On the Association between Prostitution Regulation and Rape*

Riccardo Ciacci†

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Abstract

This paper proposes a theoretical model that connects rape and prostitution taking into account the substitutive relationship between the two recently documented in the economic literature. First, it provides a theoretical underpinning of the close connection between rape and the prostitution market (i.e. supply and demand). Second, it studies the effects of the most popular prostitution regulations on rape. Using legalized prostitution as a benchmark, this paper finds that both the Nordic and Dutch model increase rape, being the effect of the former larger than that of the latter. Estimated correlations using a panel data of European countries offer suggestive evidence in favor of these findings.

Keywords: Rape, sex crimes, prostitution, prostitution law, prostitution regulation

JEL codes: D19, J16, J47, K14

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†Universidad Pontificia Comillas, Department of Economics and Business Management, rciacci@comillas.edu

1 Introduction

1 out of 3 women in the European Union has been victim of physical or sexual violence at least once since the age of 15 (European Union Agency for Fundamental Rights 2014). In particular, for that same age group, 11% of women have been victims of sexual violence and 5% (a group of around 9 million) have been victims of rape. In about 35% of the cases the victim did not report the crime to the authorities.[1] The main psychological consequences for the victims of such crimes are depression, anxiety, loss of self confidence and panic attacks.

Recent economic literature established a substitutable relationship between rape and activities linked to prostitution (Cunningham and Shah 2018; Bisschop et al. 2017; Ciacci and Sviatschi 2019). Namely, Cunningham and Shah (2018) found that moving from a criminalization to a decriminalization regulation of prostitution brings about a fall in rape. Similarly, Bisschop et al. (2017) estimated that regulating prostitution via licenses reduces rape with respect to criminalization. Ciacci and Sviatschi (2019) finds that neighborhoods with adult entertainment establishments experience lower levels of rape. Taken together, these empirical findings suggest that rape might be a substitute for prostitution. Moreover, these results hint at the possibility that prostitution regulations could affect rape.

Currently prostitution regulation is a broadly discussed topic. In the U.S., prostitution is illegal in any state but Nevada. In Europe, regulations vary across countries, ranging from decriminalization (e.g. Denmark), licenses (e.g. the Netherlands and Germany) to banning the purchase of prostitution (e.g. Sweden, Norway and Island). In addition, in 2014 the European parliament passed a non-binding resolution calling on other European countries to adopt the Nordic model. To this end, recently Northern Ireland and France also opted for such a regime. Regarding the afore-mentioned debate, it is extremely important to fully understand the consequences and potential unitended effects of prostitution regulation.

To the best of our knowledges, this is one of the first papers to establish a theoretical framework to understand the potential effects of the most popular prostitution regulations on rape. This analysis is built on the substitutable relationship between rape and prostitution found in the empirical literature presented above. Next, this study also presents some simple cross-country regression correlations between the most popular prostitution regulations and rape. Our results support the two main findings of the theoretical model. Namely, both licensing and criminalization of clients increases rape, being

[1] Own computations based on Table 3.4 of European Union Agency for Fundamental Rights (2014).

the effect of the latter larger than that of the former.

This manuscript has two main contributions. First, it builds a theoretical underpinning that might be used to understand the close connection between rape and prostitution. Second, it computes the sign of the effects of the most popular prostitution regulations on rape. Our findings suggest that both licensing and criminalizing prostitution (either the clients or the prostitutes) increases rape with respect to decriminalization. Criminalization of prostitutes leads to a larger increase in rape than licenses. While, criminalization of clients brings about a larger increment in rape than criminalization of prostitutes. In addition, this article finds that, if governments are interested in enforcing criminalization of clients, as the European parliament suggests, there exists an optimal expected fine to minimize the weighted sum of rape and prostitution .

This paper contributes to a growing line of research in economics that studies prostitution theoretically (Edlund and Korn 2002; Cameron 2002; Cameron and Collins 2003; Della Giusta et al. 2009; Lee and Persson 2013; Stadtmann and Sonnabend 2019; Cunningham and Shah 2021). To this extent, Cunningham and Shah (2021) offer a comprehensive review of the economic literature on prostitution regulation.

Specifically, this paper furthers the line of research of the following studies. Edlund and Korn (2002) build a theoretical model suggesting that prostitutes might earn a wage-premium due to their *undergone* opportunity cost of getting married. On the other hand, Della Giusta et al. (2009) pin down a theoretical model that suggests that the wage-premium might be due to a reputational loss. Our model makes use of both hypotheses. Lee and Persson (2013) and Stadtmann and Sonnabend (2019) compute theoretical models to nail down the effect of prostitution regulations on either human trafficking or the prostitution market. This paper contributes to this branch of the literature by suggesting a theoretical model to determine the effects of such regulations on rape.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 estimates how prostitution regulations might impact rape. Section 4 introduces the empirical test. Next, Section 5 describes the dataset used for the analysis. Section 6 shows the main results of the empirical test. Finally, Section 7 concludes.

2 An Economic Model of Rape

Consider a society formed by two sexes male and female, and where prostitution is legal. Let the population of both sexes be normalized to 1. In this economy there is one period and two goods: the consumption good c and sex s. There are three types of sex:

mating sex s_m, prostitution sex s_p and rape sex s_r.[2] Sex is a weighted sum of these three types.

Each individual i in the population of males differs in how they value these three types of sex. Let γ_{mi} and γ_{pi} respectively denote the weight for mating and prostitution type of sex of individual i. Since we focus on the decision of potential sex offenders, we only consider individuals who value rape positively. Thus, we normalize the weight associated to rape sex s_r to 1. Therefore, we define total sex as $s \equiv \gamma_{mi} s_m + \gamma_{pi} s_p + s_r$.[3] Moreover, let $\gamma_{ji} \in [0, \ldots, a_j]$ for some upper-bound $a_j \geq 1$ where $j = m, p$. Both weights are distributed in the population using the densities $h_j(\gamma_{ji})$ s.t. $0 < h_j(\gamma_{ji}) < 1$ and $\int_0^{a_j} h_j(x)\, dx = 1$. These densities reflect the proportion of each type of man in the total population. In addition we are going to assume that the two densities are independent.

Men makes mating offer and then decide s_p and s_r. Women who receive the mating offer accepts, women who don't receive any offer stay single. Ex-ante (i.e. before receiving a mating offer) women are identical between them. Ex-post single women can decide whether to sell sex or not, while mated women cannot. In particular let δ_{pi} measure how much a certain single woman dislikes selling sex. In the same fashion than before $\delta_{pi} \in [1, \ldots, u]$ for some upper-bound $u \geq 1$.[4] The parameter δ_{pi} is drawn from a function $g(\delta_{pi})$ s.t. $0 < g(\delta_{pi}) < 1$ and $\int_1^u g(x)\, dx = 1$. We assume that individuals can have only monogamous mating relationships, this assumption does not affect the results but simplifies computations.

2.1 Timing of decisions

1. Parameters γ_m and γ_p are drawn for each individual

2. Men decide whether to offer a mating relationship to women

[2] Mating relationships can be seen as marriages, engagements or simply relationships with some frequency. The key component is that there is a certain regularity in the relationship. This regular component is taken into account via the fixed amount of sex s_m that mated individuals receive. This amount of sex is fixed since it is not individually chosen as s_p or s_r.

[3] Previous literature in economics (Cunningham and Shah 2018; Bisschop et al. 2017; Ciacci and Sviatschi 2019), psychology (Farley et al. 2009, 2011) and biology (Thornhill and Thornhill 1983; Thornhill and Palmer 2000a,b) provided evidence that rape is an alternative to consesual sex. This feature is captured by the total amount of sex, defined as a weighted sum of the three different types of sex. These three *types* of sex could also be described respectively as: non-pecuniary paid consensual sex s_m, pecuniary paid consensual sex s_p and non-consensual sex s_r.

