Despite these limitations, we believe that our analysis can help designing better policies towards prostitution, especially towards the particular sub-markets of the sex industry were the factors that we use in our model are more relevant. We cannot help observing though, that the welfare of a very large number of people is at stake.

Appendix

A Proof of Proposition

To derive the equilibria of the model under regulation we first notice that, both for $\gamma = 0$ and for $\gamma = 1$, there are only three possible orderings for the thresholds $u^{l/o}$, $u^{l/i}$ and $u^{i/o}$. Indeed it is easy to show that $u^{l/o} \geq u^{i/o}$ if and only if $u^{i/o} \geq u^{l/i}$, so that, either $u^{l/o} \geq u^{i/o} \geq u^{l/i} \geq 0$ (ordering 1) or $u^{l/i} \geq u^{i/o} \geq u^{l/o} \geq 0$ (ordering 2). Moreover, since $u^{l/i}$ can be negative, we also have the additional ordering $u^{l/o} \geq u^{i/o} \geq 0 > u^{l/i}$ (ordering 3). Applying the same logic we have only three possible ordering for the customers with $\omega^{l/o} \geq \omega^{i/o} \geq \omega^{l/i} \geq 0$ (ordering 4), $\omega^{l/i} \geq \omega^{i/o} \geq \omega^{l/o} \geq 0$ (ordering 5) or $\omega^{l/o} \geq \omega^{i/o} \geq 0 > \omega^{l/i}$ (ordering 6). This makes 9 possible cases of which except $(1, 4)$ and $(2, 5)$ all the others lead to a contradiction.

1) If $(3, 4)$ prevails there would be only legal supply but demand for both markets. This would lead to $q^l < q^i$. Then, $u^{l/i}$ would be positive contradicting 3.

2) If $(3, 5)$ prevails there would be only legal supply and illegal demand. This once again would lead to $q^l < q^i$ and $u^{l/i}$ positive contradicting 3.

3) For $(3, 6)$ to prevail we need both $u^{l/i}$ and $\omega^{l/i}$ negative but this implies $q^l(1-t) > q^i$ and $q^l < q^i$ which is clearly impossible.

4) If $(1, 5)$ prevails there would be supply for both markets but only illegal demand. This would push the legal price to zero contradicting 1 since we would have $u^{i/o} > u^{l/o} = 0$.

5) If $(1, 6)$ prevails we would have supply in both markets but only legal demand. This would lead to $q^l > q^i = 0$. Then, either $u^{l/i} < 0$ (this is the only possibility for $\gamma = 1$) contradicting 1 or $u^{l/i} > 0$ (this is only possible for $\gamma = 0$) but then, since $u^{i/o} = 0$, $u^{l/i}$ would be larger than $u^{i/o}$ contradicting 1 once again.

6) If $(2, 4)$ prevails we would have only illegal supply but both legal and illegal demand. This would push the legal price to infinite contradicting 4 since we would have $\omega^{l/o}$ would be negative.

7) If $(2, 6)$ prevails there is only illegal supply and legal demand. This would push the illegal price to zero and the legal price to infinite implying $u^{l/o} > u^{i/o}$ which contradicts 2.

We are then left with $(1, 4)$ or $(2, 5)$. If the parameters and the policy variables are such that ordering 1 and ordering 4 prevail, there will be an equilibrium where both markets can coexist. If instead $(2, 5)$ prevails only an illegal market exist.

B Numerical algorithm

To compute the model equilibrium we code a double grid search procedure over the equilibrium probabilities and prices. We provide here a brief description of the algorithm used to find the equilibrium in the *laissez-faire* regime, since it has the same structure as the full algorithm used for the regulation regime but is simpler and easier to explain. The algorithm starts with a guess for the equilibrium probabilities π^c and π^{sw}. For each risk pair we have a further guess for the equilibrium price q. Given the price and the risks, we compute the thresholds $\widetilde{u}$ and $\widetilde{\omega}$ for both infected and non-infected individuals via a grid search over the support of u and ω. Using the thresholds and the measures of infected and non-infected in the data, we compute demand and supply for both groups and, summing the two, total demand and supply. We then store the values of total demand and supply for each price. For a given initial guess of the probabilities, the equilibrium price is the one for which demand equals supply. Using this price, we compute the ex-post equilibrium risks associated with the market equilibrium. The equilibrium risk for clients (sex workers) is simply equal to the product of the transmission probability and the ratio of the total supply (demand) from infected sex workers (clients) over total supply (demand). We then store, for each value of the initial guess of the equilibrium probabilities, the equilibrium price, the associated equilibrium quantities and the equilibrium ex-post risks associated with these prices and quantities. The market equilibrium is such that the ex-post equilibrium risks are equal to the initial guess. The algorithm used to compute the equilibrium under regulation shares this structure. The difference is that there are 4 initial guesses for the probabilities, 2 equilibrium prices, 6 thresholds and 2 sets of equilibrium quantities associated with the legal and the illegal market. In addition, when we study the licensing system, we also have to compute the demand and supply for the illegal market deriving from the fraction of infected individuals that has been screened out, and thus has seen its choice restricted to the illegal market or non participation. We then add these individuals to the illegal demand and supply from non-infected and from infected individuals who have not been screened.

C Italian Prostitution Law

Until 1958, prostitution in Italy was legal and strictly regulated by a 1931 law. Among other things, the law was very specific provisions governing brothels, but the main concern of the legislator was public order, morals and decency; little if any attention was paid to the prostitutes and their condition. For instance, it was forbidden to locate a brothel close to a school, a church or even a public market, and it was forbidden to open the windows even at night (which is the reason why the brothels were typically called "Closed Houses"). But the only protection granted to the prostitutes was the freedom to quit at will, which rarely happened, given the social stigma associated with prostitution and thus the substantial lack of alternatives for these women, either work and marriage.[21] The main problem is that it was legal for the brothel owner to hire prostitutes and to collect part of the proceeds, thus exploiting them economically. Given the lack of any outside option for the women, many of them were forced into a condition akin to slavery.

