



# Prostitution or marriage? Evidence from the Nordic model

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## Abstract

We provide the first empirical evidence that prostitution is a sexual substitute for marriage. Using the adoption of the Nordic model of penalizing sex buyers, we find that restraining commercial sex leads to a significant increase in marriage rates and a significant decrease in divorce rates. These results are mainly driven by marriages among young people and marriages among previously single people, compared to those who were previously in legal unions. We further show that the substitution effect of prostitution on marriage is stronger when women's socioeconomic status is weaker and when people prefer marriage over cohabitation.

**Keywords** Prostitution · Commercial sex · Marriage · Divorce · Nordic model

**JEL Classification** J12 · J47 · J48 · K23 · K42

“Many a marriage hardly differs from prostitution, except being harder to escape from.”

Bertrand Russell

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## 1 Introduction

Prostitution is a profitable industry that employs millions of women worldwide. For example, a recent study that compiles information from HIV prevalence data, NGOs, and other sources estimates that there were between 541,957 and 1,309,634 female sex workers across the EU in the late 2000s (Adair and Nezhyvenko 2017). Reports with varying methodologies have estimated that between 10 and 80% of all men in a given country buy sex (Farley et al. 2011). For instance, Germany's prostitution industry, likely the largest in Europe, generates 16.3 billion USD per year, with 400,000 prostitutes working throughout the country and 1.2 million men purchasing sex every day (Business Insider 2019). Despite the fact that sex is a basic human need and that the prostitution market plays an important role in sex transactions, the influence of the commercial sex industry on households' behavior is relatively under-examined. In this paper, we shed light on this issue by examining the effect of the prostitution market on the marriage market.

The markets for prostitution and marriage are commonly viewed as two distinct entities that serve two vastly different purposes. On the prostitution market, commercial sex workers sell their services in exchange for payment—a transaction that is often illegal or unregulated and occurs in the black market. By contrast, on the marriage market, which is often regulated by laws and customs, individuals seek out long-term partnerships, based on romantic attraction rather than monetary transactions. Through dating, arranged marriages, or other forms of matchmaking, in this market, individuals meet, assess each other's suitability as partners, and if deemed compatible, proceed to marry. Accordingly, these two markets are generally considered separate and serve distinct social functions.<sup>1</sup> Extending this common view, our paper provides the first empirical evidence identifying a substitution effect of prostitution on marriage choices, which represent one of the most significant milestones in an individual's life.

Our tests utilize the staggered adoption of the Nordic model in Europe from 1980 to 2022. This model represents the recent global trend of combating prostitution and sexual exploitation by penalizing men for buying commercial sex. We expect the Nordic model to increase marriage rates and decrease divorce rates for the following reasons. From men's perspective, restrictions on commercial sex transactions may result in a notable scarcity. Such limitations could shift these transactions into the so-called black markets, consequently increasing the associated costs and intensifying

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<sup>1</sup> For further theoretical discussion on the prostitution market, see Barry (1995), Farley (2004), Sanders (2008), Brents and Sanders (2010), Weitzer (2010), Cunningham and Shah (2021), and Della Giusta and Hui (2021). For more information on the marriage market, see, for instance, Becker (1974) and Bethmann and Kvasnicka (2011). To the best of our knowledge, studies that examine the two markets simultaneously are very scarce and limited in scope, one of the most prominent examples being Davis (1937). As he puts it (p.746), "The sexual institutions are distinguished by the fact that though they all provide gratification, they do not all tie it to the same social functions...Marriage and its subsidiary patterns constitute the chief cultural arrangement through which erotic expression is held to reproduction. It is accordingly the most respectable sexual institution, with the others diminishing in respectability as they stand further away from wedlock."

the risks related to health, safety, and broader societal implications. Moreover, the Nordic model particularly increases men's legal risk for purchasing sexual services. Considering that commercial sex and marriage are two alternatives for men to obtain sexual gratification, the Nordic model makes prostitution a less attractive substitute for marriage, thereby increasing men's propensity to seek a traditional partnership and get married (Edlund and Korn 2002; Lee and Persson 2022). From women's perspective, a rise in men's interest in marriage could make women more willing to marry, as it becomes easier for them to find potential partners.

Our empirical setting is appealing for at least four reasons. First, the primary motives behind governments' adoption of the Nordic model are usually to deter commercial sex and reduce human trafficking for sexual exploitation (Hughes 2000; Di Nicola et al. 2005; Jakobsson and Kotsadam 2013). These legal changes are not aimed at affecting marriage rates; therefore, any potential effect on marriage is likely to be an unintended consequence. Second, these staggered legal changes enable us to identify their effect in a difference-in-differences (DiD) framework. Because multiple countries adopted the Nordic model at different times, our setting mitigates the common challenge faced by studies with a single policy change: Some potential noise coincides with the Nordic model and directly affects marriage (Roberts and Whited 2013). Third, European statistics show high conformity levels (Alstalo 2018), allowing us to better identify the causal effects of the Nordic model in a cross-country setting. Moreover, our cross-country approach helps shed light on how the heterogeneity in countries' social environments influences the Nordic model's impact on marriage. Lastly, due to the staggered policy changes, a country can be in both the treatment group and the control group at different times, which helps mitigate concerns regarding any large differences between the two groups.

We find that the adoption of the Nordic model leads to a significant increase in marriage rates. On average, countries that implemented such a model (i.e., the treated countries) experienced an increase in marriage rates of approximately 0.93 marriages per 1,000 population, relative to countries that did not adopt the Nordic model (i.e., the control countries). Further, the Nordic model leads to a decrease in divorce rates of 16.17 divorce cases per 100 new marriages in the treated countries relative to the control countries.

The assumption central to a causal interpretation of the DiD estimation is that, in the absence of treatment, treated and control countries would have parallel trends both before and after the countries' legal change. This assumption is inherently untestable, because we do not observe the treated countries in the absence of treatment. However, we can obtain supporting evidence by examining pre-treatment trends. We show that the pre-treatment trends of these two types of countries are indistinguishable, and that most of the impact of the Nordic model on marriage occurs several years after the change, suggesting a causal effect.

We examine the influence of the Nordic model on marriage decisions across different age groups. Younger men typically exhibit a higher demand for sex than older men, and men often prefer to marry women younger than themselves. Consequently, the treatment effect is likely stronger among younger individuals. Supporting this hypothesis, our findings indicate that the impact of the Nordic model on marriage rates is primarily driven by younger couples. Furthermore, we investigate the effect

of the Nordic model on marriage decisions based on previous marital status (i.e., single vs. in a legal union). Since single men generally experience less stable sexual lives than men in legal partnerships, the treatment effect is likely more pronounced for single men. Relatedly, single women are more likely to respond to shifts in men's demand within the marriage market than women in legal unions, suggesting a stronger treatment effect for single women. Consistent with these expectations, we find that the Nordic model's effect on marriage rates is predominantly driven by individuals who were previously single, compared to those previously in a legal union.

Next, we implement triple-differences tests to examine two possible sources of heterogeneity in the treatment effect. According to Tzeng and Mare (1995) and Olivetti et al. (2024), women with lower socioeconomic status are more responsive to men's demands in marriage decisions. When the Nordic model heightens men's desire for marriage, these women may be more likely to enter into marriage. Thus, we expect and indeed find a stronger treatment effect when women have lower socioeconomic status. Furthermore, given that some individuals opt for cohabitation instead of marriage when forming unions, we find that our treatment effect is more pronounced when individuals are more inclined to choose marriage over cohabitation. This finding suggests that cohabitation may lead to an underestimation of the Nordic model's effect on the marriage market.

Our paper makes at least three key contributions. First, it adds to the growing body of literature examining the interaction between the prostitution and marriage markets. The model of Edlund and Korn (2002) predicts that the opportunities in the prostitution market and those in the marriage market are substitutes for women. In their framework, since a woman generally cannot simultaneously fulfill the roles of wife and prostitute, she may choose the market that offers her greater welfare. The model of Lee and Persson (2022) extends that of Edlund and Korn (2002) by differentiating between coerced and voluntary prostitutes. They particularly analyze the impact of the Nordic model and predict that its introduction shrinks the prostitution market and expands the marriage market. Empirically, Ciacci (2023) shows that the adoption of unilateral divorce laws in some U.S. states is associated with a decrease in the number of arrested female prostitutes, which is interpreted as evidence that improved welfare for wives reduces the supply of prostitution. Arunachalam and Shah (2008), in their study of prostitution markets in Ecuador and Mexico, argue that the premium associated with sex work is a compensating differential rather than being directly influenced by the marriage market. To the best of our knowledge, our study provides the first empirical evidence that prostitution market conditions significantly influence the marriage market: Worse business conditions in the prostitution market lead to more marriages and fewer divorces.