[4] The domain of this parameter starts at a positive number instead than zero since selling sex for single women is modelled as working time, therefore its marginal utility cannot be equal to zero. Hence, starting at 1 is a normalization.

3. Women who receive an offer accept it
4. Parameter δ_p is drawn for each single woman
5. Men decide how much $s_p$and s_r to consume
6. Single women decide whether to sell sex or not
7. Single women who decided to sell sex decide how much sex to offer
8. Market of prostitution clears

2.2 Men's problem

Men's preferences over the two goods are described by $U(c,s)$. Assume that men's utility is additively separable, so it might be written as $U(c,s) = u_c(c) + u_s(s)$. Where $u_s()$ has positive first order derivative, negative second order derivative and $\lim_{x\to\infty} u_s'(x) = 0$. Furthermore, assume $u_s'''(s) > 0$ which is known in the literature as *prudence*, in our case it implies that high expected fines are worse for individuals with low incomes than for those with high incomes.

At the beggining of the period the parameters γ_{mi} and γ_{pl} are drawn for each man. Then men take the decision of whether offering a mating relationship and women who receive the offer accept. Since at this stage all women are identical: men are indifferent between who to propose to. All men earn wage y that can be consumed as consumption good. Men who chose a mating relationship get a fixed amount of sex s_m but have to pay a fixed cost k in terms of consumption good.

The fixed amount of sex reflects the difference between mating sex and the other two types of sex: in the former the decision could be seen as an outcome of a bargaining process between the two partners, so relatively fixed with respect of the decision of only one partner, while for the latter two types of sex the consumer decides unilaterally how much to consume depending on the faced cost (e.g. price or expected fine).

The fixed cost k can be interpreted as the cost men have to pay to formulate the proposal, the cost of marriage, the expenses of growing up their descendants and/or the cost of acquiring rights on the offsprings, as it has been suggested in the literature (Edlund and Korn 2002; Edlund 2013).[5]

After choosing whether to mate or not all men choose whether to commit rape and/or to buy sex. Rape offenders are caught with probability $q(s_r)$ where $q()$ is a linear probability function, increasing in its argument and with $q(0) = 0$. Therefore, $q(s_r) = qs_r$ for

[5]Clearly, $0 < k < y$.

some $q > 0$ such that $\frac{1}{q}$ is the maximum amount of rapes that an individual can commit (i.e. $s_r \in \left[0, \frac{1}{q}\right]$). If caught, offenders have to pay a fine $F(s_r) = Fs_r + f$ for some positive F and f.[6] As for prostitution sex, individuals might purchase sex at a price p for each unit purchased s_p. Thereby, we can write the budget constraint for men who are caught commiting rape as: $c + \mathbb{I}_m k + Fs_r + f + ps_p = y$ and $c + \mathbb{I}_m k + ps_p = y$ for men who are not caught committing rape or who do not commit rape, where $\mathbb{I}_m$ is an indicator function that takes value 1 for mated men.

This problem can be written as:

$$\max_{s_r, s_p} q(s_r) u_c(y - \mathbb{I}_m k - Fs_r - f - ps_p) + (1 - q(s_r)) u_c(y - \mathbb{I}_m k - ps_p) + u_s(\gamma_{mi} s_m \mathbb{I}_m + \gamma_{pl} s_p + s_r)$$

2.3 Women's problem

Women at the beginning of the period might receive a mating offer. Women who receive a mating offer know that they will get s_m in the sex good and k in the consumption good while they would get 0 if remaning single. Thereby accepting a mating offer always makes women better off. Consequently, women who receive a mating offer will accept it, whereas women who do not receive any mating offer stay single.

As in the seminal paper Edlund and Korn (2002) mated women cannot sell sex. In order to analyse single women's choice to sell sex we need to introduce their preferences. Let $V(c, s_p)$ denote single women's preferences. Assume they are additively separable then we can write them as $V(c, s_p) = u_c(c) - \delta_{pi} v_s(s_p)$ where $v_s()$ is a function with $v_s(0) = 0$ and both positive first and second order derivative. Recall that δ_{pi} reflects how much a certain single woman dislikes selling sex.

Single women earn a wage w, besides they have to choose whether they want to sell sex. If they decide to sell sex they earn p for every unit of sex sold but have to pay a fixed cost of k_p.This fixed cost k_p can be interpreted as any fixed cost connected to enter into the business of prostitution or as a cost due to reputational loss (Della Giusta et al. 2009). Hence, women's budget constraint might be written as $c = w + ps_p - \mathbb{I}_p k_p$, where $\mathbb{I}_p$ is an indicator function that takes value 1 for single women whose optimal solution is to sell sex and 0 otherwise.

[6]Note that even if $f > 0$ the expected value of the fine for men who do not commit rape is zero since $q(0) = 0$. Clearly in the model men who do not commit rape do not have to pay any fine. The fixed amount of the $f > 0$ only reflects that the fine is fixed and not proportional to the amount of crime committed.

Note that single women's decision on whether selling sex depends on the parameter δ_{pi} that is drawn unexpectedly only for single women. Thus, women cannot forecast that if they do not accept a mating offer they will choose between selling sex or not. This assumption reflects that in this paper we do not want to analyze the choice of selling sex which has been extensively studied in the theoretical literature (Edlund and Korn 2002; Della Giusta et al. 2009). Rather we focus on the connection between the prostitution market and the rape market given the substitutable relation between the two found in the empirical literature.

Therefore, the problem of single women boils down to:

$$\max_{s_p} u_c\left(w + ps_p - \mathbb{I}_2 k_p\right) - \delta_{pi} v_s\left(s_p\right)$$

Single women compute the optimal s_p and then decide whether to sell sex comparing the utility they would get by selling sex and their reservation utility given by $u_c\left(w\right)$.

2.4 Total supply, total demands and equilibrium

The heterogeneous parameters that differ between individuals, namely γ_{mi}, γ_{pi} and δ_{pi}, imply that some men get mated, commit rape and/or buy prostitution while some single women sell prostitution sex. Using the densities for each case we can build the total supply of prostitution aggregating the invidual supply of prostitution of each type of single woman who decide to sell sex weighted by its corresponding density. We can do the same for the total demand of prostitution. This latter case is a bit more complex, we can easily start by computing the demand of prostitution for mated and single men.

The total demand is a weighted average, where the densities are the weights, of the mated and single demands of prostitution. Simmetrically we can build the demand of rape. Note that for rape there is not any supply, no victim offers to be raped and there is no price exchanged between consumers and suppliers. Then the equilibrium will be determined by the equilibrium price of prostitution. A formal definition for the total supply of prostitution s_p^{sT}, the total demand of prostitution s_p^{dT} and the total demand of rape s_r^{dT} can be found in Appendix Section A.

In this model an equilibrium is a situation in which the total demand of prostitution and the total supply of prostitution equalize (i.e. $s_p^{sT} = s_p^{dT}$) and all individual demands and supplies are non negative. As stated above note that the equilibrium condition implies an equilibrium price of the prostitution market p^* that indirectly sets the equilibrium in rape as well (i.e. $s_r^* = s_r^{dT}\left(p^*\right)$). Also in this a formal definition of this equilibrium can

be found in Appendix Section A.