[21] On this see Edlund and Korn (2002).

In an attempt to protect prostitutes and to improve their condition, the 1958 Merlin Law, named after its sponsor, Senator Lina Merlin and still in force, made it illegal for any individual except the prostitute to gain economic advantage from prostitution, as by intermediation, soliciting, etc. But prostitution itself, the exchange of sex for money, is not illegal. The brothels, which hired prostitutes as workers or took a percentage of their fees, were declared illegal and they were all closed soon after the law was enacted. Furthermore, the law specifically barred all public offices from keeping records of prostitutes. This last provision implies that the income from prostitution cannot be taxed, coherently with the spirit of a law that does not allow anybody to profit from prostitution, not even the government.

References

[1] Becker, Gary S., Kevin M. Murphy and Michael Grossman. 2006. "The Market for Illegal Goods: The Case of Drugs," *Journal of Political Economy,* 114: 38-60.

[2] Beltrame A., Matteelli A., Casalini C. et al. 2001. "Malattie Sessualmente Trasmesse in Donne Immigrate Dedite alla Prostituzione. XXXI Congresso Nazionale della Societá Italiana per lo Studio delle Malattie Infettive e Parassitarie." *Italian Journal of Infectious Disease.* 7: S74.

[3] Cameron, S. 2002. "The Economics of Sin," Edward Elgar Publishing Limited, Cheltenham.

[4] Cameron, S., Alan Collins and Neill Thew. 1999. "Prostitution Services: An Exploratory Empirical Analysis," *Applied Economics*, 31: 1523-9.

[5] Cameron, S. and Alan Collins. 2003. "Estimates of a Model of Male Participation in The Market for Female Heterosexual Prostitution Services," *European Journal of Law and Economics*, 16: 271-88.

[6] Cunningham, Scott and Todd Kendall. 2011. "Prostitution 2.0: The changing face of sex work" *Journal of Urban Economics*, 69: 273-287.

[7] D'Antuono Antonietta, Cocci C., De Tommaso S. 1999. "Prevalence of STDs and HIV infection among immigrant sex workers attending an STD centre in Bologna, Italy," *Sex Transm Infect.* 75(4): 273-274.

[8] D'Antuono Antonietta, Andalò F, Carlà EM, De Tommaso S. 2001. "Prevalence of STDs and HIV infection among immigrant sex workers attending an STD centre in Bologna, Italy," *Sex Transm Infect.* 77: 220.

[9] Della Giusta, Marina, Maria Laura Di Tommaso, Isilda Shima, and Steinar Strom. 2009a. "What Money Buys: Clients of Street Sex Workers in the US," *Applied Economics*, 41: 2261-77.

[10] Della Giusta, Marina, Maria Laura Di Tommaso, and Steinar Strom. 2009b. "Who is watching? The market for prostitution services," *Journal of Population Economics*, 22: 501-516.

[11] Della Giusta, Marina, Maria Laura Di Tommaso, and Sarah L. Jewell. 2014. "Stigma and Risky Behavior among clients of prostitutes" forthcoming in Cunningham S. and Shah, M. (2014) *Handbook on the Economics of prostitution*, Oxford University Press.

[12] Edlund, Lena and Evelyn Korn. 2002. "A Theory of Prostitution," *Journal of Political Economy,* 110: 181-214.

[13] EU New Encounter Module Project.

[14] European Network for HIV-STD Prevention in Prostitution. Southern Regional report, 2000.

[15] Gertler, Paul, Manisha Shah and Stefano M. Bertozzi. 2005. "Risky Business: The Market for Unprotected Prostitution," *Journal of Political Economy,*113: 518-550.

[16] Gertler, Paul and Manisha Shah. 2011. "Sex Work and Infection: What's Law Enforcement Got to do with it? "*Journal of Law and Economics*, 54(4): 811-840.

[17] Giuliani, M, B. Suligoi and The STD Surveillance Working Group. 1998. "Sentinel surveillance of sexually transmitted diseases in Italy," *Euro Surveill.* 3(6): 55-58.

[18] Giuliani, M, B. Suligoi and The Italian STI Surveillance. 2004. "Working Group Differences Between Nonational and Indigenous Patients with Sexually Trasmitted Infections in Italy and Insights into the control of Sexually Trasmitted Infections." *Sexually Transmissable Diseases*. 31(2): 79-84.

[19] Gray, Ronald, Maria J. Waver, Ron Brookmeyer, Nelson Sewankambo, David Serwadda and the Rakai Project Team. 2001. "Probability of HIV-1 Transmission per Coital Act in Monogamous, Heterosexual, HIV-1 Discordant Couples in Rakai, Uganda." *The Lancet*. 357: 1149-1153.

[20] Greenwood, Jeremy, Philipp Kircher and Michle Tertilt. 2010. "An Equilibrium Model of the African HIV/AIDS Epidemic," mimeo.

[21] Heiges, Moira. 2009. "From the Inside Out: Reforming State and Local Prostitution Enforcement to More Effectively Combat Sex Trafficking in the U.S. And Abroad," Available at SSRN: http://ssrn.com/abstract=1472125.

[22] Hogg, R., Lima V., Sterne J.A. et al. 2008. "Life Expectancy of Individuals on Combination Antiretroviral Therapy in High-Income Countries: a Collaborative Analysis of 14 Cohort Studies, " *Lancet*, 372(9635): 293-299.

[23] Hubert M, Bajos N, Sandfort T, eds. Sexual behaviour and HIV/AIDS in Europe: comparisons of national surveys UCL Press, 1998.