Our paper's second contribution lies in addressing the controversial nature of prostitution regulation (Weitzer 2010; Barnett et al. 2011; Della Giusta and Munro 2016). The Nordic model—widely viewed as an innovative regime that aims to deter commercial sex by punishing clients rather than prostitutes—has gained increasing global popularity (Langford and Skilbrei 2021). Despite its prominence, research on the effects of this model remains limited, with most studies focusing primarily on its impact on sex crimes. For example, Gao and Petrova (2022) document that

liberalizing prostitution increases sexual crimes while prohibiting it does the opposite, using staggered legislative changes in European countries. Similarly, Ciacci (2024) finds that the Nordic model reduced rapes in Sweden; however, a subsequent re-evaluation by Ciacci (2025), alongside a formal replication comment by Zimmermann (2025), concludes that these results are not robust. While that debate focuses on crime outcomes, our paper shifts attention to household formation, highlighting broader and unintended consequences of prostitution regulation. In particular, we find that the Nordic model promotes marriage and reduces divorce—outcomes with substantial policy relevance, as stable marriages foster stronger interpersonal bonds and more resilient family structures, ultimately improving societal welfare (Friedman 2000).

Third, our study contributes to the literature on the economics of marriage. This body of research posits that two individuals decide to marry when their union generates a positive surplus compared to remaining single. The benefits of marriage include synergies from specialization in home and market production, economies of scale, risk-sharing, the utility derived from adhering to social customs, commitment mechanisms that encourage relationship-specific investments, and the signaling of genuine affection between partners (e.g., Becker 1973, 1974; Brinig and Crafton 1994; Cohen 2002; Matouschek and Rasul 2008). In addition to these well-documented economic advantages, marriage also provides sexual access to a spouse. Some researchers have argued that the availability of extramarital sexual options can diminish the necessity of marriage for satisfying sexual needs, thereby reducing individuals' propensity to marry (e.g., Friedman 2000; Regnerus 2017). However, empirical evidence supporting this argument remains sparse. Expanding on this literature, we provide evidence that access to commercial sex—an important source of extramarital sexual options—can reduce the perceived surplus generated by marriage, thereby decreasing the likelihood of individuals entering marital unions.

## 2 Background on the Nordic model

The leading reasons behind efforts to deter commercial sex are that it is “incompatible with the dignity and worth of the human person,” that it is intrinsically abusive, and that it incites human trafficking (UN 1949, p.1). Historically, anti-prostitution laws have punished the supply side, but the Swedish government pioneered the unprecedented position of criminalizing sex buyers. Since the early 1980s, Swedish feminists have consistently argued that prostitution should be outlawed. In 1987, ROKS—the National Organization for Women's Shelters and Young Women's Shelters in Sweden—presented this demand to female parliamentarians. Due to their dedicated lobbying and the strong civil will of Sweden's female politicians, who held nearly half of the country's parliamentary seats at the time, The Law that Prohibits the Purchase of Sexual Services was approved and came into force on January 1, 1999 (Ekberg 2004).

The so-called Nordic model (also called the Swedish model) was designed to have a normative function: to manifest that women are not commodities to be bought, and to exterminate prostitution by tearing up its root cause—male demand.

The main catalyst for reform was the public belief that prostitution was irreconcilable with gender equality and inseparably linked with human trafficking. The offense comprises all forms of sexual services, whether purchased on the street, in brothels, or through escorts; procuring and operating a brothel is also illegal. The law prohibiting the purchase of sex has the support of Swedish society—80% of the population stands behind it (Ekberg 2004; Kuosmanen 2011).

When the new legislation came into force, the Swedish police, tasked with intervening to prevent crimes, were granted approximately 1 million USD for enforcement purposes. In 2003, another 4.1 million USD was set aside for the National Board of Police to combat sex purchases and trafficking. Penalties for sex purchases include hefty fines or up to a year of imprisonment and apply to all types of sexual services, whether consumed on the street, in brothels, or massage parlors.<sup>2</sup> Respectively, pimps face up to eight years in prison (the most severe penalty in the Swedish Penal Code being ten years).

As a result of the adoption of the Nordic model in Sweden, the number of female prostitutes has decreased from 2,500 before the reform to no more than 1,500 in 2002 (Gripenlöf 1991–2002). Moreover, the number of buyers has shrunk by 75% to 80%. Danna (2007) also points out that Stockholm street prostitution halved after the reform: from 280 street workers the year before to 170 the year after. The Swedish government assessed the law's effectiveness and implementation after ten years. The evaluations, which compared the assumed prevalence of people in the sex trade in Sweden to Norway and Denmark, showed that the legislation had significantly reduced the demand for commercial sex and had the intended effect of combating prostitution and human trafficking for sexual purposes (Ministry of Justice 2010).

The Nordic model, which aimed to prosecute “the real culprit” and gradually change social behavior, quickly spread around the world: from neighboring Scandinavian countries (Iceland and Norway, both in 2009) to South Korea (2004) and Canada (2014). In 2014, the members of the European Parliament adopted a non-binding resolution in its favor. Since then, the model has continued to build momentum: Northern Ireland (2015), France (2016), the Republic of Ireland (2017), and most recently Israel (December 31, 2018) have all banned the consumption of prostitution services. As of 2023, the tide is turning in Italy as well: The approval of the newly drafted bill would make Italy the latest addition to the Nordic model club (Bindel 2022).

### 3 Hypothesis development

We expect the Nordic model to increase the marriage rate for the following two reasons. First, from men's perspective, suppose that a man could obtain sex in two ways: through commercial sex or through marital sex, and that he makes a choice

<sup>2</sup> The offence, as stated in the Swedish Penal Code, Chapter 6 s.11, makes it an offence “for anyone who: obtains casual sexual relations in return for payment is sentenced for purchase of sexual services to a fine or imprisonment not exceeding one year.”

based on the relative costs and benefits of these two options.<sup>3</sup> Men may choose marriage over prostitution if prostitution becomes costlier and more difficult to access, and may do the opposite if prostitution is readily available. The Nordic model could significantly increase the cost of consuming commercial sex by shrinking the size of the sex market, raising the price of sex services, and imposing higher legal risks on men (Lee and Persson 2022; Gao and Petrova 2022). In addition to monetary costs, the Nordic model could increase the stigma associated with commercial sex transactions, further decreasing men's willingness to obtain sex via prostitution (Della Giusta et al 2009; Della Giusta 2010). If we think of the Nordic model as a large "tax" imposed on prostitution, the above conjecture is also consistent with the seminal theory of Edlund and Korn (2002), in which they model the cost of prostitution as a "tax", and point out that (p.197): "*A tax on prostitution makes men poorer and makes prostitution more expensive, both of which should reduce prostitution and hence increase marriage.*" Lee and Persson (2022) further extend the above model by incorporating additional elements (such as occupational hazards and sex trafficking) and differentiating between voluntary and coerced prostitutes. They particularly analyze the Nordic model and predict that (p.103): "*Criminalizing johns shifts demand from the prostitution market to the marriage market.*" Therefore, in response to the Nordic model's adoption, men are more likely to enter the marriage market than the prostitution market.<sup>4</sup>

Second, from women's perspective, an increase in men's desirability for marriage can lead to a corresponding rise in women's willingness to marry, primarily because it becomes easier for them to find suitable partners. Becker (1981) provides a theoretical framework that conceptualizes men and women as suppliers and demanders in the marriage market. When men's interest in marriage grows, it effectively increases the demand for marriage, making it easier for women to secure suitable matches and thereby enhancing their willingness to marry. Based on the discussion above, we expect the Nordic model to increase marriage rates by shifting men's demand from the prostitution market to the marriage market and enhancing women's willingness to marry due to improved partner availability.<sup>5</sup>

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<sup>3</sup> Casual sex could be another way for men to fulfill their sexual needs. However, due to the "casual" nature, this type of sex may not be as easily available as prostitution. The existence of casual sex could undermine the simple one-to-one substitution relationship between prostitution and marriage, which works against us finding a significant effect of the Nordic model on marriage.

<sup>4</sup> Della Giusta et al. (2009) show that, after controlling for other demographic characteristics, married men are less likely to purchase commercial sex than non-married men. This observation is broadly consistent with the substitution relation between prostitution and marriage.

<sup>5</sup> The Nordic model could also have an additional effect of inducing the otherwise would-be prostitutes to go to the marriage market. Suppose that such a woman could enter into the prostitution market or the marriage market, and she makes that choice based on the relative prospects of these two options (Edlund and Korn 2002). When prostitution is restrained by the Nordic model, her prospects in the prostitution market diminish and they become more likely to enter into the marriage market. However, we don't expect this explanation to be the main mechanism for our results because the number of prostitutes is a very small share of the population and the vast majority of females may never consider becoming prostitutes.