Proposition 1. *: Assume that men's utility is quasi-linear in the consumption good (i.e.* $u_c(c_t) = c_t$*)) and women's utility is quadratic in prostitution services* $v_s(s_p) = s_p^2$*.*[7] *Then:*

(i) There is a unique threshold value such that only individuals with $\gamma_{pi} \leq \frac{p}{qf} \equiv \gamma_{pg_r}$ *commit rape.*

(ii) The demand of rape is independent of γ_{mi}*.*

(iii) There is a unique threshold function $\gamma_{pg_p}(\gamma_{mi})$*, such that individuals with pair* $(\gamma_{pi}, \gamma_{ml})$ *and satisfying* $u_s'\left(\frac{p}{2qF\gamma_{pg_p}} - \frac{f}{2F} + \gamma_{mi}s_m\mathbb{I}_m\right) \geq \frac{p}{\gamma_{pg_p}}$ *buy prostitution.*[8]

(iv) There is a unique threshold function $\gamma_{mg_m}(\gamma_{pi})$*, such that individuals with ratio* $\frac{\gamma_{mi}}{\gamma_{pi}} \geq \frac{k}{ps_m}$ *get mated.*[9]

(iv) There is a unique threshold value such that only single women with $\delta_{pi} \leq \frac{p^2}{4k_p} \equiv \delta_{pd_p}$ *sell sex.*

Appendix Section C proves Proposition 1. Proposition 1 establishes thresholds that determine how many men commit rape, buy sex and get mated. Note that depending on the parameters and on the densities we could get an equilibrium with men doing the three actions or only part of them. In the same way this result also determines the women who sell sex. of thresholds for men's problem.

3 The impact of prostitution regulations on rape

So far we have studied the effect of prostitution on rape in a situation in which prostitution is not criminalized. This situation might also be considered tantamount to a situation in which prostitution is criminalized but the law (for whatever reason) is difficult to enforce and *de facto* it is as if prostitution were legal. As in the U.S. it is the case for indoor prostitution. Whelehan (2001) documents that 85% of prostitution services come from

[7] Assuming quasi-linearity in the consumption good is a common in the literature (Edlund 2013) and simplifies computations related to the fine for commiting rape, $F(s_r)$. Further, these preferences imply that the marginal rate of substitution for good c is constant, an assumption that makes sense in our setting since good c can be thought of as *general consumption*. Note that in our analysis this assumption rules out wealth effects on the sexual good s, in other words the optimal quantity of s is not a funcion of the individual's income y.

[8] This threshold is a function of γ_{mi} for mated men (due to the indicator function $\mathbb{I}_m$ being equal to 1 in that case) while it is a threshold value for single men.

[9] Appendix Section B graphs such threshold functions/ values.

indoor prostitution. It seems plausible that policemen find many difficulties to be aware and punish indoor prostitutes rather than outdoor ones. As a matter of fact, a study by the Urban Justice Center states that indoor prostitutes are vigilant and concerned with the issue of criminal justice but they usually experience less police interference and lower rate of arrests than their outdoor colleagues (Urban Justice Center 2005). In the previous model we were assuming that neither prostitutes or clients were criminalized.

In this section we analyze the three most important regulations of the market of prostitutes. It is important to observe that two of these regulations aim to decrease the number of prostitutes at equilibrium and they succeed in it, but they have unwanted effects on the quantity of rape at equilibrium. This section does not quantify the size of these effects but focuses on whether they increase or decrease rape at equilibrium.

It might be important for policy makers to be aware of the possible effects behind each one of these policies and the mechanisms at play. Policy makers by focusing on the market of prostitution might disregard that they are affecting rape as well.

First, we are going to analyze the effects of criminalizing prostitutes. Under this policy only individuals, in our case women, who sell sex will be criminalized. Second, we study criminalizing customers of prostitutes, this regulation is also informally known as *the Nordic model*. This regulation only affects the customers of prostitutes and not the prostitutes *per se*. Third, we considerl *the Dutch model*: prostitution is legal only for prostitutes who have a costly license (being the number of linceses fixed), while unlicensed prostitutes are criminalized. Note that the main difference between each policy is whether the punishment affects the choices of the customer or of the seller.

3.1 Criminalizing prostitutes

Consider a law that bans the sale of prostitution. Such a law penalizes prostitutes if caught selling sex. This law changes only the problem of single women. Let F_p be the fixed fine prostitutes have to pay if caught and let $q_p(s_p)$ be the probability (as a function of sold sex s_p) that a prostitute is caught. Then their expected utility may be written as:

$$\max_{s_p} q_p(s_p)\, u_c(w + ps_p - k_p - F_p) + (1 - q_p(s_p))\, u_c(w + ps_p - k_p) - \delta_{pi} v_s(s_p)$$

Also in this framework, single women compute the optimal quantity of sex they would sell and compare it to their outside option: getting only their wage w. Moreover, we assume that $q_p(s_p)$ is linear so that $q_p(s_p) = q_p s_p$ for some positive q_p where $\frac{1}{q_p}$ can be seen

as the maximum amount of prostitution that a prostitute can sell.[10] Hereinafter, we refer to this scenario as CP.

3.2 Criminalizing *johns*

Now consider a law that penalizes buying prostitution. In this case customers of prostitution are the ones who bear the fixed fine. Let F_c be the fixed fine and $q_c(s_p)$ be the probability that a *john* is caught buying sex. Using the same notation as in the previous section the problem of men at period 1 can be written as:

$$\begin{aligned}
&\max_{s_r,s_p} u_c(y_0 - \mathbb{I}(k)) + u_s(\gamma_{mi} s_m) \\
&+\beta\{q(s_r)\left[q_c(s_p)\left(u_c(y_1 - \mathbb{I}k - Fs_r - f - ps_p - F_c) + u_s(\gamma_{mi} s_m \mathbb{I} + \gamma_{rl} s_r + s_p)\right)\right. \\
&\quad \left. + (1 - q_c(s_p))\left(u_c(y_1 - \mathbb{I}k - Fs_r - f - ps_p) + u_s(\gamma_{mi} s_m \mathbb{I} + \gamma_{rl} s_r + s_p)\right)\right] \\
&\quad + (1 - q(s_r))\left[q_c(s_p)\left(u_c(y_0 - \mathbb{I}k - ps_p - F_c) + u_s(\gamma_{mi} s_m \mathbb{I} + \gamma_{rl} s_r + s_p)\right)\right. \\
&\quad \left. + (1 - q_c(s_p))\left(u_c(y_0 - \mathbb{I}k - ps_p) + u_s(\gamma_{mi} s_m \mathbb{I} + \gamma_{rl} s_r + s_p)\right)\right]\}
\end{aligned}$$

Men are forward looking so they only have to choose whether to offer a mating relationship or not, given their optimal choices taking into account the expected fine they face whenever purchasing sex. Moreover, let's assume that $q_c(s_p)$ is linear so that $q_c(s_p) = q_c s_p$ for some positive q_c where $\frac{1}{q_c}$ can be seen as the maximum amount of prostitution that a *john* can purchase. Hereinafter, we refer to this scenario as CJ.

3.3 The Dutch case

In the Netherlands brothels were banned until the year 2000. In that year prostitution was regulated by licenses: this created a dual market according to having the license or not. It is estimated that only 4% of persons selling sexual services have a license (Barnett et al. 2011). Prostitution is legal only for those prostitutes that have a license, while prostitutes that do not have a license can still be charged under the Penal Code. Hence, the market of prostitution in the Netherlands changed from a situation where prostitutes were penalized to a situation where only unlicensed prostitutes were penalize.

There are several reasons that might push a prostitute to work without a license: limited number of licenses, reluctance to register due to social stigma, illegal immigrant status of the prostitutes, etc. In this model we do not focus on how prostitutes get licenses

[10] In this case the problem is well defined if and only if $p > q_p F_p$. Put it differently, the price for selling sex is higher than its corresponding expected fine.

but rather we assume that prostitutes can get a license if they wish so. Note that in this case single women have three options and they compare the three of them according to their optimal choice.[11]

Specifically, in this case when a single woman decides to become a prostitute she compares her expected utility as prostitute with a license to her expected utility as prostitute without a license (i.e. facing the risk of being penalized) and to the reservation utility of not selling sex. Note that since getting a license entails bearing a fixed cost it does not affect the optimal solutions but it affects the final level of utility.