[24] Immordino, Giovanni and Francesco F. Russo. 2012. "Regulating Prostitution: Theory and Evidence from Italy," CSEF working paper n. 308.

[25] Immordino, Giovanni and Francesco F. Russo. 2012. "Prostitution policy," forthcoming in Cunningham S. and Shah, M. (2014) *Handbook on the Economics of prostitution*, Oxford University Press.

[26] Istituto Superiore di Sanitá. 2004. "Infezione da HIV, AIDS e Popolazioni Migranti:Quali Possibili Interventi in Ambito Psico-Socio-Sanitario. " *Rapporti Istan* 6/29.

[27] Darius Lakdawalla, Neeraj Sood and Dana Goldman. 2006. "HIV Breakthroughs and risky sexual behavior," *Quarterly Journal of Economics*, 121: 1063-102.

[28] King, Joseph T., Amy C. Justice, Mark S. Roberts, Chung-Chow Chang, Jennifer S. Fusco and the CHORUS program team. 2003. "Long-Term HIV/IDS Survival Estimation in the Highly Active Antiretroviral Therapy Era," *Medical Decision Making*, 23 (1): 9-20.

[29] Kotsadam, Andreas and Niklas Jakobson. 2011. "Do laws affect attitudes? An assessment of the Norwegian prostitution law using longitudinal data," *International Review of Law and Economics*, 31: 103-115.

[30] Kremer, Michael. 1996. "Integrating Behavioral Choice into Epidemiological Models of AIDS," *Quarterly Journal of Economics*, 111: 549-573.

[31] Moffatt, Peter G. and Simon A. Peters. 2004. "Pricing Personal Services: An Empirical Study of Earnings in the UK Prostitution Industry," *Scottish Journal of Political Economy,* 51: 675-690.

[32] Oster, Emily. 2005. "Sexually Transmitted Infections, Sexual Behavior, and the HIV/AIDS Epidemic," *Quarterly Journal of Economics*, 120: 467-515.

[33] Rao, Vijayendra, Indrani Gupta, Michael Lokshin and Smarajit Jana. 2003. "Sex Workers and The Cost of Safe Sex: The Compensating Differential for Condom Use Among Calcutta Prostitutes," *Journal of Development Economics*, 71: 585-603.

[34] Roth, Alvin E. 2007. "Repugnance as a Constraint on Markets," *Journal of Economic Perspectives*, 21: 37–58.

[35] Smacchia C., Parolin A., Di Perri G., Vento S., Concia E. 1998. "Syphilis in Prostitutes from Eastern Europe." *Lancet*. 351: 572.

[36] Vance, Carole. 2011. "States of Contradiction: Twelve Ways to Do Nothing about Trafficking While Pretending To?" *Social Research*, 78: 933.

[37] Vandepitte, J., R. Lyerla, G. Dallabetta, F. Crabbe, M. Alary and A. Buvé. 2006. "Estimates of the number of female sex workers in different regions of the world," *Sex Transm Infect,* 82(Suppl III):iii18–iii25.

[38] Van Ours, Jan C. 1995. "The Price Elasticity of Hard Drugs: the Case of Opium in the Dutch East Indies, 1923-1938," *Journal of Political Economy*, 103: 261-279.

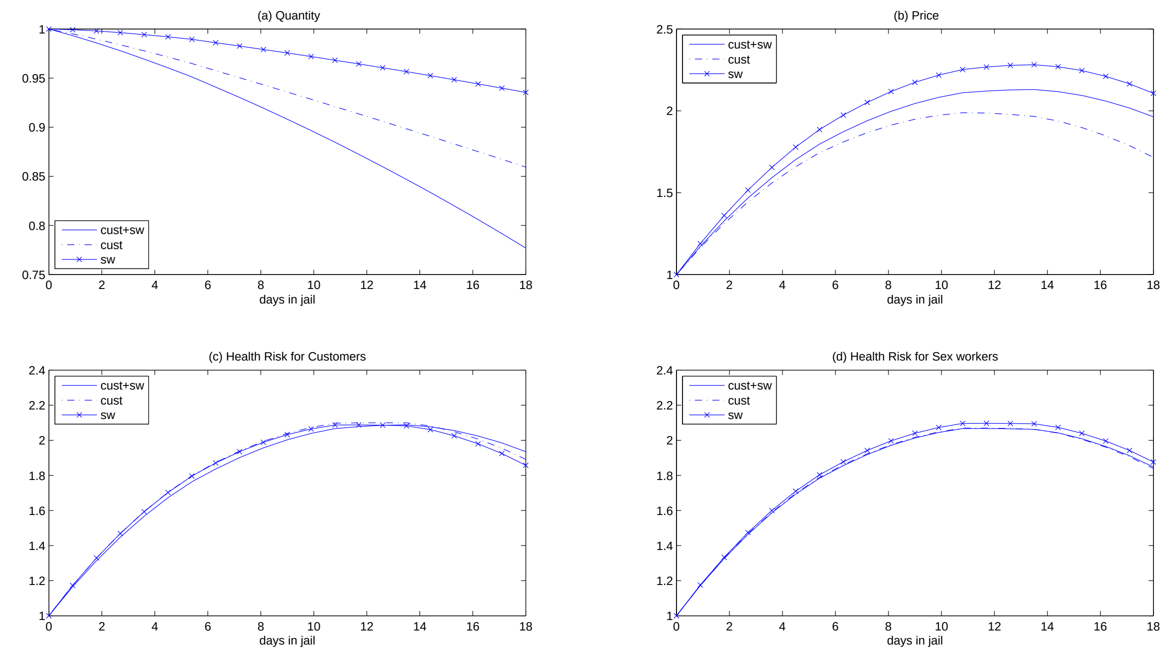
[39] Viscusi, W. Kip. 1993. "The Value of Risks to Life and Health," *J. Econ. Literature*, 31: 1912–46.