Following the same rationale, we also expect the Nordic model to decrease divorce rates, because (1) it decreases access to commercial sex for men, making the loss of marital sex associated with divorce costlier, and (2) husbands' stronger desire to maintain marriage could naturally increase wives' welfare in the family, consequently reducing their incentive to divorce. Furthermore, women often perceive their husbands' engagement with commercial sex as a form of infidelity, which is a significant cause of divorce (Jones 2008; Meskó and Láng 2013).<sup>6</sup> Thus, after the Nordic model curbs prostitution, the divorce rate is likely to decrease.<sup>7</sup>

In summary, we expect the Nordic model to increase the marriage rate and decrease the divorce rate via the channel of substituting the prostitution market with the marriage market.<sup>8</sup>

## 4 Sample construction

We gather data on marriage in European countries from 1980 to 2022, primarily using Eurostat, the statistical office of the European Union. Eurostat provides detailed country-level marriage statistics, including marriage rates, divorce rates, and marriages by previous marital status. Throughout the paper, we use the number of marriages per 1,000 population as the marriage rate and the number of divorces per 100 new marriages as the divorce rate. We also collect information on marriages by gender and age group from the United Nations Statistics Division's (UNSD) Year Demography. Using these data, we calculated the marriage rate for each gender and age group as the number of marriages per 1,000 population within that group.

We track the legal status of prostitution and the corresponding reforms by examining the Sex Work Laws provided by the Institute of Development Studies, the U.S.

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<sup>6</sup> Infidelity, defined as a breach of sexual fidelity within a committed relationship, is universally disapproved of under any circumstances (National Survey of Sexual Attitudes and Lifestyles 2013). Over recent decades, attitudes toward infidelity have hardened, particularly among women, reflecting increasing expectations of sexual exclusivity in relationships (Van Hooff 2017). Studies show a significant rise in the percentage of women willing to end relationships due to infidelity, growing from 41% in 1979 to 63% in the period of 1989–1993 (Wouters 2004). Additionally, National Survey of Sexual Attitudes and Lifestyles data shows that the proportion of female respondents who deemed adultery “always wrong” increased markedly from 53% in 1990 to 70% in 2012. Moreover, the General Social Survey reveals that 13% of married men in the 2002–2010 sample admitted to having paid for sex at least once in their lifetime (Monto and Milrod 2014).

<sup>7</sup> Another view is that commercial sex helps maintain a stable marriage relation because it provides men with more diverse sexual opportunities (Della Giusta et al. 2009). However, this view is not consistent with our findings.

<sup>8</sup> An alternative hypothesis regarding the impact of prostitution availability on marriage decisions warrants consideration. Specifically, access to prostitution markets may primarily influence younger men, leading them to delay marriage from their 20s to their 30s, while still eventually marrying. Under this scenario, the introduction of Nordic policies might prompt these men to marry earlier, shifting the timing of marriage without altering the overall lifetime marriage rate within the male population. If the available time series data does not span decades, it may fail to fully capture such “re-timing” effects. Over shorter post-policy time frames, such effects might superficially appear as an increase in total marriage rates. While the impact of the Nordic model on marriage timing is beyond this paper's scope, it could be an interesting area for future research.

Human Rights Reports, and numerous news articles from each country. As detailed in Table 1 Panel A, five countries adopted the Nordic model in our sample period: Sweden (1999), Norway (2009), Iceland (2009), France (2016), and Ireland (2017). It is worth noting that the prostitution models preceding the adoption of the Nordic model in these five countries are all categorized as decriminalization (Gao and Petrova 2022). Under this regulatory form, sex work is viewed as labor just like any other and, thus, it should not be subject to special regulation or laws (i.e., neither indoor nor outdoor sexual services is prohibited). Therefore, it is unsurprising that the Nordic model represents a dramatic tightening of prostitution regulation and substantially shrinks the prostitution market.

Since all these treated countries are in Western Europe, we exclude Eastern European countries and keep the remaining twelve Western European countries as the control group: Austria, Belgium, Denmark, Finland, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain, and Switzerland (see Table 1 Panel A).<sup>9</sup> Excluding countries in Eastern Europe from our sample helps us better estimate the effect of the Nordic model, because (1) it makes the treated group more comparable to the control group and (2) we can avoid the dramatic confounding legal changes in Eastern Europe following the collapse of the Soviet Union, especially as our sample period spans the collapse. While the UK is one of the Western European countries, we do not include it in our sample because of the ambiguity in classifying it either as a treated or control country: Part of it (Northern Ireland) adopted the Nordic model in 2015, but the other parts (England, Scotland, and Wales) have never done so. Country characteristics, such as GDP per capita and population growth, are obtained from the World Bank's national accounts data. The sex ratio is calculated based on the population information from Eurostat. Variable definitions are provided in Table IA8 of the Internet Appendix. Our final sample consists of 731 country-year observations from 1980 to 2022.

Table 1 Panel B provides summary statistics. On average, our sample countries have 5.02 marriages per 1,000 population and 39.66 divorces per 100 new marriages. The average country has a GDP per capita of 34,870 USD, a population growth rate of 0.55%, and a sex ratio of 99.12 women per 100 men. Unsurprisingly, people under 30 years of age have higher marriage rates compared to those above 30. Among women under 30, the average marriage rate is 18.20 per 1,000 population, compared to 9.15 for those over 30. Similarly, for men under 30, the marriage rate is 14.10, while it decreases slightly to 12.10 for those over 30. Categorized by marital history, the average number of marriages among previously single individuals is 8.26 out of every 1,000 females and 8.46 out of every 1,000 males, while the average number of marriages among individuals previously in a legal union is 1.69 out of every 1,000 females and 1.87 out of every 1,000 males.

<sup>9</sup> Due to political reasons, Europe is historically divided into Western and Eastern Europe. Geographically, the region of Western Europe includes the regions of northern Europe, southern Europe, central Europe, and the British Isles; Eastern Europe is everything east of Germany, Austria, and Italy.

**Table 1** Summary statistics**Panel A. Countries in the treated and control groups**

Treated group	Control group
Sweden (1999)	Austria
Norway (2009)	Belgium
Iceland (2009)	Denmark
France (2016)	Finland
Ireland (2017)	Germany
	Greece
	Italy
	Luxembourg
	Netherlands
	Portugal
	Spain
	Switzerland

**Panel B: Summary statistics**

Variable	N	Mean	Std. Deviation	P25	Median	P75
Marriage rate	729	5.02	1.12	4.40	5.00	5.60
Divorce rate	700	39.66	16.36	30.00	40.95	50.90
Marriage rate (Female under 30)	515	18.20	6.47	13.43	17.58	22.25
Marriage rate (Female aged 30+)	515	9.15	3.56	6.21	9.04	11.48
Marriage rate (Male under 30)	515	14.10	6.31	9.10	13.24	18.59
Marriage rate (Male aged 30+)	515	12.10	3.53	9.51	12.01	14.70
Marriage rate (Female single)	671	8.26	2.01	6.82	8.15	9.59
Marriage rate (Female legal union)	671	1.69	0.81	1.10	1.73	2.21
Marriage rate (Male single)	669	8.46	2.08	7.04	8.32	9.85
Marriage rate (Male legal union)	669	1.87	0.79	1.33	1.88	2.41
GDP per capita (Thousand)	731	34.87	23.64	17.62	28.60	47.43
Population growth (%)	731	0.55	0.55	0.24	0.47	0.76
Sex ratio	731	99.12	2.50	97.37	98.62	100.57

Note: Our sample consists of 731 country-year observations from 1980 to 2022. Panel A lists the treated and control countries. Panel B presents summary statistics of our sample

## 5 Empirical results

### 5.1 Visual illustration

Figure 1 provides a visual illustration of the dynamics of marriage and divorce rates around the adoption of the Nordic model. We follow Pierce and Schott (2016) and

plot the point estimates and 90% confidence intervals of the parameters  $\beta\tau$  from the following regression:

$$\begin{aligned} \text{Marriage rate}_{i,t}(\text{or Divorce rate}_{i,t}) = & \alpha + \sum_{n=-10}^{10} \beta_n \times \text{Enact Year}_{i,t+n} + \gamma \text{Country characteristics}_{i,t} \\ & + \text{Year FE} + \text{Country FE} + \varepsilon_{i,t}. \end{aligned} \quad (1)$$

The y-axis represents the marriage rate (Fig. 1A) and the divorce rate (Fig. 1B), while the x-axis indicates the time relative to the adoption year of the Nordic model, spanning from ten years before the adoption to ten years after. The shaded area in each figure denotes the 90% confidence intervals of the coefficient estimates.

Figure 1A shows that the Nordic model is associated with a clear increase in countries' marriage rates. In the year prior to the adoption, the  $\beta_{-1}$  coefficient is close to zero; in the sixth year after the adoption, the corresponding coefficient of  $\beta_6$  is approximately 0.18. Ten years after the adoption of the Nordic model, the coefficient of  $\beta_{10}$  is 2.30.