Licensed prostitutes are modelled as legal prostitutes that on top of paying the reputational cost k_p have to pay also the cost of their license l. Whereas unlicensed prostitutes are modelled in the same way as illegal ones: they face a probability of being caught $q_p(s_p)$ and a fixed fine F_p if caught. As in the previous sections, we are going to assume that the probability function is linear. Hereinafter, we refer to this scenario as L.

3.4 Effects of prostitution regulations on rape

Proposition 2. *Assume γ_m and δ_p follow a uniform distribution, $u_s(s) = \log(s)$ and the fixed cost of entering prostitution k_p is bounded by a function of other parameters.*[12] *Then:*

(i) *There exists a unique equilibrium in the prostitution market.*

(ii) *There exist thresholds at equilibrium for each of the three policies.*

(iii) *The effect on rape of CP and L is positive. The effect of CP is always larger than that of L for similar expected fines.*

(iv) *The effect on rape of CJ is positive and always as large as the one of CP for similar expected fines.*

Appendix Section D proves c. There are four key findings of Proposition 2. First, CJ, CP and L always increase rape with respect to decriminalization (benchmark). Second, if we fix the amount of the fine the effect of CP on rape is always larger than that of L. Third, if we fix the amount of the fine the impact of CJ on rape is always as large as that of CP. Four, consequently, if we fix the amount of the fine the effect of CJ on rape is always larger than that of L.

[11] Clearly their optimal choice will depend on their type δ_{pi}.

[12] The intuition of this assumption is clear: if selling sex involves a fixed cost that is extremely large it might be that no single woman prefers to sell sex.

Taken together, these results have three important implications for public policy. First, anytime prostitution is regulated via CJ, CP and L there is an unintended increment in rape. Second, regulating prostitution via either CJ or CP causes a larger increase in rape than via L. Third, the effects of CJ and CP are not symmetrical, being the effect of the former larger than that of the latter. An issue which has been extensively debated in the literature (Cunningham and Shah 2021; Cameron et al. 2021).

These results find broad support in the empirical literature. Cunningham and Shah (2018) find that decriminalization reduces rape by 30%, while Bisschop et al. (2017) find that licensing reduces rape by 16%. These findings are aligned with result (iii) of Proposition 2. Ciacci (2021) finds that the Nordic model boosts rapy by 47%. Comparison of Cunningham and Shah (2018) and Ciacci (2021) upholds result (iv) of Proposition 2. Further support for this result is found if we consider sexually transmitted infections. To this extent, Cunningham and Shah (2018) find that decriminalization decreases gonorrhoea by over 40%, whereas Cameron et al. (2021) estimate that criminalization of prostitution raises sexually transmitted infections by 58%.

3.5 Optimal expected fine for CJ regime

Consider a CJ regime. Assume the government wants to choose the expected fine $q_c F_c$ faced by *johns* in order to minimize $s_p^{dT} + A s_r^{dT}$ for some $A \geq 1$. The parameter A reflects that the government might prefer reducing rape than the demand of prostitution . Then we can establish the following result.

Lemma 1. *There exists an expected fine $q_c F_c$ that minimizes the weighted sum of total demand of prostitution and rape taking prices as given.*

Proof. It follows trivally taking the first order conditions and noting that the second derivative is always positive.

□

Lemma 1 gains importance since in 2014 the European parliament passed a non-binding resolution calling on other European countries to adopt the Nordic model. The Nordic model was first adopted by Sweden in 1999. Different countries followed suit, such as Norway (2009), Iceland (2009), Norther Ireland (2015) and France (2016). Furthermore, there is evidenced that recent acts in Scotland, England and Wales aimed to tackle demand in a similar way as the Nordic model (Della Giusta et al. 2019).

In this framework, Lemma 1 establishes that governments who opt for a CJ regime might establish a value of the expected fine in order to minimize the weighted sum of

total demand of prostitution and rape. As a result, they need to set the value of the fine and choose a level of enforcement (i.e. probability to be caught).

4 Empirical test

In this section we analyze a database covering different European countries. This analysis allows us to find suggestive evidence for the following results:

(i) The effect on rape of CJ is larger than that of L

(ii) The effect on rape of CJ and L is positive

Analysing different regulations in the prostitution market entails a problem of comparability. As a matter of fact, comparing policies betweeen countries is an ambitious task. Laws are different from country to country: the words used to formulate the law, the institution that enforces the law, the penalty and probability to be caught faced by criminals, etc., these are factors hard to compare. Furthermore, it is also troublesome to compare the number of rapes between countries since the definition of rape might differ across countries.

A deeper problem closely related to the prostitution market is the historical existence of a regulatory gap for this issue: until recent times the market of prostitution stood out for having a discrepancy between the laws in their *de jure* and *de facto* enforcement. This problem rose in this sector for several reasons. First, it is difficult to observe prostitution when it happens (especially indoor) so it might be difficult to enforce the law. Second, historically there have been problems, most likely related to moral issues, on how to regulate prostitution and enforce prostitution laws. For instance, in many countries as the UK, Spain or Italy there are different laws for individual prostitutes than for groups of at least two prostitutes.

Consider the case of Italy and Spain. In Italy exchanging money for sex is legal, but *organized* prostitution is illegal. In Spain *de iure* prostitution is not illegal but prostitutes cannot pay taxes and can be convicted depending on the municipality where the transaction takes place. As a whole, cases of this sort raises questions about how to interpret the law (Villacampa 2017). Namely, when should prostitutes be tagged as *organized*? How do we compare this law with countries that legalized prostitution as Denmark?

During the last two decades many governments decided to be more transparent and strict on prostitution laws. As a result our control group comprises countries that did

not have a clear regulation for the market of prostitution in the years considered in our sample.

To address the cross-country comparability problem we compare only groups of similar countries such as the Nordic European countries and the Western-Central European countries. As for the prostitution-law problem in our empirical analysis we compare countries that either opted for decriminalization or a CJ or L regime with countries that have differences between the *de jure* and *de facto* law.

5 Data

This describes the data used to carry out the empirical analysis. Our panel data is composed by two data-sets. The first data-set contains information about the number of rapes over countries during the period spanning from 1975 to 2012. This data-set is drawn from the United Nations' database. Since 1975 each year the United Nations records the crime statistics reported to the authorities via a survey sent to all countries. An issue of this data-set is that for some years a few countries did not disclose their crime statistics to the United Nations. As far as we know for the countries considered in this paper there is no concern to think that not reporting crime statistics might be correlated with the number of crimes occurred in that very year. In addition, it is reassuring to encounter that from the 90s reporting of the data for the countries considered in this paper is perfectly balanced.

Table 1 provides descriptive statistics over countries for this data-set. Unexpectedly this table shows that crime descriptive statistics vary substantially across countries. Sweden and Belgium experience the higher values of rapes on average. This motivates including countries fixed effect in our empirical econometric model. Countries in the Nordic group are Sweden, Denmark, Norway and Finland. While, the Central-Western group is formed by:Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Ireland, Italy, Holland, Poland, Portugal, Spain Switzerland and the UK. Countries hs been chosen on the basis of data availability in the United Nations' database.

Clearly this data-set might suffer the same problems of accuracy that have official crime data recorded by each country. In the case of rape, there might be underreporting since the victims could prefer not to report the crime to the authorities due to social stigma or fear of the aggressor.

The second data-set contains three binary variables that take value 1 in the year a certain regulation of the market of prostitution is enacted and later. Precisely, we consider three binary variables to take into account regulations that criminalize *johns*, legalize prostitution or grant licenses to prostitutes. These binary variables take value 0 when there

is not a clear regulation of the market of prostitution and value 1 from the year in which one of these three policies goes into effect. Table 2 displays the year in which prostitution regulations became effective across treated countries in both Nordic and Central Western groups. This table also shows what countries comprise the control group.