[40] Waver, Maria J., Ronald Gray, Nelson Sewankambo, David Serwadda, Xianbin Li et al. 2005. "Rates of HIV-1 Transmission per Coital Act by Stage of HIV-1 Infection in Rakai, Uganda." *Journal of Infectious Diseases*. 191(9): 1403-1409.

[41] Weller, S.C. and K. Davis-Beaty. 2002. "Condom Effectiveness in Reducing Heterosexual HIV Transmission (Review). " *Cochrane Database of Systematic Reviews*, 1, Art. no CD003255.

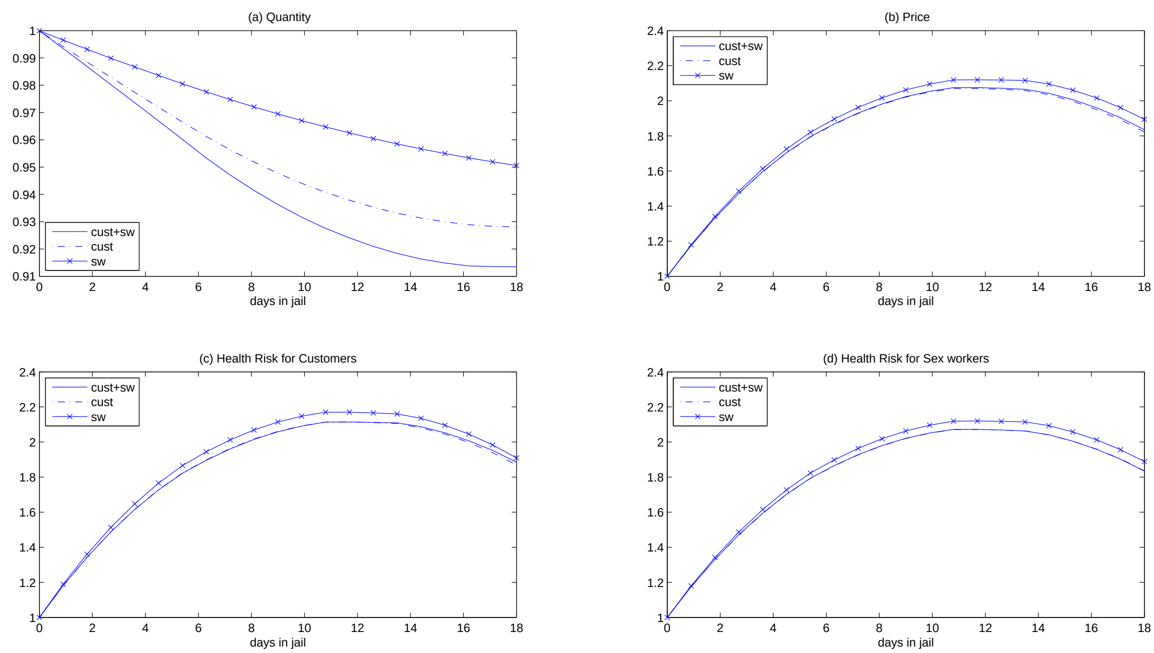
[42] Zwahlen, Marcel and Matthias Egger. 2006. "Progression and Mortality of Untreated HIV-Positive Individuals Living in Resource-Limited Settings: Update of Literature Review and evidence Synthesis. " *UNAIDS Obligation*, HQ/05/422204.

Figure 1: **Prohibition. Symmetric costs**



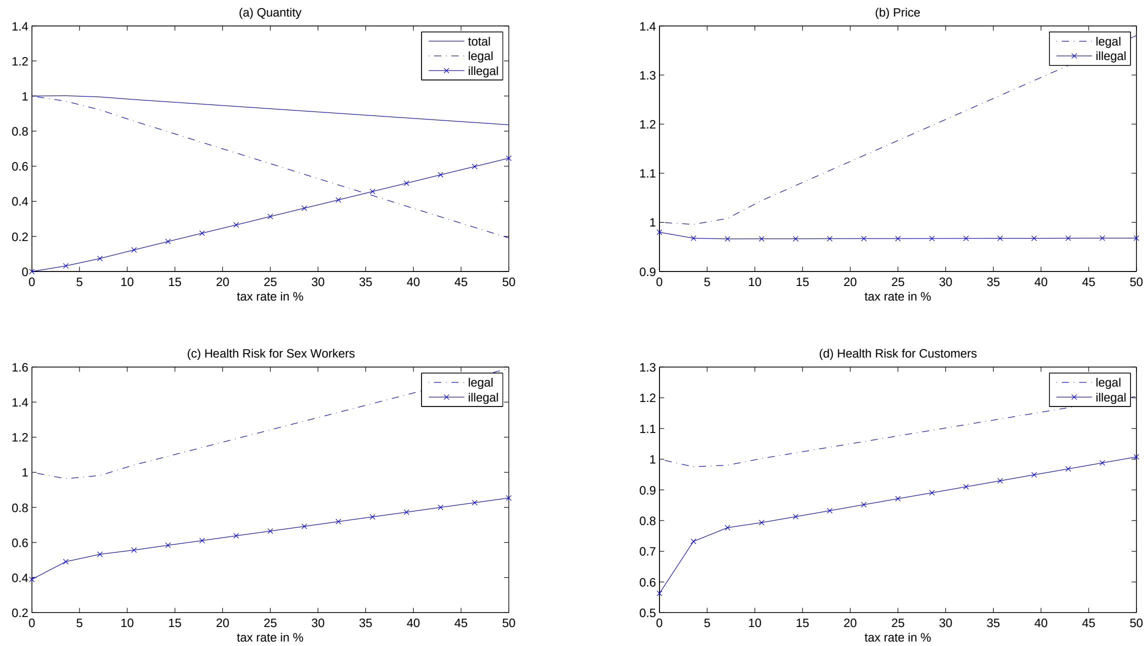
Notes: Equilibrium quantities under prohibition for different levels of the sanctions expressed in jail days. Enforcement probability 2%. Clockwise from the upper left corner: (a) Equilibrium quantity of prostitution exchanged in equilibrium in units of the quantity under laissez-faire for sanctions on customers only (cust, dashed line with dots), sex workers only (sw, solid line with x) and on both (cust+sw, solid line). (b) Equilibrium price in units of the price under laissez-faire for sanctions on customers only, sex workers only and on both. (c) Health risk faced by customers in units of the risk under laissez-faire for sanctions on customers only, sex workers only and on both. (d) Health risk faced by sex workers in units of the risk under laissez-faire for sanctions on customers only, sex workers only and on both.

