The causal impact of women's age at marriage on domestic violence in India[*]

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Abstract

Domestic violence affects one in three women in their lifetime. It remains a crucial problem with adverse health and economic consequences in both developed and developing countries. In this paper, we provide the first causal analysis of the impact of women's age at marriage on prevalence of domestic violence using newly available nationally representative household data from India. We use an empirical strategy that utilizes variation in age at menarche to obtain exogenous variation in women's age at marriage. We find robust evidence that a one-year delay in women's marriage causes a significant decline in physical violence, although it has no impact on sexual or emotional violence. Further, we show that the effect of women's marital age on physical violence arises independent of women's educational attainment, which indicates that direct age-related behavioral attributes (e.g. emotional maturity, bargaining power, etc.), and not education, are probably driving the observed relationship between women's marital age and physical violence. Overall, our findings bolster the relevance of policies that seek to delay marriages of women in reducing the prevalence of domestic violence in a developing country.

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"My husband came into the room, locked the door. He turned up the music so that no one could hear us outside. Then he took out his belt and started to hit me. He kept whipping me for the next 30 minutes...As he was doing this, he warned me that I shouldn't make a sound, I shouldn't cry, I shouldn't scream, because if I did, he was going to hit me even harder. He was hitting me with his belt, his hands... soon he began to choke me. He was just so angry."

– Experience of a 19 year old woman, Aditi (name changed), one of the millions of victims of domestic violence in India[1]

1 Introduction

Domestic violence is a global pandemic that affects one in three women in their lifetime. According to a study by the World Health Organization (WHO), partner violence is the most common form of violence in women's lives and is far greater than assaults or rape by strangers, acquaintances or any other perpetrators in both developing and developed countries.[2] Women who suffer domestic violence experience serious health consequences including injury, emotional distress, suicidal thoughts, physical symptoms of severe illness, absence from work, alcohol and substance abuse, sexually transmitted diseases and unintended pregnancies (Campbell 2002; Coker et al. 2002; Ackerson and Subramanian 2008; Ellsberg et al. 2008). The cost of domestic violence to an economy in terms of victim's suffering, medical bills, lost productivity, judicial expenditures and the lost productivity from the incarcerated offender is massive. For example, according to an article published in *The Washington Post* (February 22, 2018) in the US alone this cost is about $460 billion annually.[3]

In this paper, we provide one of the first pieces of *causal* evidence of the impact of women's

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[1] http://www.bbc.com/news/world-asia-india-29708612

[2] http://apps.who.int/iris/bitstream/handle/ 10665/77432/WHO_RHR_12.36_eng.pdf;jsessionid=6CADDFE06611AE8566C228C40575BE46?sequence=1

[3] https://www.washingtonpost.com/opinions/the-cost-of-domestic-violence-is-astonishing/2018/02/22/f8c9a88a-0cf5-11e8-8b0d-891602206fb7_story.html?noredirect=on&utm_term=.9c1983316e34

age at marriage on their exposure to domestic violence, and more specifically spousal or intimate partner violence (IPV).[4] We use newly available nationally representative data from India, where according to a *BBC* report (October 24, 2014), one incident of domestic violence is reported in every five minutes (which, of course, is only a fraction of how much actually occurs).[5] We find that a year of delay in women's marriage causes a significant reduction in (non-sexual) physical violence, but does not impact sexual or emotional violence.

In theory, the causal impact of women's age at marriage on domestic violence could be either negative or positive. On one hand, women who marry early are likely to be unassertive, naive, socially isolated, experience severe psychological depression and have lesser bargaining power within marriage (Field and Ambrus 2008; Nour 2009; Le Strat et al. 2011; Chari et al. 2017). This makes them less resistive to domestic violence and hence 'safer' to be victimized. They are also likely to be less educated since early marriage often interrupts the accumulation of formal education for women due to family responsibilities (Field and Ambrus 2008). This limits their options outside marriage and the economic and social resources at the women's disposal (Chowdhury et al. 2004) negatively influencing their empowerment within marriage (Farmer and Tiefenthaler 1996; Stevenson and Wolfers 2006; Aizer 2010; Hidrobo and Fernald 2013; Erten and Keskin 2018; Yount et al. 2018). Both these factors would suggest a negative relationship between women's age at marriage and domestic violence.