Additionally, we have a set of controls for gender, labor and economic conditions. This dataset is drawn from the World Bank. Specifically, to control for gender conditions we use the expected years of life at birth for females, the fertility rate and the female labor participation. As for controlling for economic-labor conditions we include GDP per capita, inflation and unemployment.[13]

These control variables are useful because there might be the concern that different regulations on prostitution were enacted in countries depending on their gender, labor and economic conditions. Therefore controlling for such variables would proxy changes in these conditions.

Figure 1 shows the log of the rape rate per 100,000 inhabitants in 2012 (last year of our dataset). Greece, Bulgaria and Spain are the two countries exhibiting the lower number of rapes. Belgium, the UK and Sweden are the ones experiencing the larger rates of rape. This corroborates that rape rates vary substantially across countries even in the last year of our sample.

Figure 2 depicts the same dataset but grouped according to the prostitution regulation chosen by each country. In this graph, different colours denote a different prostitution regulation. Red denotes legalized prostitution, blue denotes licensed prostitution, green denotes a regulatory gap (i.e. difference between *de jure* and *de facto*) and black means criminalizing the purchase of prostitution. All in all, this graph suggests that countries where prostitution is *tolerated* (legalized or licensed) exhibit lower levels of rape compared to countries where prostitution is criminalized or where there is a regulatory gap.

6 Results

First, we consider the group of Nordic countries: Finland, Sweden, Denmark and Norway. In two of these countries *johns* were criminalized while in one prostitution was legalized. Namely, we consider the following regression model:

$$log\left(rape_{cy}\right) = \alpha_c + \alpha_y + \beta CJ_{cy} + \gamma decriminalization_{cy} + X_{cy}\theta + \varepsilon_{cy} \tag{1}$$

[13]GDP per capita is measured at 2005 $. While inflation comes from the variation of the CPI for each countries. Using the inflation measured through the GDP deflator does not change our results.

where $log\,(rape_{cy})$ is the log of the numbers of rapes for country c at year y, α_c and α_y are respectively fixed effects for country and year, while CJ_{cy} is a binary variable taking value 1 if buying prostitution was illegal in country c at year y and 0 otherwise, and $decriminalization_{cy}$, in the same fashion, is a binary variable taking value 1 if prostitution was legal in country c at year t and 0 otherwise. X_{cy} comprises a set of variables to control for economic, labor and gender conditions.

Second, we consider the Central-Western group of European countries. In four of these countries prostitution was licensed, the regression analyzed is similar to the previous one:

$$log\,(rape_{cy}) = \alpha_c + \alpha_y + \delta L_{cy} + X_{cy}\theta + \varepsilon_{cy} \tag{2}$$

where now L_{cy} is a dummy variable that takes value 1 if prostitution is licensed and 0 otherwise.

There could be concerns that changes in rape and/or approval of a certain prostitution regulation are due to changes in the women's rights conditions. Our data-set span since 1975 to 2012 in this period women gradually gained more rights and their participation in the labor market increased. Thereby, we decided to include three control variables capturing change in women's conditions (gender equality): labor female participation, life expectancy of females and fertility rate. In the tables of results we refer to these three variables with the name *gender controls*. Labor female participation captures all the changes due to the rise of working women, while life expectancy of women proxies better women's quality of life. The third variable used in the *gender controls* is fertility. This variable proxies the sexual revolution (specially due to contraceptives) that took place in our sample period. Indeed due to the sexual revolution countries experienced substantial reductions in the fertility rate.[14]

Another type of threat to the correlations of the regressions come from the economic and labor conditions. There might be the concern that rape increases during economic crisis. To tackle this concern we include three controls variables, namely: unemployment, GDP per capita at 2005 $ and inflation (coming from CPI). We refer to these three variables as *economic-labor controls*.

These regressions cannot have a causal interpretation. Indeed, the aim of our empirical analysis is to estimate the sign and size of the statistical associations between CJ and L regimes and rape.

It is key to note that in the theoretical model we were comparing different regulations

[14]Recall that fertility measures the average number of births per woman in a given year for a certain country.

on the market of prostitution to the benchmark case (i.e. legalized prostitution). However in the empirical analysis the control group is comprised of countries' with a regulatory gap in their prostitution law.

Table 3 presents the results of regression model (1). Column (1) presents the results without controls, column (2) adds the *gender controls*, column (3) adds the *economic-labor controls*. Finally, column (4) adds both sets of controls. Results confirm our predictions about the two coefficients. As expected, CJ is associated to an increase in the number of rapes while decriminalization is negatively correlated with rape.

Likewise, table 4 presents the results of regression model (2). As expected, L is negatively associated to rape. Appendix Section E shows the estimated results for both regression models (1) and (2) using rape, instead of the rape per 100,000 inhabitants, as dependent variable. Results do not change.

Table 5 normalizes the results using the estimated coefficient for legalized prostitution (i.e. Denmark) as benchmark. Our estimated coefficients from regression models (1) and (2) suggest that both CJ and L increase rape with respect to decriminalization, and that the effect of CJ is larger than that of L. The last three rows of the table display the p-values corresponding to three null hypothesis: (i) CJ and L have the same effect on rape, (ii) L and decriminalization have the same effect on rape and (iii) CJ and decriminalization have the same effect on rape. It is reassuring to find that we reject the null for each of the three hypotheses. As a whole, these results offer suggestive evidence for the results indicated by the theoretical model.

7 Concluding remarks

This paper builds a theoretical framework connecting rape and prostitution based on the substitutable relationship between the two found in a recent branch of the empirical literature (Cunningham and Shah 2018; Bisschop et al. 2017; Ciacci and Sviatschi 2019). This framework is also useful to determine the potential effects of prostitution regulations on rape.

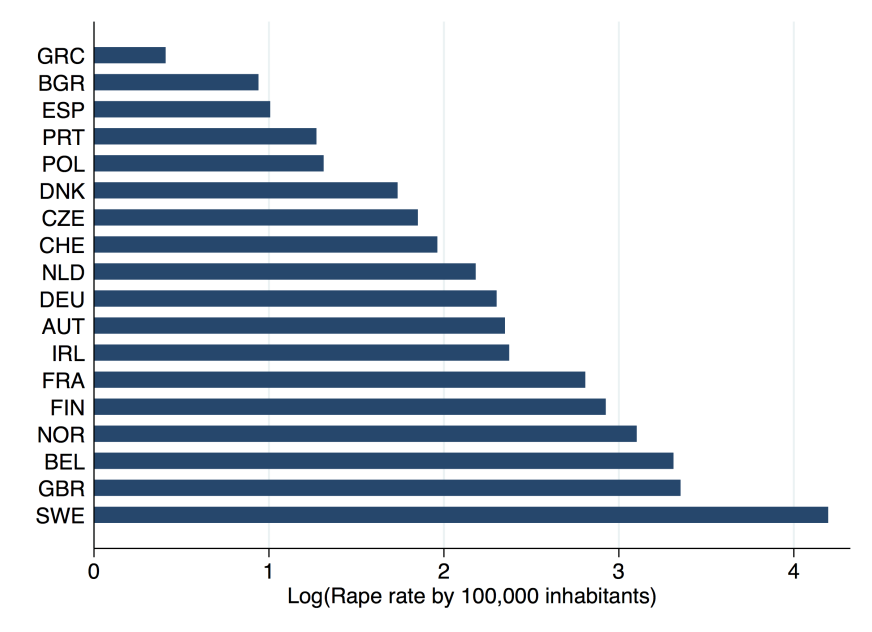
Our findings suggest that criminalization of either the purchase or the sale of prostitution boosts rape (with respect to decriminalization), being the effect of the former larger than that of the latter. Likewise, licensing prostitution raises rape (with respect to decriminalization); the effect of this regime is smaller than that of criminalization of the sale of prostitution. These results are aligned with causal evidence estimated in the literature (Cunningham and Shah 2018; Bisschop et al. 2017; Cameron et al. 2021; Della Giusta et al. 2019; Ciacci 2021).