Figure 1B demonstrates that the Nordic model is associated with a noticeable decrease in countries' divorce rates. In the year prior to the adoption of the Nordic model, the  $\beta_{-1}$  coefficient is about 0.68; in the first year after the adoption, the corresponding coefficient of  $\beta_1$  is approximately  $-5.86$ . Ten years after the adoption of the Nordic model, the coefficient of  $\beta_{10}$  is  $-16.94$ .

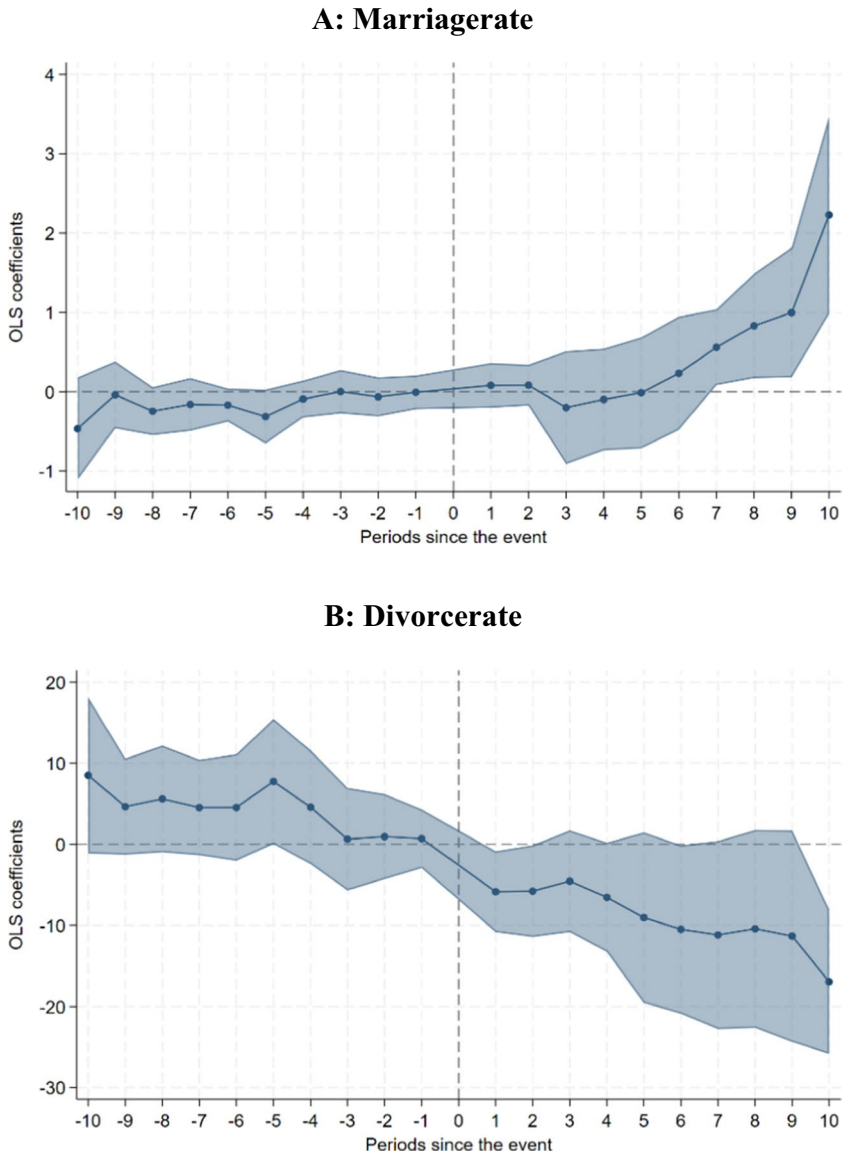
In summary, these figures provide preliminary evidence that the Nordic model increases a country's marriage rate and decreases its divorce rate. Moreover, the observed rise in marriage rates and decline in divorce rates continue several years after the legislative change, suggesting that the Nordic model has a persistent long-run effect on marriage decisions.

## 5.2 Baseline regression

During our sample period, several countries adopted the Nordic model in different years, which enables us to examine the before-after effects of the regulatory reforms in affected countries (the treatment group) compared to those in countries that did not adopt the Nordic model (the control group). This is a DiD design with multiple treatment groups and multiple time periods, as employed by Imbens and Wooldridge (2009). We implement this test through the following regression:

$$\begin{aligned} \text{Marriage rate}_{i,t}(\text{or Divorce rate}_{i,t}) = & \alpha + \beta_1 \text{Nordic}_{i,t} + \beta_2 \text{Country characteristics}_{i,t} \\ & + \text{Year FE} + \text{Country FE} + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

The indicator *Nordic* takes the value of one if the Nordic model of prostitution is adopted in country *i* in a given year, and zero otherwise. The year fixed effects enable us to control for intertemporal trends in marriage decisions. The country fixed effects allow us to control for time-invariant differences in marriage across countries. Considering that our treatment is defined at the country level, we cluster standard errors by country.



**Fig. 1** Dynamic effects of the Nordic model on marriage and divorce **A:** Marriage rate shows a visual DiD test examining the effect of the Nordic model on marriage rates in countries that adopt such a model relative to the countries that do not adopt it. The y-axis denotes the coefficients of  $\beta_{-10}$  to  $\beta_{10}$  estimated from Eq. (1), while the x-axis denotes the time relative to the Nordic model’s enactment year (ranging from ten years prior to the law enactment to ten years afterward) with year 0 denoting the event year. The shaded area corresponds to the 90% confidence intervals based on robust standard errors clustered by country. Similarly, **B:** Divorce rate shows a visual DiD test examining the effect of the Nordic model on divorce rates in countries that adopt such a model relative to the countries that do not adopt it

**Table 2** Effect of the Nordic model on marriage and divorce

	Marriage rate		Divorce rate	
	(1)	(2)	(3)	(4)
Nordic	1.032** (2.63)	0.926** (2.61)	-17.239*** (-4.23)	-16.169*** (-3.70)
GDP per capita		0.008 (0.50)		-0.111 (-0.44)
Population growth		0.272 (1.49)		-3.508 (-1.72)
Sex ratio		-0.015 (-0.41)		-1.148 (-1.07)
Constant	4.935*** (145.30)	6.024 (1.69)	40.939*** (135.35)	160.407 (1.48)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	729	729	700	700
Adjusted $R^2$	0.457	0.478	0.638	0.652
Mean dependent variable	5.02		39.66	

Note: This table reports the impact of the Nordic model on marriage and divorce. The regression specification is provided in Eq. (2). Our sample consists of 731 country-year observations from 1980–2022. The dependent variable *Marriage rate* measures the number of marriages per 1,000 population during the year. *Divorce rate* measures the number of divorces per 100 new marriages during the year. The indicator variable *Nordic* takes the value of one if a country has adopted the Nordic model for prostitution regulation in a given year, and zero otherwise. Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

The employed country fixed effects lead to  $\beta_1$  being estimated as the within-country differences before and after the policy change, as opposed to similar before-after differences in countries that did not make such a change during the same period (Imbens and Wooldridge 2009).

Columns (1) and (2) in Table 2 report the effect of the Nordic model on marriage rates. The coefficients on *Nordic* are positive and significant in both columns. In column (1), we include only *Nordic*, country, and year fixed effects. The coefficient estimate on *Nordic* is 1.032 and significant at the 5% level. In column (2), we additionally control for various country characteristics and obtain similar results: The coefficient on *Nordic* is 0.926 and is significant at the 5% level. These results indicate that, as compared to countries that do not adopt the Nordic model, marriage rates in countries that adopt the Nordic model increase by about 0.926 marriages per 1,000 population. This effect is economically significant, representing roughly 83% of the standard deviation in marriage rates (1.12).

Columns (3) and (4) in Table 2 report the effect of the Nordic model on divorce rates. The coefficients on *Nordic* are negative and significant in both columns. In column (3), where we include only *Nordic*, country, and year fixed effects, the

coefficient estimate on *Nordic* is  $-17.239$  and significant at the 1% level. In column (4), we additionally control for various country characteristics. The coefficient on *Nordic* is  $-16.169$  and significant at the 1% level. It indicates that, as compared to control countries, divorce rates in treated countries decrease by about 16.169 divorces per 100 new marriages. This effect is economically sizeable, representing approximately one standard deviation in divorce rates (16.36).

Taken together, we find that a country's marriage rate (divorce rate) is significantly increased (decreased) after the country adopts the Nordic model of prostitution. These results are consistent with the view that the prostitution market has a substitution effect on the marriage market.

### 5.3 Pre-treatment trends

The validity of DiD estimation depends on the parallel trends assumption: Absent the Nordic model, marriage decisions could have evolved in the same way in both the treatment and control countries. Table 3 investigates the pre-treatment trend between the two groups of countries. In particular, we define eleven indicator variables to designate the enactment year for the Nordic model: *Year - 5*, *Year - 4*, *Year - 3*, *Year - 2*, *Year - 1*, *Year 0*, *Year 1*, *Year 2*, *Year 3*, *Year 4*, and *Year 5+*. For example, *Year 0* flags the event year in which the policy change takes place; *Year - 1* denotes one year before the policy change; *Year 1* denotes one year after the policy change; *Year 5+* indicates five or more years after the policy change.