Figure 2: **Prohibition. Higher cost for sex workers**



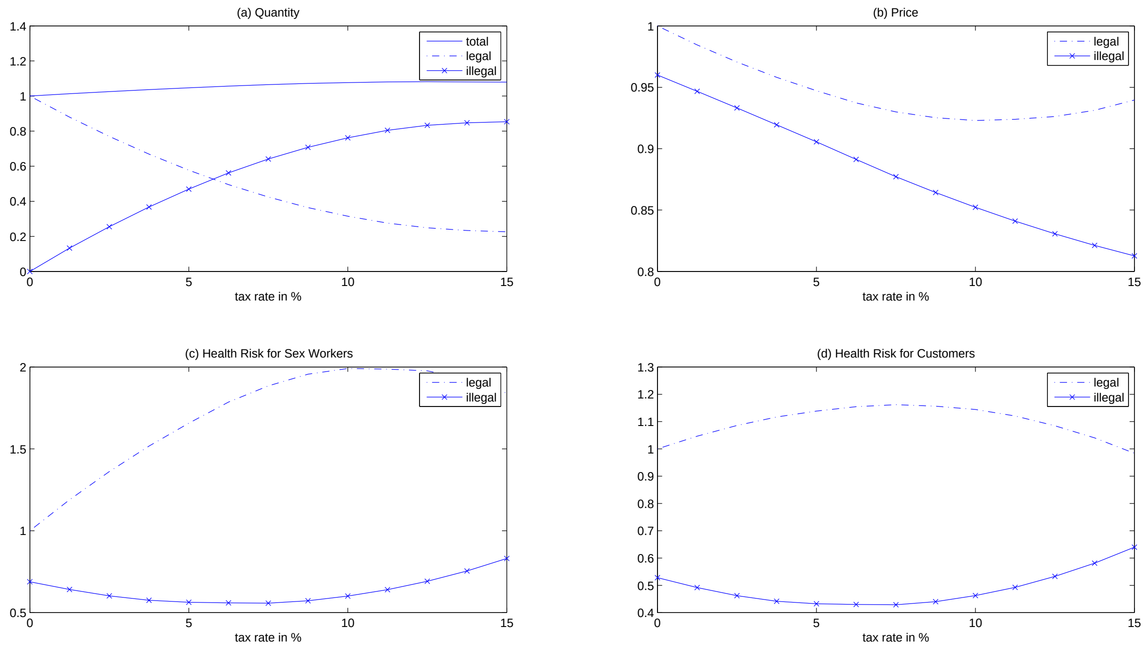
Notes: Equilibrium quantities under prohibition for different levels of the sanctions expressed in jail days. Enforcement probability 2%. Clockwise from the upper left corner: (a) Equilibrium quantity of prostitution exchanged in equilibrium in units of the quantity under laissez-faire for sanctions on customers only (cust, dashed line with dots), sex workers only (sw, solid line with x) and on both (cust+sw, solid line). (b) Equilibrium price in units of the price under laissez-faire for sanctions on customers only, sex workers only and on both. (c) Health risk faced by customers in units of the risk under laissez-faire for sanctions on customers only, sex workers only and on both. (d) Health risk faced by sex workers in units of the risk under laissez-faire for sanctions on customers only, sex workers only and on both.

Figure 3: **Taxes. Symmetric costs**



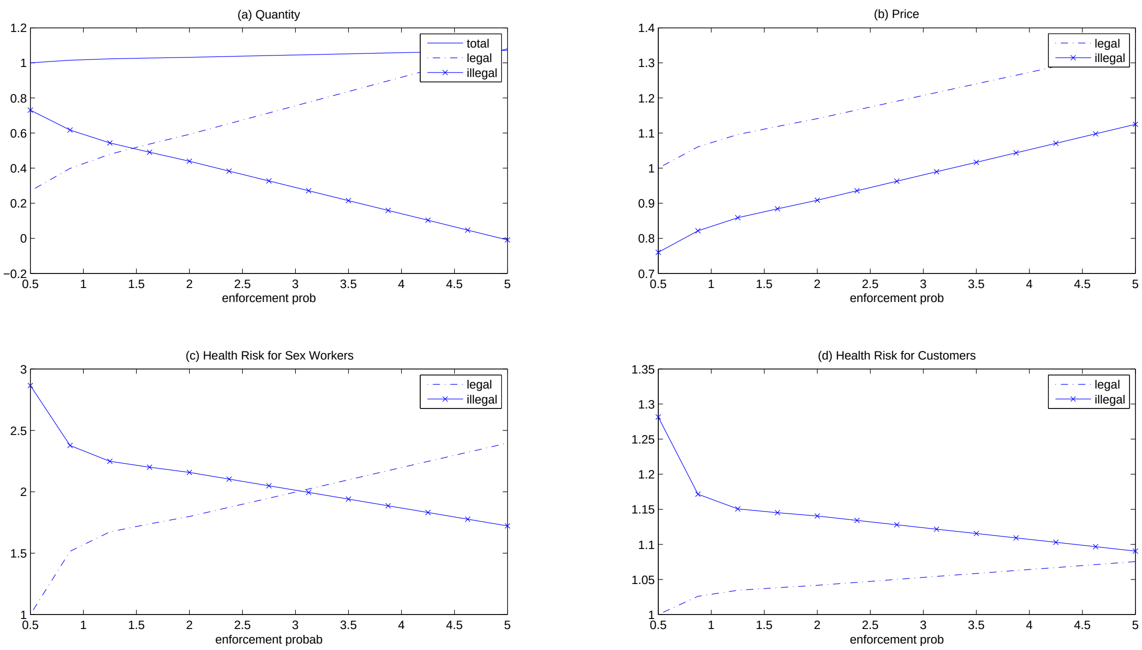
Notes: Equilibrium quantities under regulation for different levels of the tax rate. Enforcement probability 2% and sanction equal to half week in jail. No prevention. Quantities, prices and risks, both in the legal and illegal markets, are expressed in units of the quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal markets (illegal, solid line with x). (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (d) Health risk faced by customers.