Since in 2014 the European parliament passed a non-binding resolution calling on other European countries to adopt the Nordic model (i.e. criminalization of the purchase of prostitution). It is important to pin down the impacts of this regime. An additional finding of this paper is that for the Nordic model there exists an optimal expected fine to minimize the sum of rape and prostitution. Finally, using cross-countries correlations this paper finds additional evidence supporting the claims of our theoretical model.

All in all, this paper sets the ground for a comprehensive analysis of the effects of prostitution regulations on rape. The results of such an analysis are extremely useful to choose and motivate how to regulate prostitution, a hot topic both in the U.S. and Europe.

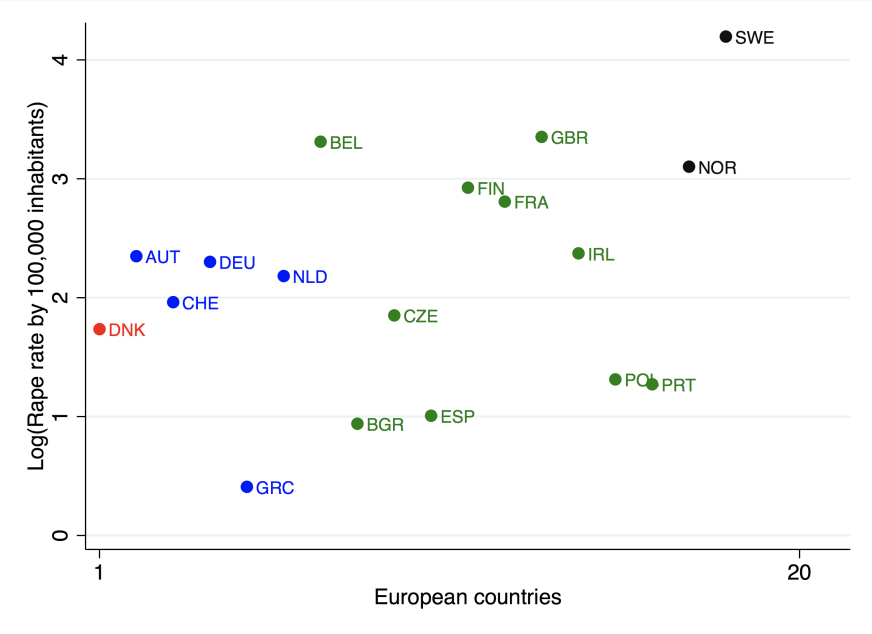
Figures & Tables

Figure 1: Rape rate per 100,000 inhabitants in 2012 in Europe (sample countries, exlcuding Italy)



Notes: This figure shows the log of the rape rate per 100,000 inhabitants in 2012 (last year of our cross-country sample) in Europe. Countries have been selected on the basis of available data. We can see that there is a substantial difference in rape rate between countries.

Figure 2: Rape rate per 100,000 inhabitants in 2012 in Europe (sample countries, exlcuding Italy)



Notes: This figure shows the log of the rape rate per 100,000 inhabitants in 2012 (last year of our cross-country sample) in Europe. Each different colour denotes a different regulation on the prostitution market. Red means legalized prostitution, blue means licensed prostitution, green means regulation gap and black means penalizing purchase of prostitution. Countries have been selected on the basis of available data. We can see that as a whole countries where prostitution is *tolerated* (legalized or licensed) exhibit lower levels of rape compared to countries where prostitution is not regulated clearly or even penalized.

Table 1: Descriptive statistics

Country	Observations	Mean	Std. Dev	Min	Max
Sweden	35	25.12	19.17	9.39	69.12
Denmark	34	8.79	1.58	5.67	11.46
Norway	36	10.16	6.26	2.68	22.23
Finland	38	9.44	3.5	5.94	19.28
Austria	31	8.54	1.79	6.36	12.4
Belgium	18	22.21	9.09	5.35	30.96
Bulgaria	33	6.73	2.71	2.14	11.81
Czech Republic	34	5.58	1.07	3.75	8.61
France	30	9.74	5.45	2.74	16.76
Germany	34	8.66	1.15	6.33	10.70
Greece	27	2.76	1.70	1.04	6.2
Ireland	26	5.84	3.44	0.99	10.84
Italy	30	3.08	1.88	0.98	7.76
Holland	31	12.73	7.52	6.02	30.58
Poland	34	4.99	0.76	3.72	6.27
Portugal	32	3.23	1.18	1.14	5.45
Spain	27	4.93	3.6	2.12	15.12
Switzerland	31	6.3	1.32	3.93	8.69
UK	38	12.41	9.33	2.43	28.58
Total for Nordic	143	13.31	12.13	2.68	69.13
Total for Central-Western	456	7.56	6.08	0.98	30.96
Total	599	8.93	8.31	0.98	69.13

Table 2: Type of regulation in the prostitution market for countries studied in the empirical section

Group	**Country**	**Prostitution Regulation**	**Year**
Nordic	Sweden	Criminalizing *johns*	1999
Nordic	Denmark	Legalization	1999
Nordic	Norway	Criminalizing *johns*	2009
Nordic	Finland	-	-
Central-Western	Austria	-	-
Central-Western	Belgium	-	-
Central-Western	Bulgaria	-	-
Central-Western	Czech Republic	-	-
Central-Western	France	-	-
Central-Western	Germany	Licenses	2002
Central-Western	Greece	Licenses	1999
Central-Western	Ireland	-	-
Central-Western	Italy	-	-
Central-Western	Holland	Licenses	2000
Central-Western	Poland	-	-
Central-Western	Portugal	-	-
Central-Western	Spain	-	-
Central-Western	Switzerland	Licenses	1942
Central-Western	UK	-	-

Table 3: Regression results for Nordic European countries.

	(1)	(2)	(3)	(4)
VARIABLES	Log(Rape/Pop)	Log(Rape/Pop)	Log(Rape/Pop)	Log(Rape/Pop)
CJ	0.404***	0.220**	0.394***	0.391***
	(0.103)	(0.103)	(0.0982)	(0.110)
Decriminalization	-0.787***	-0.947***	-0.417***	-0.475***
	(0.123)	(0.150)	(0.127)	(0.138)
Observations	143	143	124	124
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls		Gender	Economic-Labor	All
Countries	Nordic	Nordic	Nordic	Nordic

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression results for Central-Western European countries.

VARIABLES	(1) Log(Rape/Pop)	(2) Log(Rape/Pop)	(3) Log(Rape/Pop)	(4) Log(Rape/Pop)
L	-0.499***	-0.534***	-0.188**	-0.130
	(0.105)	(0.111)	(0.0795)	(0.0908)
Observations	456	456	333	333
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls		Gender	Economic-Labor	All
Countries	Centr-Western	Centr-Western	Centr-Western	Centr-Western

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Normalized results.