In column (1) of Table 3, we show the pre-treatment trends in marriage rates between the treatment and control countries. We re-estimate column (2) of Table 2 by replacing *Nordic* with the eleven indicator variables (*Year - 5* to *Year 5+*) explained above. The coefficients on the *Year - 5* to *Year - 1* indicators are especially important because their significance indicates whether there is any difference in marriage decisions between the treatment and the control groups prior to the policy change. The coefficients on these indicators are small in magnitude and not statistically significant, suggesting that the parallel trend assumption is not violated.

The impact of the Nordic model starts to show up five years after the enactment: The coefficient on *Year 5+* is significantly positive and is much larger in magnitude than the coefficient on *Year - 1*, indicating that it takes a few years to fully reveal the impact of the Nordic model on marriage decisions. For example, the coefficient on *Year - 1* is 0.377 (not significantly different from zero); in contrast, the coefficient on *Year 5+* is approximately 4.3 times larger (1.617 and significant at the 1% level). The fact that it takes several years for the Nordic model to affect marriage decisions is understandable, because it usually takes time for a person to find and get to know the potential spouse, and eventually get married (Surra 1990).

In column (2) of Table 3, we focus on divorce rates and find again that the treatment and the control groups share similar trends prior to the policy change: The coefficients of *Year - 5* to *Year - 1* are not significantly different from zero, and the negative effect of the Nordic model on a country's divorce rate shows up starting one year after the policy change.

**Table 3** Testing for pre-treatment trends and reversals

	Marriage rate (1)	Divorce rate (2)
Year-5	0.029 (0.10)	0.080 (0.02)
Year-4	0.231 (0.70)	-3.072 (-0.70)
Year-3	0.353 (0.97)	-7.164 (-1.41)
Year-2	0.315 (0.85)	-6.901 (-1.24)
Year-1	0.357 (0.95)	-7.026 (-1.30)
Year 0	0.333 (1.08)	-7.572 (-1.52)
Year 1	0.377 (1.22)	-12.997**
Year 2	0.289 (0.91)	-13.066**
Year 3	0.041 (0.10)	-11.918**
Year 4	0.183 (0.47)	-13.908***
Year 5+	1.617*** (4.01)	-21.479*** (-3.81)
GDP per capita	0.010 (0.64)	-0.109 (-0.45)
Population growth	0.187 (1.20)	-2.927 (-1.54)
Sex ratio	0.004 (0.10)	-1.121 (-0.99)
Constant	4.080 (1.08)	157.701 (1.37)
Country FE	Yes	Yes
Year FE	Yes	Yes
Observations	729	700
Adjusted $R^2$	0.501	0.656

Note: This table investigates the pre-treatment trends between the treated and control groups. The variables *Year-5* to *Year 5+* indicate the year relative to the event year when the country adopted the Nordic model of prostitution. The regression specifications in columns (1) and (2) are the same as those of columns (2) and (4) in Table 2, respectively, except that we replace the *Nordic* variable with the eleven year indicators specified above. Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Overall, Table 3 shows that the treatment group and the control group share similar trends in their marriage and divorce rates prior to the adoption of the Nordic model, thus supporting the parallel trends assumption. Moreover, most of the impact of the Nordic model on marriage and divorce rates occurs after these laws are enacted, which suggests a causal effect.

#### 5.4 Marriage rate by age

In this section, we examine the Nordic model's effect on marriage decisions across different age groups. From the male perspective, younger men typically exhibit a higher demand for sex than older men (Kontula and Haavio-Mannila 2009).<sup>10</sup> Consequently, the substitution effect between marriage and commercial sex is likely more pronounced for younger men. This, in turn, could lead to an increase in the marriage rates of younger women, as men often prefer to marry women younger than themselves (England and McClintock 2009; Low 2024). Based on these discussions, we expect the Nordic model to have a stronger effect on marriage rates for younger men and women.

Table 4 presents marriage rates disaggregated by gender and age group. The regression specifications align with those in column (2) of Table 2, but we replace the overall marriage rate with the marriage rates specific to each gender and age group. We find that the effect of the Nordic model on marriage is indeed mainly driven by young people. In column (1), the coefficient of *Nordic* for males under 30 is positive and statistically significant at the 5% level, whereas for males aged 30 and above (column (2)), the coefficient is negligible in magnitude and not statistically significant. A similar pattern emerges for females, as shown in columns (3) and (4): The Nordic model predominantly influences the marriage rates of females under 30.

Overall, these findings indicate that our results are mainly driven by the marriage decisions of younger people, who are more likely to be affected by the prostitution market than older ones. Notably, these findings cannot simply be attributed to higher marriage rates among younger couples relative to older couples. The average marriage rates in columns (1) and (2) are comparable—14.10 and 12.10 per 1,000 population, respectively—but the economic impact of the Nordic model in column (1) is substantially greater than in column (2) (3.103 vs.  $-0.036$ ). Similarly, while the average marriage rate in column (3) is twice as large as that in column (2)—18.20 vs. 9.15 per 1,000 population—the economic magnitude of the Nordic model in column (3) exceeds that in column (2) by more than fourfold (3.109 vs. 0.730).

#### 5.5 Marriage rate by previous marital status

In this section, we explore the impact of the Nordic model on marriage decisions across individuals with varying marital histories. From a male perspective, men who

<sup>10</sup> Numerous studies have identified a decrease in sexual interest and activity in old age (see, e.g., Araujo et al. 2004; Laumann et al. 2005; Nicolosi et al. 2006).

**Table 4** Marriage rate by age group

	Male under 30 (1)	Male aged 30+ (2)	Female under 30 (3)	Female aged 30+ (4)
Nordic	3.103** (2.84)	-0.036 (-0.09)	3.109*** (3.36)	0.730 (1.52)
GDP per capita	0.020 (0.44)	-0.021 (-0.88)	0.000 (0.01)	-0.017 (-0.73)
Population growth	0.808* (1.86)	0.972*** (3.30)	1.112** (2.32)	0.767** (2.47)
Sex ratio	0.133 (0.64)	0.289** (2.77)	0.205 (1.01)	0.150 (1.20)
Constant	-0.273 (-0.01)	-16.384 (-1.54)	-2.902 (-0.14)	-5.622 (-0.44)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	515	515	515	515
Adjusted $R^2$	0.881	0.855	0.829	0.877
Mean dependent variables	14.10	12.10	18.20	9.15

Note: This table reports the impact of the Nordic model on marriage rates in different age groups. *Male under 30* is the marriage rate for males under 30 years old. *Male aged 30+* is the marriage rate for males aged 30 or older. *Female under 30* and *Female aged 30+* are defined similarly. The indicator variable *Nordic* takes the value of one if a country has adopted the Nordic model for prostitution regulation in a given year, and zero otherwise. All columns follow the regression specification in Table 2 column (2). Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

were previously in legal unions typically experience more stable sexual lives than single men. As a result, the substitution effect between marriage and prostitution is likely to be more pronounced for single men. This effect may, in turn, increase the marriage rates of single women, as women previously in legal unions often maintain family-like relationships with their partners and are less influenced by shifts in marriage market demand. Therefore, we predict that the Nordic model will have a stronger impact on the marriage rates of single men and women.

Columns (1) and (2) of Table 5 examine the marriage rate for males who were previously single or in a legal union, respectively. The coefficient on *Nordic* in column (1) is 1.551 (significant at the 1% level) and the coefficient in column (2) is only 0.225 (not significantly different from zero). This result indicates that the effect of the Nordic model on marriage is essentially driven by single men. Similarly, columns (3) and (4) examine the marriage rate for females based on their previous marital status. The coefficient on *Nordic* in column (3) is 1.434 (significant at the 5% level) and the coefficient in column (4) is only 0.260 (not significantly different from zero), indicating that the Nordic model's effect on marriage is largely driven by single women.