Figure 4: **Taxes. Higher cost for sex workers**



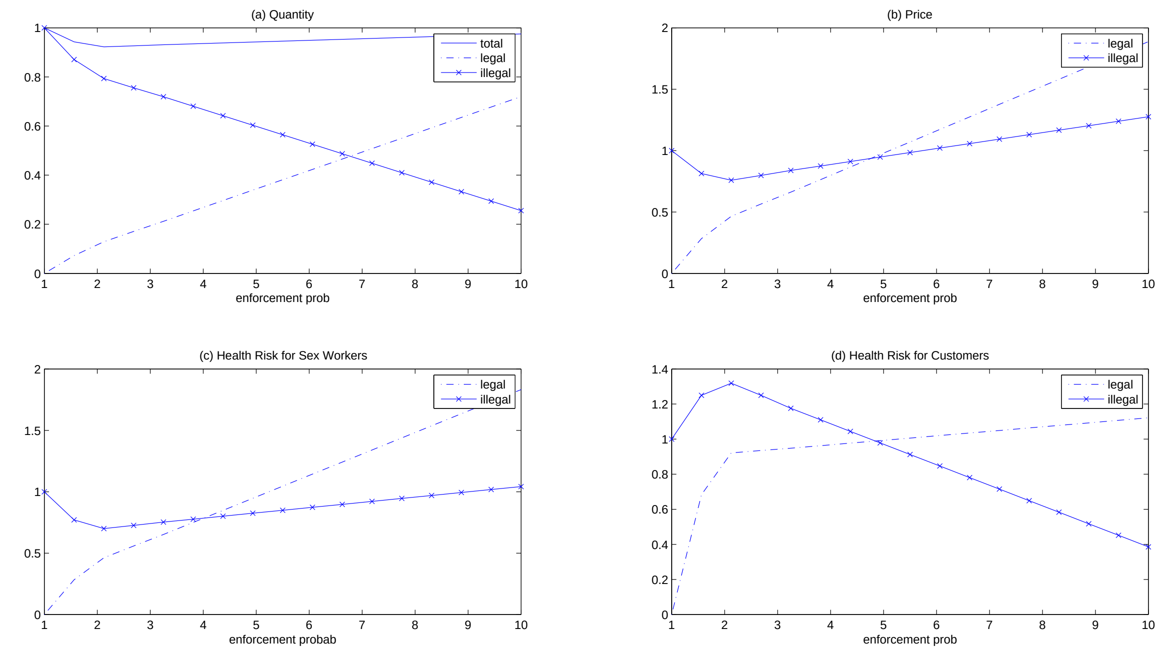
Notes: Equilibrium quantities under regulation for different levels of the tax rate. Enforcement probability 2% and sanction equal to half week in jail. No prevention. Quantities, prices and risks, both in the legal and illegal markets, are expressed in units of the quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal markets (illegal, solid line with x). (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (d) Health risk faced by customers.

Figure 5: **Enforcement. Symmetric costs**



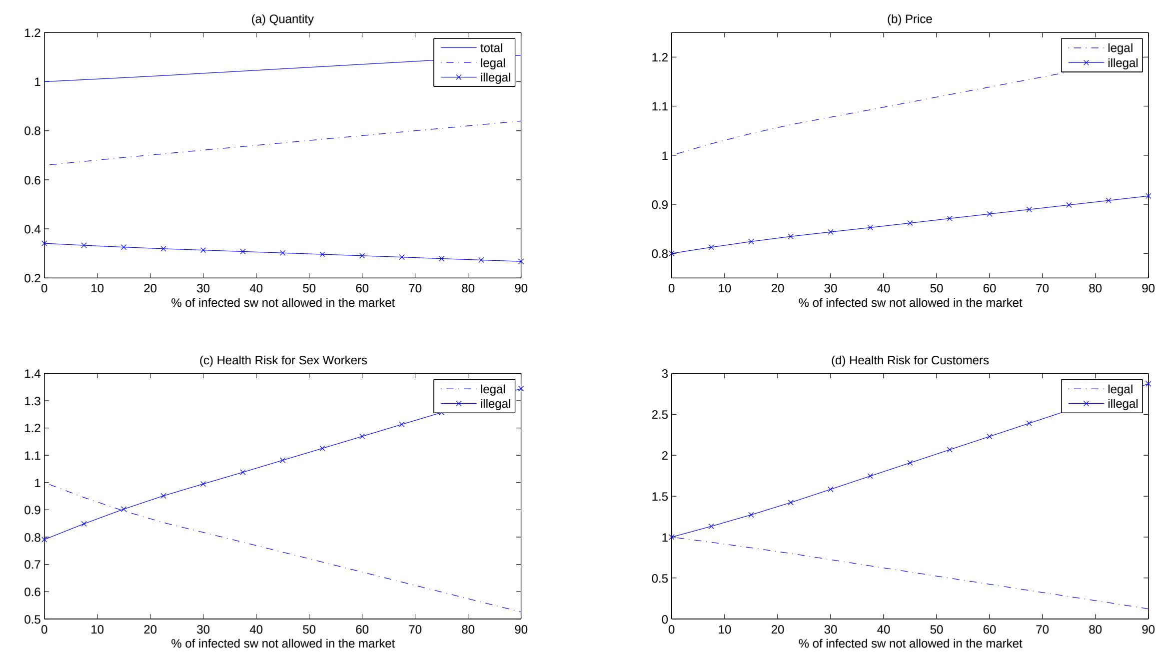
Notes: Equilibrium quantities under regulation for different levels of the enforcement probability (in percentage terms). Tax rate 30% and sanction equal to half week in jail. No prevention. Quantities, prices and risks are in units of the corresponding quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal (illegal, solid line with x) markets. (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (d) Health risk faced by customers.