VARIABLES	(1) Log(Rape/Pop)	(2) Log(Rape/Pop)	(3) Log(Rape/Pop)	(4) Log(Rape/Pop)
L	.288	0.413	0.229	0.345
CJ	1.191	1.167	0.811	0.866
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls		Gender	Economic-Labor	All
p-values				
CJ= L	0.000	0.000	0.000	0.000
L= Decriminalization	0.044	0.011	0.073	0.013
CJ = Decriminalization	0.000	0.000	0.000	0.000

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Appendix

A Definitions of total supply, total demands and equilibrium

Definitions:

- The total supply of prostitution is $s_p^{sT} \equiv \int_0^{\bar{\gamma_m}} h_m(x)\,dx \int_1^{\bar{\delta_p}} g(x)\, s_p^s(x)\,dx$ where $s_p^s()$ is the solution of the maximization problem of single women and $\int_0^{\bar{\gamma_m}} h_m(x)\,dx$ is the total number of single individuals.
- The total demand of prostitution is $s_p^{dT} \equiv \int_{\bar{\gamma_m}}^{a_m}\int_{\bar{\gamma_p^m}}^{a_p} h_{p,m}(x,y)\, s_p^{dm}(x,y)\,dxdy + \int_0^{\bar{\gamma_m}}\int_{\bar{\gamma_p^s}}^{a_p} h_{p,m}(x,y)\, s_p^{ds}(x,y)\,dxdy$ where $s_p^{dm}()$ is the demand (i.e. optimal solution) of prostitution sex for mated men, $s_p^{ds}()$ for single men and $h_{p,m}(x,y)$ denotes the joint density.
- The total demand of rape is $s_r^{dT} \equiv \int_0^{\gamma_{g_r}} h_p(x)\, s_r^d(x)\,dx$ where $s_r^d()$ is the demand (i.e. optimal solution) of rape for each man.

Note that a nice feature of this model is that takes into account both the extensive and intensive margin of the sex good. For instance a rise in the extensive margin of rape would be reflected by an increase in the terms entering the integral while an increase in the intesive margin would be taken into account by an increase in the solution of the maximization problem.

Definition: For given parameters y_0, y_1, k, s_m, w and k_p, functions $u_c()$, $u_s()$, $q()$ and $v_s()$ that follows conditions written above, sets of invidual parameters G_m, G_r and G_p and densities $f_m()$, $f_p()$ and $g_p()$, an equilibrium is defined as s_r^*, s_p^* and p^* such that:

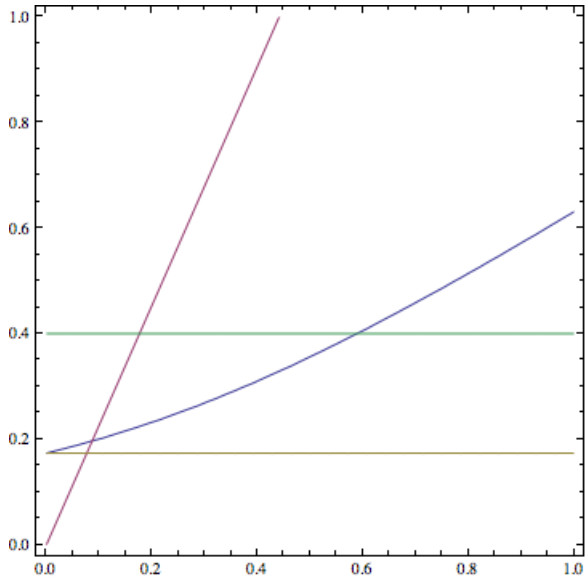
1. $s_p^{dT}(p^*) = s_p^{sT}(p^*) = s_p^*$
2. $s_r^* = s_r^{dT}(p^*)$
3. All men's demands, single women's supply and p^* are non-negative.

B Graph threshold functions/values

Assume $u_s(s) = \log(s)$and choose the parameters, then we can depict men who will get a mating relationship, but prostitution and/or commit rape in a graph like the following one. Note thatonce we fixed the functional form we can also pin down the threshold functions for men who will buy sex. Precisely this threshold function will be characterized by $\frac{(\gamma_{pg_p})^2}{p} + \left(\frac{f}{2F} - \gamma_{mi} s_m \mathbb{I}_m\right) \gamma_{pg_p} - \frac{p}{2qF} \geq 0$ which depicts two functions due to the indicator function that takes value 1 only for mated individuals. These two functions are depicted by the blue and brown line below. All the points above and on the blue line represent all the combinations of γ_p and γ_m that will prefer to buy sex, while the brown line represents this combination for single men. All individuals with γ_p below or on the green line will commit rape, whereas men with γ_p and γ_m on the red line or on the right of the red line will get mated.

Hence, Figure7 depicts, given the fixed parameters, all the possible combinations between buying sex, get mated and commit rape for all men according to their heterogenous weights γ_p and γ_m.

Figure A.1: Threshold functions/values for parameters γ_p and γ_m.



Notes: Example of threshold functions for a given functional form of $u_s(s)$ and fixed parameters.

C Proof of Proposition 1

Proof. Use the super indexes to denote the status of man, specifically m for mated and s for single.

(i) and (ii) From the first order conditions of the men's problem get:

$s_r^{dm} = s_r^{ds} = \max\left\{\frac{1}{2qF}\left(\frac{p}{\gamma_{pi}} - qf\right), 0\right\}$. Note that the result is the same for mated men than for single ones. Then the result follows.

(iii) From the first order conditions of men's problem get:

$s_p^{dj} = \frac{1}{\gamma_{pi}}\left[u_s'^{\leftarrow}\left(\frac{p}{\gamma_{pi}}\right) - \frac{p}{2qF\gamma_{pi}} + \frac{f}{2F} - \gamma_{mi}s_m\mathbb{I}_m\right]$ where the arrow $\leftarrow$ denotes the inverse function, $\mathbb{I}_m = 1$ if $j = m$ and $\mathbb{I}_m = 0$ if $j = s$.

(iv) Get the first order conditions of men's problem for mated and single men. Plug the optimal s_r and s_p for mated and single men in their respected utility functions. After simplificating the equation note that mating gives higher utility than bachelerhood if $s_p^{ds} - s_p^{dm} \geq \frac{k}{p}$ where s_p^{ds} and s_p^{dm}respectively denote the demand for prostitution by single and mated men. Thus $\frac{1}{\gamma_{pi}}\gamma_{ml}s_m \geq \frac{k}{p}$

(v) Consider single women's problem. Get the first order condition and plug it into the utility function. Then a single woman will prefer to sell sex if and only if $pv_s'^{\leftarrow}\left(\frac{p}{\delta_{pg_p}}\right) \geq k_p + \delta_{pg_p}v_s\left(v_s'^{\leftarrow}\left(\frac{p}{\delta_{pg_p}}\right)\right)$ where the arrow $\leftarrow$ denotes the inverse function. Substitute the functional form $v_s(s_p) = s_p^2$ and the result follows easily.

□

D Proof of Proposition 2

Proof. **(i)** In this proof we are going to fix $\gamma_p = 1$. Solve the model and get

$$s_p^{dT} = \int_{\bar{\gamma_m}}^{a_m}\int_{\bar{\gamma_p^m}}^{a_p} h_{p,m}(\gamma_{pl}, \gamma_{ml})\frac{1}{\gamma_{pl}}\left(u_s'^{\leftarrow}(p) - \left(\frac{p}{\gamma_{pl}2qF} - \frac{f}{2F}\right) - \gamma_{ml}s_m\right)d\gamma_{pl}d\gamma_{ml}$$
$$+\int_{0}^{\bar{\gamma_m}}\int_{\bar{\gamma_p^s}}^{a_p} h_{p,m}(x, y)\frac{1}{\gamma_{pl}}\left(u_s'^{\leftarrow}(p) - \left(\frac{p}{\gamma_{pl}2qF} - \frac{f}{2F}\right)\right)d\gamma_{pl}d\gamma_{ml}$$

and $s_p^{sT} \equiv \int_0^{\bar{\gamma_m}} h_m(x)\,dx\int_1^{\bar{\delta_p}} g(\delta_{pi})\frac{p}{2\delta_{pi}}d\delta_{pi}$. Then clear the prostitution market $s_p^{dT} = s_p^{sT}$, note that $\int_{\bar{\gamma_p^m}}^{a_p}$ denotes the integral over all the region where $u_s'\left(\frac{p}{2qF\gamma_{pg_p}} - \frac{f}{2F} + \gamma_{mi}s_m\right) \geq \frac{p}{\gamma_{pg_p}}$ (i.e. all the region where mated individuals buy sex) while $\int_{\bar{\gamma_p^s}}^{a_p}$ denotes the integral over all the region where $u_s'\left(\frac{p}{2qF\gamma_{pg_p}} - \frac{f}{2F}\right) \geq \frac{p}{\gamma_{pg_p}}$ (i.e. all the region where

single individuals buy sex). Note that once we solve the integrals for this case the clearing market condition can be written as:

$$\frac{k}{2u_p a_m s_m}\log\left(\frac{p^2}{4k_p}\right)=\left(\frac{1}{p}-\frac{p}{2qF}+\frac{f}{2F}\right)+\frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ps_m}\right)^2-a_m\right)$$