**Table 5** Marriage rate by previous marital status

	Male single (1)	Male legal union (2)	Female single (3)	Female legal union (4)
Nordic	1.551*** (3.08)	0.225 (1.62)	1.434** (2.68)	0.260 (1.43)
GDP per capita	0.015 (0.55)	-0.009** (-2.39)	0.015 (0.57)	-0.007 (-1.08)
Population growth	0.685** (2.35)	0.169** (2.46)	0.670** (2.42)	0.128 (1.69)
Sex ratio	0.121 (1.44)	-0.005 (-0.12)	0.062 (0.79)	-0.035 (-1.05)
Constant	-4.500 (-0.53)	2.543 (0.65)	1.163 (0.15)	5.271 (1.59)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	669	669	671	671
Adjusted $R^2$	0.650	0.852	0.648	0.856
Mean dependent variable	8.46	1.87	8.26	1.69

Note: This table reports the impact of the Nordic model on marriage among groups with different previous marital status. *Male single* is the marriage rate for previously single males per 1,000 males. *Male legal union* is the marriage rate for males previously in legal unions per 1,000 males. *Female single* is the marriage rate for previously single females per 1,000 females. *Female legal union* is the marriage rate for females previously in legal unions per 1,000 females. The indicator variable *Nordic* takes the value of one if a country has adopted the Nordic model for prostitution regulation in a given year, and zero otherwise. All columns follow the regression specification in Table 2 column (2). Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Overall, Table 5 provides evidence that our results are mainly driven by the marriage decisions of single individuals, who are more likely to be influenced by changes in the prostitution market compared to those already in legal unions. Importantly, these findings cannot be merely attributed to the higher marriage rates among single individuals relative to those in legal unions. The economic impact of the Nordic model in column (1) is nearly 7 times greater than in column (2) (1.551 vs. 0.225), while the average marriage rate in column (1) is 4.5 times higher than that in column (2) (8.46 vs. 1.87 per 1,000 population). Similarly, while the average marriage rate in column (3) is 4.8 times higher than in column (2) (8.26 vs. 1.69 per 1,000 population), the economic impact of the Nordic model in column (3) is 5.5 times greater than in column (2) (1.434 vs. 0.260).

## 5.6 Heterogeneous treatment effect

### 5.6.1 Female socioeconomic status

In this section, we implement triple-differences tests to explore the heterogeneity of female socioeconomic status in the treatment effect. Existing studies show that women with lower socioeconomic status are more responsive to men's demands in marriage decisions because these women may have fewer financial resources and limited access to opportunities for social mobility, which makes marriage appear more attractive as a means of improving economic stability (Tzeng and Mare 1995; Olivetti et al. 2024). When the Nordic model increases men's demand for marriage, women with lower socioeconomic status, compared to women with higher socioeconomic status, may feel more compelled to prioritize the demands of potential partners and get married accordingly. Thus, we expect a stronger treatment effect when women have lower socioeconomic status.<sup>11</sup>

We measure female socioeconomic status using the gender pay gap, which is an important aspect of women's economic empowerment (Akchurin and Lee 2013; Aksoy et al. 2021). The indicator *Large gender pay gap* takes the value of one if the pay gap between males and females under 35 years old is greater than the sample mean, and zero otherwise. We further use gender poverty gap as our second measure of female socioeconomic status (Wiepking and Maas 2005). Likewise, the indicator *Large gender poverty gap* takes the value of one if the poverty gap between males and females is higher than the sample mean, and zero otherwise. Both indicators imply lower female socioeconomic status.

In Table 6 columns (1) and (2) (where the dependent variable is marriage rate), we re-estimate Table 2 column (2) by adding the interaction *Nordic*×*Large gender pay gap* and *Nordic*×*Large gender poverty gap*, respectively. The coefficients on both interactions are significantly positive, indicating that the positive effect of the Nordic model on marriage rates is stronger when females earn less and have a higher poverty ratio (i.e., females in weaker socioeconomic status). We examine the divorce rate in Table 6 columns (3) and (4), and we show that the negative effect of the Nordic model on divorce rates is also more pronounced when females have lower socioeconomic status. Overall, Table 6 validates that our treatment effects are stronger when female socioeconomic status is lower.

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<sup>11</sup> Another reason to expect such a heterogeneous treatment effect is the choice of women who might otherwise enter the prostitution market. The model of Lee and Persson (2022) predicts that the trade-off between entering the prostitution industry as a sex worker or the marriage market as a wife is more likely to be relevant for a woman with a weaker socioeconomic status. Similarly, Devine et al. (2010) and Sinha (2015) show that the primary reason for women's entry into sex work is economic necessity or financial hardship. However, as we have explained in Footnote 5, this explanation is unlikely the main driving force for the heterogeneous treatment effects because of a very small proportion of prostitutes among the general population.

**Table 6** Heterogeneous treatment effects: Female socioeconomic status

	Marriage rate		Divorce rate	
	(1)	(2)	(3)	(4)
Nordic	-0.585 (-0.75)	-0.663 (-0.86)	1.865 (0.33)	1.878 (0.35)
Nordic×Large gender pay gap	1.718* (2.10)		-19.705*** (-3.16)	
Nordic×Large gender poverty gap		1.759** (2.18)		-18.636*** (-3.22)
GDP per capita	0.013 (0.71)	0.013 (0.71)	-0.142 (-0.57)	-0.118 (-0.47)
Population growth	0.243 (1.22)	0.251 (1.39)	-3.177 (-1.34)	-3.390 (-1.63)
Sex ratio	0.012 (0.30)	0.022 (0.56)	-1.483 (-1.22)	-1.218 (-1.12)
Constant	3.149 (0.80)	2.184 (0.56)	194.859 (1.58)	167.594 (1.51)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	686	729	657	700
Adjusted $R^2$	0.484	0.491	0.666	0.653

Note: This table reports the heterogeneous treatment effects on marriage and divorce. The indicator variable *Large gender pay gap* takes the value of one if the pay gap between males and females under 35 years old is higher than the sample mean, and zero otherwise. The indicator variable *Large gender poverty gap* takes the values of one if the poverty gap between males and females is higher than the sample mean, and zero otherwise. Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

## 5.6.2 Cohabitation

In Europe, the increase in cohabitation has been one of the most striking changes in family life in the past few decades (Kiernan 2004; Perelli-Harris et al. 2010; Perelli-Harris and Gassen 2012). Instead of formally getting married, unmarried couples often prefer to live together, making cohabitation a separate form of union from marriage. Existing literature shows that the choice between marriage and cohabitation depends on various factors, such as the cost of separation, tax schedules, welfare granted to married couples, and the rights to inherit from partners (Alm and Whittington 2003; Carlson et al. 2004; Holland 2012; Perelli-Harris and Gassen 2012; Fisher 2012). The possibility of cohabitation works against us in identifying any effect of the Nordic model on marriage for the following reasons. Suppose that only  $\beta$  percent of couples among the general population are formally married (the remaining ones are in cohabitation) and that the Nordic model changes the actual

coupling cases from  $M$  to  $N$  cases per 1,000 population. In this situation, although the actual impact of the Nordic model on coupling is  $(N-M)$ , the estimated impact based on recorded marriage data is only  $\beta*(N-M)$ . When  $\beta \rightarrow 0$  (i.e., cohabitation dominates marriage), the estimated effect of the Nordic model on marriage will also be biased toward zero. When  $\beta$  increases from 0 to 1, the estimated effect from our regression analysis will increase accordingly.

Based on the discussion above, we expect our results to be stronger if people prefer marriage over cohabitation when considering union formation. To empirically examine this conjecture, we focus on three proxies to measure the extent of preference for marriage over cohabitation.

First, the unilateral divorce law, which allows one spouse to terminate the marriage without the consent of the other, greatly reduces the separation cost of marriage and increases the relative attractiveness of marriage to cohabitation (Lundberg et al. 2016). We define the *Unilateral divorce* indicator as taking the value of one if a country has adopted the unilateral divorce law in a given year, and zero otherwise.<sup>12</sup> In column (1) of Table 7 (marriage rate as the dependent variable), we re-estimate our baseline regression by adding the interaction *Nordic* × *Unilateral divorce*, and we show that the coefficient on this interaction is positive and significant at the 10% level. Likewise, in column (4) (divorce rate as the dependent variable), we find that the coefficient on *Nordic* × *Unilateral divorce* is negative and significant at the 5% level. These results indicate that the positive (negative) effect of the Nordic model on marriage (divorce) rates is more pronounced in countries that have simplified divorce processes (i.e., when the relative benefits of cohabitation over marriage are reduced).

Similar in spirit to the unilateral divorce law, marital property division in divorce is another driving force for the higher separation cost of marriage relative to cohabitation (Lundberg et al. 2016). When a marriage dissolves, marital property is divided between ex-spouses; when a cohabiting union dissolves, there is no analog of marital property—possessions remain with the ex-partner who holds legal title to the asset. A few countries have implemented laws to regulate the division of property after the dissolution of cohabiting unions. In Sweden, for example, long-term cohabiting partners may request mediation in dividing the joint home and household goods at the request of either partner. As cohabitation dissolution policies become more akin to divorce policies, the relative benefit of cohabitation diminishes, and therefore, people on the margin are more likely to choose marriage over cohabitation. Based on the above rationale, we define the *Divorce-like division* indicator variable as taking the value of one if a country in a given year has aligned cohabitation and marriage policies in terms of division of property and household goods after union dissolution, and zero otherwise.<sup>13</sup> In column (2) of Table 7, we re-estimate

<sup>12</sup> The divorce law status by country follows Table 1 of González and Viitanen (2009).