Figure 6: **Enforcement. Higher costs for sex workers**



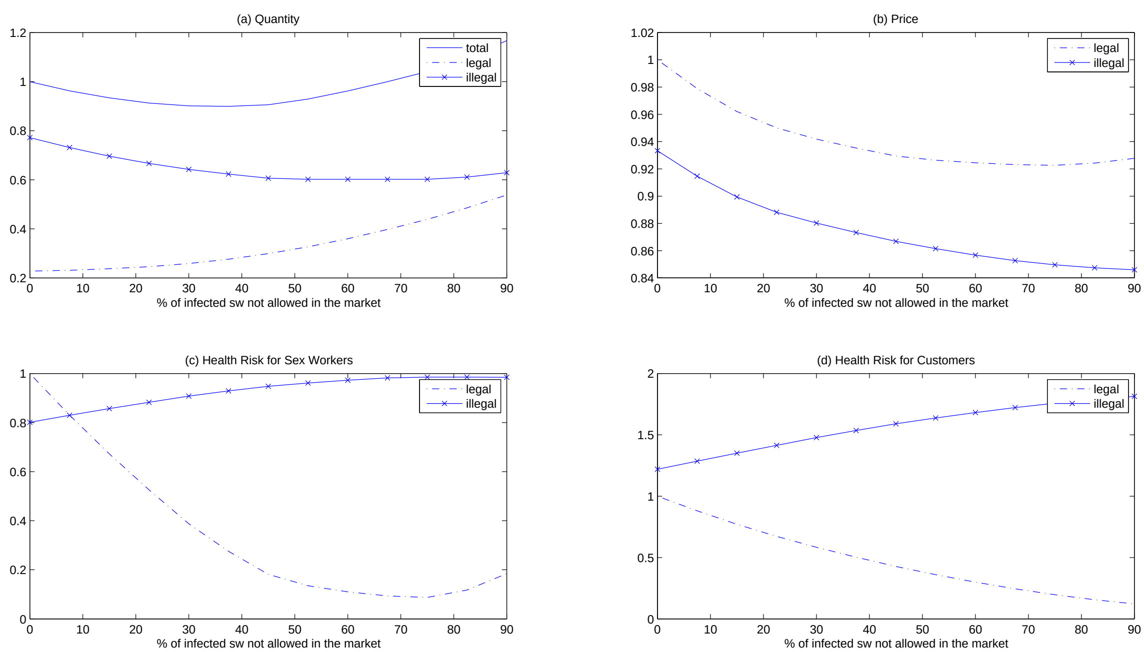
Notes: Equilibrium quantities under regulation for different levels of the enforcement probability (in percentage terms). Tax rate 30% and sanction equal to half week in jail. No prevention. Quantities, prices and risks are in units of the corresponding quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal (illegal, solid line with x) markets. (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (d) Health risk faced by customers.

Figure 7: **Prevention. Symmetric costs**



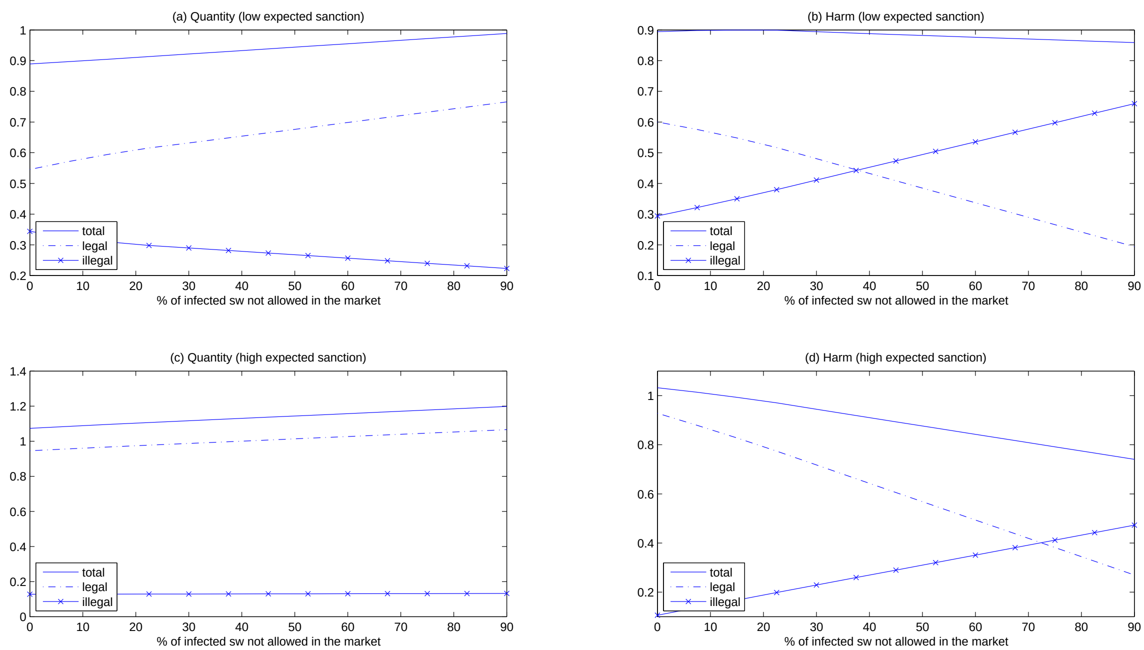
Notes: Equilibrium quantities under regulation for a preventive policy that reduces the access of HIV infected sex workers to the legal market. Effectiveness of the policy (prev-percentage of infected prevented to join the legal market) on the x axis. 30% tax rate, enforcement probability 2% and sanction equal to half week in jail. Quantities, prices and risks are in units of the corresponding quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal markets (illegal, solid line with x). (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (4) Health risk faced by customers.