Note that the left hand-side is an increasing continuos function of p that goes to minus infinity if the price approaches zero, whereas the right hand-side is an decreasing function of $p$that goes to minus infinity if the price approaches zero.

Define $\tilde{p}\equiv\left\{p\mid\left(\frac{1}{p}-\frac{p}{2qF}+\frac{f}{2F}\right)+\frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ps_m}\right)^2-a_m\right)=0\right\}$ assuming $k_p\leq\tilde{p}$ guarantees that the solution is non-negative.

(ii) Specifically we need the following conditions.

Conditions for CP: $\delta_{pi}\leq\frac{(p-q_pF_p)^2}{4k_p}\equiv\delta_{pd_{p'}}$

Conditions for CJ: $\frac{\gamma_{mi}}{\gamma_{pi}}\geq\frac{k}{(p+q_cF_c)s_m}$, $\gamma_{pi}\leq\frac{(p+q_cF_c)}{qf}$ and $u'_s\left(\frac{(p+q_cF_C)}{2qF\gamma_{pg_p}}-\frac{f}{2F}+\gamma_{mi}s_m\mathbb{I}_m\right)\geq\frac{(p+q_cF_c)}{\gamma_{pg_p}}$

Conditions for L: Define $\delta_{pd_{p'}}\equiv\frac{(p-q_pF_p)^2}{4k_p}$, $\delta_{pd_l}\equiv\frac{q_pF_p(2p-q_pF_p)}{4l}$ and $\delta_{pd_{l'}}\equiv\frac{p^2}{4(k_p+l)}$

Then the proof follows similarly to the proof of Proposition 1. Nonetheless note that in the case of licenses there are two cases:

a. If $\delta_{pd_l}<\delta_{pd_{p'}}$ then there exists thresholds value such that only single women with $\delta_{pi}<\delta_{pd_{p'}}$ and $\delta_{pi}>\delta_{pd_{l'}}$will sell sex without a license, whereas single women with $\delta_{pi}\leq\delta_{pd_l}$ and $\delta_{pi}\leq\delta_{pd_{l'}}$will get a license.

b. If $\delta_{pd_l}\geq\delta_{pd_{p'}}$ then no single woman will sell sex without a license, there exist thresholds value such that single women with $\delta_{pi}\leq\delta_{pd_l}$ and $\delta_{pi}\leq\delta_{pd_{l'}}$ will get a license.

(iii) Note that in CJ scenario $s_r^{dT}(p)=\frac{1}{2qF}(p+q_cF_c)$. Note that $p+q_cF_c$ as a function of $q_cF_c$is implicitly defined by the market clearing condition in this case $\frac{k}{2u_pa_ms_m}\log\left(\frac{p^2}{4k_p}\right)=\left(\frac{1}{p+q_cF_c}-\frac{p+q_cF_c}{2qF}+\frac{f}{2F}\right)+\frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ps_m}\right)^2-a_m\right)$. While in the CP scenario $s_r^{dT}(p)=\frac{1}{2qF}(p)$ and the market clearing conditions become $\frac{k(p-q_pF_p)}{2u_pa_ms_mp}\log\left(\frac{(p-q_pF_p)^2}{4k_p}\right)=\left(\frac{1}{p}-\frac{p}{2qF}+\frac{f}{2F}\right)+\frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ps_m}\right)^2-a_m\right)$. We are interested in comparing for the same fines $q_cF_c=q_pF_p$ the function $p+q_cF_c$ implicitly defined by market clearing condition in CJ to the function p implictly define in CP. Define the expected price paid by prostitutes customers as $y\equiv p+q_cF_c$ in the CJ case and $y\equiv p$ in the CP case. Further fixed the

same expected fine $x = q_c F_c = q_p F_p$. Then the two clearing market conditions for CJ and CP can respectively be written as $\frac{k}{2u_p a_m s_m} \log\left(\frac{(y-x)^2}{4k_p}\right) = \left(\frac{1}{y} - \frac{y}{2qF} + \frac{f}{2F}\right) + \frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{(y-x)s_m}\right)^2 - a_m\right)$ and $\frac{k(y-x)}{2u_p a_m s_m y} \log\left(\frac{(y-x)^2}{4k_p}\right) = \left(\frac{1}{y} - \frac{y}{2qF} + \frac{f}{2F}\right) + \frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ys_m}\right)^2 - a_m\right)$. Denote respectively the LHS and RHS of market clearing condition in CJ scenario as $t_1(y,x) = \frac{k}{2u_p a_m s_m} \log\left(\frac{(y-x)^2}{4k_p}\right)$ and $t_2(y,x) = \left(\frac{1}{y} - \frac{y}{2qF} + \frac{f}{2F}\right) + \frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{(y-x)s_m}\right)^2 - a_m\right)$. In the same pattern we can write $t_3(y,x) = \frac{k(y-x)}{2u_p a_m s_m y} \log\left(\frac{(y-x)^2}{4k_p}\right)$ and $t_4(y,x) = \left(\frac{1}{y} - \frac{y}{2qF} + \frac{f}{2F}\right) + \frac{1}{2}\left(\frac{1}{a_m}\left(\frac{k}{ys_m}\right)^2 - a_m\right)$. Recall that in this case $0 < x < y$.[15] Note that for given x we have $t_2(y,x) > t_4(y,x)$ and $t_3(y,x) > t_1(y,x)$. But $t_2(y,x) - t_4(y,x) > t_3(y,x) - t_1(y,x)$ for $0 < x < y$.

□

E Robustness of results: cross-country without taking into account population

In this subsection we analyze the specifications (1) and (2) using $log(rape$ instead of $log(\frac{rape}{population})$. Results support the two predictions tested via our empirical analysis.

Table A.1: Cross country

VARIABLES	(1) Log(Rape)	(2) Log(Rape)	(3) Log(Rape)	(4) Log(Rape)
CJ	0.414***	0.225**	0.408***	0.407***
	(0.105)	(0.107)	(0.0964)	(0.108)
Decriminalization	-0.806***	-0.967***	-0.411***	-0.467***
	(0.126)	(0.154)	(0.127)	(0.138)
Observations	143	143	124	124
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls		Gender	Economic-Labor	All
Countries	Nordic	Nordic	Nordic	Nordic

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[15] Take a look to the maximization problem of prostitutes in CP to remember why.

Table A.2: Cross country

VARIABLES	(1) Log(Rape)	(2) Log(Rape)	(3) Log(Rape)	(4) Log(Rape)
L	-0.484***	-0.509***	-0.197**	-0.144
	(0.104)	(0.110)	(0.0786)	(0.0907)
Observations	456	456	333	333
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls		Gender	Economic-Labor	All
Countries	Centr-Western	Centr-Western	Centr-Western	Centr-Western

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1