<sup>13</sup> We follow Perelli-Harris and Gassen (2012) to define whether a country has aligned cohabitation and marriage or continues to distinguish between the two regarding the division of household goods. Specifically, we divide countries into Neutrality (no difference), Treated differently, and Intermediate positions. We further define the countries in Neutrality or Intermediate position as harmonizing cohabitation and marriage.

**Table 7** Heterogeneous treatment effects: Cohabitation

	Marriage rate			Divorce rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Nordic	-0.618 (-0.78)	-0.076 (-0.31)	-0.426 (-0.99)	1.147 (0.21)	2.081 (0.76)	1.338 (0.40)
Nordic×Unilateral divorce	1.702* (2.02)			-17.530** (-2.77)		
Nordic×Divorce-like division		1.180** (2.53)			-18.842*** (-4.23)	
Nordic×Pro-marriage attitude			1.799*** (3.69)			-19.416*** (-4.71)
Unilateral divorce	0.326 (0.95)			-8.784** (-2.29)		
Divorce-like division		-0.082 (-0.27)			5.000 (0.87)	
Pro-marriage attitude			-0.005 (-0.02)			3.154 (0.60)
GDP per capita	0.012 (0.65)	0.007 (0.40)	0.010 (0.65)	-0.091 (-0.38)	-0.118 (-0.46)	-0.113 (-0.47)
Population growth	0.263 (1.39)	0.276 (1.57)	0.266 (1.57)	-3.658 (-1.74)	-2.982 (-1.68)	-3.562 (-1.59)
Sex ratio	0.022 (0.55)	0.002 (0.05)	0.046 (1.22)	-1.165 (-1.03)	-1.256 (-1.18)	-1.220 (-1.09)
Constant	1.946 (0.50)	4.375 (1.02)	-0.079 (-0.02)	169.072 (1.48)	170.046 (1.57)	165.917 (1.45)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	729	729	729	700	700	700
Adjusted R <sup>2</sup>	0.492	0.484	0.502	0.660	0.656	0.657

Note: This table reports the heterogeneous treatment effects on marriage and divorce. The indicator variable *Unilateral divorce* takes the value of one if a country has adopted the unilateral divorce law in a given year, and zero otherwise. The indicator variable *Divorce-like division* takes the value of one if a country in a given year has aligned cohabitation and marriage in terms of division of property and household goods after union dissolution, and zero otherwise. The indicator variable *Pro-marriage attitude* takes the value of one if the proportion of people who disagree with the statement “Marriage is an outdated institution” is greater than the sample mean, and zero otherwise. Variable definitions are provided in Table IA8 of the Internet Appendix. Robust t-statistics based on standard errors clustered by country are reported in parentheses. \*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

our baseline regression by adding the interaction *Nordic×Divorce-like division*, and the coefficient on the interaction is significantly positive. Similarly, the coefficient on *Nordic×Divorce-like division* is significantly negative when we examine divorce rate as the dependent variable in column (5). These findings suggest that the positive effect of the Nordic model on marriage rates and its negative effect on divorce rates are more pronounced when cohabitation involves property division complexities

similar to those of marriage (i.e., when the relative benefits of cohabitation over marriage are reduced).

Third, social attitudes towards marriage also play a central role in the choice between marriage and cohabitation. People are more likely to choose marriage over cohabitation if they value marriage more (Thornton 1989). We obtain information on attitudes towards marriage from the European Values Studies survey.<sup>14</sup> Specifically, following Camarero (2014) and Yucel (2015), we utilize the answer to the question “*Marriage is an outdated institution*” to assess people’s outlook towards marriage. We define the *Pro-marriage attitude* indicator variable as taking the value of one if the proportion of people who disagree with this statement is greater than the sample mean, and zero otherwise. Column (3) shows that the coefficient on the interaction term *Nordic*×*Pro-marriage attitude* is positive and statistically significant at the 1% level, indicating that the positive effect of the Nordic model on marriage rates is more pronounced among individuals who place a higher value on marriage. Similarly, column (6) demonstrates that the negative effect of the Nordic model on divorce rates is also stronger when individuals hold a greater appreciation for marriage.

In summary, Table 7 provides evidence that our treatment effects are stronger when individuals are more inclined to choose marriage over cohabitation. These results are consistent with our conjecture that the presence of cohabitation leads to an underestimation of the effect of the Nordic model on the marriage market.

## 6 Robustness check and additional investigation

### 6.1 Alternative difference-in-differences methods

Goodman-Bacon (2021) shows that standard DiD estimates can be biased when multiple treatments occur in different years, partially because earlier treatment groups serve as controls for later treatment groups. Given that we exploit the staggered adoption of the Nordic model in different years, we apply three alternative DiD methods to address the heterogeneity in the timing of treatment, including (1) the method proposed by Sun and Abraham (2021), (2) the method in Borusyak et al. (2024), and (3) the stacked DiD approach suggested by Cengiz et al. (2019).

For the estimator developed by Sun and Abraham (2021), we first estimate the individual cohort-time-specific treatment effects, allowing for treatment effect heterogeneity; we then aggregate these treatment effects to produce the overall treatment effects. For the estimator developed by Borusyak et al. (2024), we first estimate a model for non-treated potential outcomes using only non-treated observations; we then extrapolate the model to treated observations, impute the non-treated potential outcomes, and obtain an estimate of the treatment effect for each treated observation.

<sup>14</sup> The European Values Study (EVS) is a large-scale, cross-national, and longitudinal survey research program on basic human values. Numerous works have made use of the data: more than 2,800 publications are listed in the EVS Bibliography (see <https://europeanvaluesstudy.eu/education-dissemination-publications/evs-publications/publications/>).

Finally, we take averages of estimated treatment effects to produce the overall treatment effects. As for the third estimator, the idea for stacked DiD is to create event-specific clean  $2 \times 2$  datasets for the treated groups and “clean” control groups within the treatment window. We then stack all of these clean  $2 \times 2$  datasets together and estimate a two-way fixed-effects DiD regression with the dataset-specific unit- and time-fixed effects (Cengiz et al. 2019).<sup>15</sup>

Panel A of Table IA1 in the Internet Appendix reports the impact of the Nordic model on marriage rates. The sample includes countries that were treated during the sample period spanning from 15 years before to 15 years after their treatment year (denoted as year 0) and clean control countries (never-treated observations) for all years with available data. The coefficients on *Nordic* are 0.904 (the method of Sun and Abraham (2021)), 0.818 (the method of Borusyak et al. (2024)), and 0.844 (the stacked DiD method); they are significant at the 1%, 1%, and 5% levels, respectively. The economic magnitude of these coefficients is largely comparable to that of our baseline regression in column (2) of Table 2 (0.926).

Panel B of Table IA1 reports the impact of the Nordic model on divorce rates. The coefficients on *Nordic* are  $-9.036$  (the method of Sun and Abraham (2021)),  $-13.793$  (the method of Borusyak et al. (2024)), and  $-11.933$  (the stacked DiD method), and all are significant at the 1%, 1%, and 5% levels. The economic magnitude of these coefficients is largely similar to that of our baseline regression in column (4) of Table 2 ( $-16.169$ ). Overall, these results show that our main inference is robust to alternative DiD methods.

## 6.2 Correcting for a small number of clusters

Existing literature shows that when the number of clusters is small, failure to control for within-cluster error correlation can cause misleadingly small standard errors and, consequently, deceptively large t-statistics and low p-values (Angrist and Pischke 2008; Conley and Taber 2011; Cameron and Miller 2015). Since we cluster standard errors by country (approximately 17 clusters in total), we follow Roodman et al. (2019) and apply a small-cluster correction with wild cluster bootstrapping.<sup>16</sup> In particular, we use wild cluster bootstrapping at the country level and subcluster wild bootstrapping for country-year combinations, presenting both equal-tailed and symmetric p-values. The p-values associated with each type of bootstrap procedure are reported in Table IA2.

Panel A re-estimates the effect of the Nordic model on marriage rates, using the regression specification from Table 2 column (2). The corresponding p-values for

<sup>15</sup> The STATA commands for the three estimation methods are `csdid`, `did_imputation`, and `stackeddev`, respectively.

<sup>16</sup> The underlying idea is to generate a large number of bootstrap samples that mimic the distribution from which the actual sample was obtained. Then, using the same test procedure as for the original sample, each bootstrap sample is used to compute a bootstrap test statistic. The bootstrap p-value is then calculated as the proportion of the bootstrap statistics that are more extreme than the actual one from the original sample. For a general introduction, see, among many others, Davison and Hinkley (1997), MacKinnon (2009), and MacKinnon and Webb (2018).

the coefficient on *Nordic* vary from 0.026 to 0.053, depending on bootstrapping specification.<sup>17</sup> Panel B re-estimates the effect of the Nordic model on divorce rates, using regression specification from Table 2 column (4). The corresponding p-values for the coefficient on *Nordic* vary from 0.000 to 0.010. The significance levels are comparable to those of the baseline regression. Overall, these results indicate that the inference remains largely unchanged after correcting for the small number of clusters.