Figure 8: **Prevention. Higher cost for sex workers**



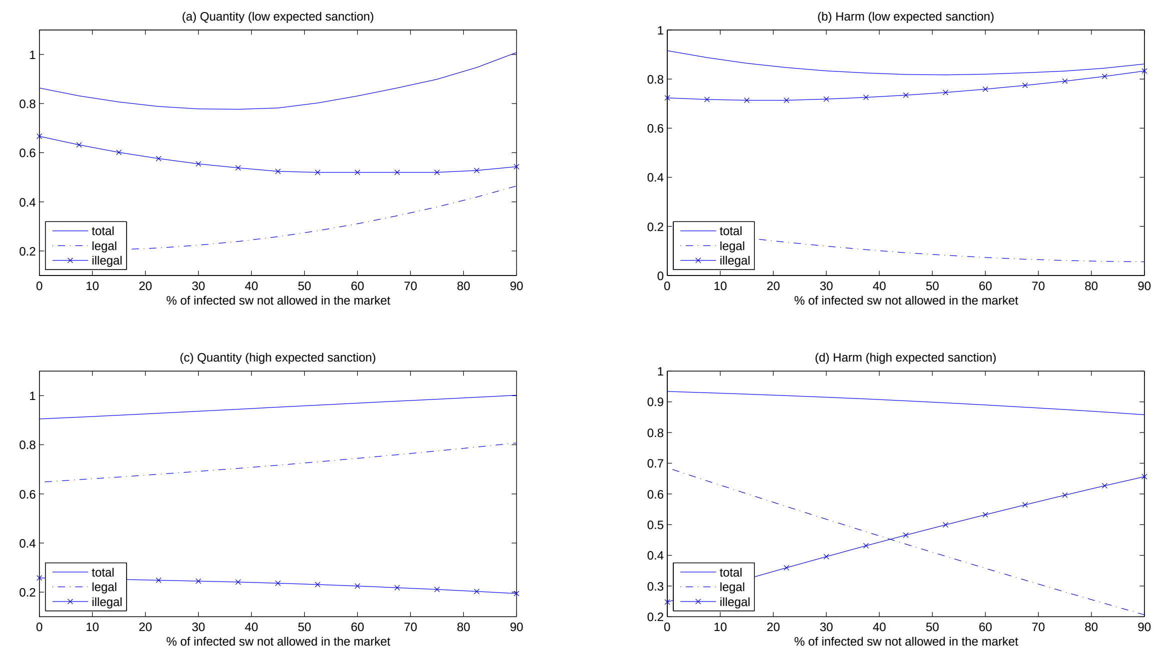
Notes: Equilibrium quantities under regulation for a preventive policy that reduces the access of HIV infected sex workers to the legal market. Effectiveness of the policy (prev-percentage of infected prevented to join the legal market) on the x axis. 30% tax rate, enforcement probability 2% and sanction equal to half week in jail. Quantities, prices and risks are in units of the corresponding quantities, prices and risks that prevail in the laissez-faire regime. Clockwise from the upper left corner: (a)Total quantity of prostitution exchanged in equilibrium (total, solid line) and quantities exchanged in the legal (legal, dashed line with dots) and illegal markets (illegal, solid line with x). (b) Equilibrium prices in the legal and illegal markets. (c) Health risk faced by sex workers. (4) Health risk faced by customers.

Figure 9: **Regulation vs Prohibition. Symmetric costs**



Notes: Equilibrium quantities and harm under regulation for a preventive policy that reduces the access of HIV infected sex workers to the legal market. Effectiveness of the policy (percentage of infected prevented to join the legal market) on the x axis. 30% tax rate. Upper panels a and b: enforcement probability 2% and sanction equal to half week in jail. Lower panels c and d: enforcement probability 6% and sanction equal to two weeks in jail. All quantities and harm (total, solid line; legal, dashed line with dots; illegal, solid line with x) are in units of the corresponding quantity and harm of a prohibition regime featuring the same expected sanction.

Figure 10: **Regulation vs Prohibition. Higher cost for sex workers**



Notes: Equilibrium quantities and harm under regulation for a preventive policy that reduces the access of HIV infected sex workers to the legal market. Effectiveness of the policy (percentage of infected prevented to join the legal market) on the x axis. 30% tax rate. Upper panels a and b: enforcement probability 2% and sanction equal to half week in jail. Lower panels c and d: enforcement probability 6% and sanction equal to two weeks in jail. All quantities and harm (total, solid line; legal, dashed line with dots; illegal, solid line with x) are in units of the corresponding quantity and harm of a prohibition regime featuring the same expected sanction.