On the other hand, although women who marry later might be more able to advocate for their preferences in the spousal household, have greater access to social capital, have greater bargaining power and consequently be more resistive to domestic violence, they might face a stronger backlash from their partners (Field et al. 2016). Moreover, since education is positively correlated to age at marriage and more education leads to greater availability of economic resources, women who marry late may experience violence or threats of violence from their spouses who might want to control these resources (Bloch and Rao 2002; Eswaran

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[4]Although technically spousal violence or IPV is a subset of domestic violence, we shall use the terms domestic violence and IPV interchangably throughout the paper since three-quarters of violence against women is intimate (Aizer 2010).

[5]http://www.bbc.com/news/world-asia-india-29708612

and Malhotra 2011; Bobonis et al. 2013). These two factors, taken together, suggest that women who marry late may be more vulnerable to mistreatment. Overall, thus, the causal effect of women's age at marriage on prevalence of domestic violence is *a priori* ambiguous.

To examine the relationship between women's age at marriage and domestic violence, we use data from the National Family Health Survey of India, 2015-16. This survey includes detailed information on the prevalence of domestic violence, gender role, health, and marriage market indicators. As noted by Golder et al. (2016), the National Family Health Survey collects information on domestic violence with utmost caution following both Indian and international guidelines (more specifically the WHO ethical guidance for research on domestic violence against women, 2001, for the ethical collection of data on violence). We focus on four types of domestic violence against women: less severe physical violence, severe physical violence, sexual violence, and emotional violence (we discuss each category in detail later in the data section).

The main empirical challenge in identifying the causal effect of age at marriage on prevalence of domestic violence is that marriage age might be endogenous due to omitted variables. For instance, according to classic patriarchy, women are expected to marry young to exchange obedience for protection from men (e.g., Kabeer 1988; Alam 2007; Yount and Li 2010), and to respect men's authority to punish disobedience. Thus, those women who come from families that strictly follow such patriarchal norms are likely to get married early as well as be more tolerant of, and hence exposed to greater domestic violence. Such unobserved characteristics of women's natal family could in theory drive the relationship between women's age at marriage and domestic violence. Unobserved ability of women might also be correlated with marital age and domestic violence. Specifically, more able women might get married late as well as be less victims of domestic violence. This might be perhaps due to the positive correlation between ability and labor market prospects. This could be also because women of higher ability might choose to marry into households relatively late only after their earnings potential is fully revealed and these households might be systematically different (perhaps

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better in terms of prevalence of domestic violence) from the average household. In addition to omitted variables, of course, endogeneity could also arise due to potential measurement error in age at marriage

To address the issue of endogeneity and estimate the causal effect of women's age at marriage on domestic violence, we employ the empirical strategy proposed by Field and Ambrus (2008), who instrument women's age at marriage by their age at menarche. This instrument is motivated by the observation that has been made by sociologists and anthropologists that parents become extremely anxious to get their daughters married once they have reached menarche, partly to avert any unwanted pregnancies (Caldwell et al. 1983; Srinivas 1984). Consequently, the variation in the age at menarche generates a quasi-random difference in the age at which a girl enters the marriage market. This instrument has recently been used by Sekhri and Debnath (2014), Chari et al. (2017) and Asadullah and Wahhaj (2018) among a few others.

We note up-front that ideally one would perhaps be better off using administrative data instead of survey data for studying domestic violence, since administrative data such as police reports or hospital records are objective measures of violence and are not subject to self-reporting bias. However, as noted by Erten and Keskin (2018), this kind of information is very likely to be flawed, especially in a developing country context. This is because in such countries only a selected group of women has access to hospitals or police stations after they experience a violent episode. Moreover, it is even more difficult, if not impossible, to capture the extent of emotional violence using administrative reports. By using a carefully designed survey that includes self-reported information on physical, sexual and emotional violence against women, we are able to examine the effect of marriage timing on different forms of domestic violence that are otherwise impossible to observe.