### 6.3 Additional controls: immigration, same-sex marriage legalization, and population aging

We examine the robustness of our baseline results with the inclusion of additional control variables. First, in the last few decades, there has been a rise in immigration to Europe (Hatton 2004; Van Mol and De Valk 2016). Immigration could affect a country's commercial sex industry because female immigrants tend to be a significant source of supply for prostitution (Jones et al. 2007; Vuolajärvi 2019). Moreover, immigration could influence the local marriage market since immigrants may have incentives to marry natives to elevate their social status (Meng and Gregory 2005; Furtado and Theodoropoulos 2010). To rule out the possibility that our results are mainly driven by immigrants, we re-estimate our baseline regressions of marriage and divorce rates by controlling for the stock and flow of immigrants. Results are shown in columns (1) and (2) in Table IA3. After controlling for immigration, the coefficients on *Nordic* are still comparable to those of our baseline regressions.

Second, a broad wave of legalization of same-sex marriage occurred globally. For instance, same-sex marriage was first legalized in the Netherlands in 2001 and was subsequently adopted by several other countries. While the prevalence of same-sex marriage remained relatively low, its legalization could have contributed to a surge in marriage rates (Chamie and Mirkin 2011). To address this confounding effect from same-sex marriage legalization, we re-estimate our baseline regressions of marriage and divorce rates, including an additional control for a dummy variable that indicates whether same-sex marriage was legalized in a given country.<sup>18</sup> Columns (3) and (4) of Table IA3 show that the coefficients of *Nordic* remain largely the same after accounting for same-sex marriage.

Third, the Nordic countries, which are pioneers of the Nordic model of prostitution legalization, are also known for their aging populations. Population aging is closely linked to marriage decisions, which could thus act as a confounding factor for the baseline results. To address this concern, in columns (5) and (6) of Table IA3,

<sup>17</sup> For more details on the procedure and comparison of the bootstrap versions, see 8.3, "Difference-in-differences with few treated clusters" of Roodman et al. (2019).

<sup>18</sup> We track the legal status of same-sex marriage for each country and define same-sex marriage as legalized when marriages between same-sex couples began to be officially certified in the country. During our sample period, fifteen countries legalized same-sex marriage: Netherlands (2001), Belgium (2003), Spain (2005), Norway (2009), Sweden (2009), Portugal (2010), Iceland (2010), Denmark (2012), France (2013), Luxembourg (2015), Ireland (2015), Germany (2017), Finland (2017), Austria (2019), and Switzerland (2022).

we re-estimate our baseline regressions for marriage and divorce rates by controlling for the median age of the country's population. Our inference is largely unchanged.

#### 6.4 Resampling the control group

We further validate the robustness of our baseline results by resampling of the control and treatment groups. First, we examine whether the baseline findings remain consistent when specific control countries are excluded from the sample. In particular, we sequentially remove one country from the control group and re-estimate the baseline regressions, following the specifications in columns (2) and (4) of Table 2, respectively. As shown in Panels A and B of Table IA4, our main results remain robust even when certain control countries are excluded.

Second, we expand our control group by including additional countries geographically proximate to the treated countries, namely the Baltic states (Lithuania, Latvia, and Estonia) as well as Slovenia and Croatia. These countries were excluded from the baseline sample due to their historical occupation by the Soviet Union prior to the 1990s or their broad association with the communist context in Eastern Europe during that period. The collapse of the Soviet Union may have introduced significant legal changes related to prostitution in these countries—for instance, prostitution was prohibited under Soviet rule but became unregulated afterward—potentially confounding our analysis. The UK is also excluded because of the ambiguity in classifying it as either a treated or control country. As part of a robustness test, we include these countries in the control group and re-estimate the baseline regressions. As shown in Panel C of Table IA4, our main findings remain robust when these additional control countries are included.

Third, there is ongoing debate about whether the never-treated group should be included in the control group, as their distinct characteristics may violate the parallel trends assumption (Sun and Abraham 2021). To address this concern, we restrict the sample to include only Sweden from 1980 to 2022 and the other four treated countries from 1980 until the year prior to their adoption of the Nordic model. For example, the sample for Norway ends in 2008, and for Ireland, it ends in 2016. Within this framework, Sweden, as the earliest adopter of the Nordic model, is regarded as the sole treated country, while the remaining four countries, which had not yet implemented the Nordic model, serve as the control group for Sweden. As shown in Panel D of Table IA4, we continue to observe a significant positive effect of the Nordic model on marriage rates and a significant negative effect on divorce rates.

#### 6.5 Resampling the treated group

Additionally, we check the robustness of our baseline results by resampling the treated group. First, concerns have been raised about including France and Ireland in the treated group, as both countries adopted the Nordic model of prostitution legalization relatively late—France in 2016 and Ireland in 2017—while our

sample period ends in 2022. This raises the issue of limited post-policy observations for these two countries. To address this, we exclude France and Ireland from the treated group and re-estimate the baseline results. As shown in columns (1) and (2) of Table IA5, our inference is largely unchanged.

Second, there is a concern that the observed effects of the Nordic model on marriage and divorce rates might be disproportionately driven by Sweden, the earliest adopter of the policy. To address this issue, we exclude Sweden from the treated group and re-estimate the baseline results. As shown in columns (3) and (4) of Table IA5, our inference remains robust.

## 6.6 Alternative measures of divorce rate

In our main analysis, divorce rates are measured as the number of divorces per 100 new marriages. In this section, we conduct robustness checks using alternative measures of divorce rates. The first alternative measure is the number of divorces per 1,000 total population. Although this provides a straightforward measure of divorce levels, it might be affected by the marital status structure of the population (González and Viitanen 2009; González-Val and Marcén, 2012): A small number of divorces per 1,000 population could either reflect a low likelihood of divorce or low marriage rates.

The second alternative is the number of divorces per 1,000 married individuals. While this measure accounts for the population most directly at risk of divorce, it has its limitations due to the scarcity of data on the total stock of marriages, which is only available when a census is conducted in each country, normally every 10 years (Furtado et al. 2013).

Despite these weaknesses, we re-estimate the regression in Table 2 column (4), using these two alternative measures of divorce rates, and we find that our inference is unchanged. As reported in Table IA6, the coefficients on *Nordic* are negative and significant at the 5% level in both columns, indicating that the Nordic model significantly reduces divorce rates.

## 6.7 Missing values and common restricted sample

As indicated in Table 1, the number of observations varies across our main variables due to limitations in the availability of certain data, particularly detailed marriage-related information. For instance, the marriage rate by age and sex group is available for only 515 observations, compared to 731 observations in the full sample. Panel A of Table IA7 provides a summary of the missing values for the key variables.

To investigate whether our results are sensitive to missing values, we re-estimate the baseline results using a common restricted sample that excludes any observations with missing values in the main variables. This restriction reduces the sample size to 450 country-year observations. As presented in Panel B of Table IA7, our main inference is largely unchanged, indicating that our results are robust even when focusing on a smaller sample with no missing values.

## 7 Conclusions

In this paper, we shed light on the influence of the commercial sex industry on household behavior by identifying a substitution effect of the prostitution market on the marriage market. Using the staggered adoption of the Nordic model, which criminalizes prostitution clients in several European countries over the last four decades, within a DiD framework, we find that the Nordic model leads to a significant increase in marriage rates and a significant decrease in divorce rates. Our parallel trends tests demonstrate no pre-treatment difference in the time trends of marriage decisions between treatment and control countries and show that the change in marriage decisions occurs after the Nordic model is adopted, suggesting a causal effect. Our treatment effects are mainly driven by the marriages of young people and those of previously single people (compared to those previously in a legal union). Our heterogeneous tests show that the treatment effect is stronger when women's socioeconomic status is weaker and when individuals prefer marriage over cohabitation. Overall, our study provides the first empirical evidence that prostitution is a sexual substitute for marriage, and that the recent global trend of restricting commercial sex has resulted in increased marriage rates.

It is important to recognize that the adoption of the Nordic model may not be a random occurrence. In Sweden, the Nordic model was part of a broader policy reform effort aimed at improving women's conditions. For example, other policies include the introduction of a new criminal offense for "self-esteem damage" caused to women by men in close relationships and tougher laws against sexual harassment in the workplace (Leander 2006). Notably, some of these policies, such as initiatives to advance women's rights in the workplace, may work against identifying a substitution effect between the prostitution and marriage markets. This is because higher socioeconomic status among women tends to weaken the substitution relationship (see Table 6). Other policies, particularly those aimed at improving women's status within marriage, may have ambiguous effects. On the one hand, they enhance the benefits of marriage for women, potentially increasing their willingness to marry. On the other hand, they may reduce the perceived benefits of marriage for men, which could diminish their willingness to marry. Therefore, examining the effect of these policies on the marriage market could be an interesting topic for future research.

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## Declarations

**Conflict of interest** The authors declare no competing interests.

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