Our results are compelling. The ordinary least squares (OLS) results for the full sample indicate that a year of delayed marriage of women is associated with a reduction in all types of domestic violence considered. However, as noted above these effects are not necessarily

causal but instead could arise due to unobserved factors. To distinguish causation from correlation, we use the instrumental variable (IV) two stage least squares approach. The first stage results for the IV are strong and rules out any concerns of weak instruments. The main IV results indicate a strong negative effect of women's age at marriage on less severe and severe forms of physical violence. Specifically, based on our preferred specification, we find that a delay in women's marriage by a year causes less severe physical violence to decrease by 7 percentage points and severe physical violence to decrease by 4 percentage points. Both these effects are significant at 5% level of significance. However, the effect of women's age at marriage on sexual violence and emotional violence are not statistically significant.

We show that our results are robust to alternative non-linear methods of estimation. Further, to assess the validity of our instrument, we also perform a falsification test by trying to find a systematic reduced form effect of age at menarche on domestic violence among a subsample of women for whom we should not find any such effect. The results of this test suggest that our instrument is likely to satisfy the exclusion restriction, and thus increase our confidence in the empirical strategy employed. Additionally, we employ carefully designed tests to rule out potential concerns regarding our IV being endogenous. Finally, we show that the effect of women's marital age on physical violence arises independent of women's educational attainment. This indicates that direct age-related behavioral attributes (e.g. emotional maturity, ability to adapt in a new environment, bargaining power, etc.), and not educational attainment of women, are likely to be driving the inverse relationship between women's marital age and physical violence.

Our study contributes to the growing body of literature that examine various possible determinants of domestic violence from a causal perspective. While the existing studies in this literature have looked at factors such as education (Erten and Keskin 2018), income (Rivera et al. 2006; Angelucci et al., 2008; Bobonis et al. 2013) and intrahousehold bargaining power (Stevenson and Wolfers 2006; Aizer 2010) that could potentially explain the prevalence of domestic violence, none of them focus on the relationship between women's

age at marriage and domestic violence. The studies that do look at how early marriage (or child marriage) impacts domestic violence, mostly report a negative correlation between them (see for e.g. Oshiro et al. 2011; Santhay 2011; Speizer and Pearson 2011; Nasrullah et al. 2014; Rahman et al. 2014; Yount et al., 2017). These studies, however, fail to establish a causal relationship by accounting for the potential omitted variable bias or measurement error. Our work contributes to this literature by providing one of the first pieces of causal evidence on the impact of women's age at marriage on domestic violence using a large-scale micro-data.

Additionally, our study relates to the literature that looks at the impact of women's marital age on their economic well-being measured along various dimensions including schooling, health, labor market outcomes, gender norms and human capital of women's children in developing countries like Bangladesh and India (see for e.g. Field and Ambrus 2008; Sekhri and Debnath 2014; Chari et al. 2017; Dhamija and Roychowdhury 2018; Asadullah and Wahhaj 2018). Given that child marriage and early marriage are issues of deep concern in developing countries,[6] this study by focusing on the relationship between women's age at marriage and domestic violence is likely to extend our understanding of the socioeconomic consequences of early marriage of women. Our findings, thus we believe, are likely to be useful for governments and policymakers in assessing the relevance and effects of policies that seek to delay marriages of women in developing countries.

The rest of the paper unfolds as follows. In section 2 we discuss the dataset used. Section 3 presents the econometric model and empirical strategy. Results are presented in the section 4. The last section concludes.

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[6]The mean marital age of women in India was 19.3 years according to the 2011 Census data. Moreover, an article in the *The Wire* (June 1, 2016) states that in India as many as 102 million girls (30% of the female population) were married before 18 in 2011 even though the Prohibition of Child Marriage Act states that a girl in India cannot marry before she turns 18. In Bangladesh 46.1% of women between the ages of 15 and 19 were married between 2003 and 2005. Corresponding figures for some other poor countries for the same period were: 42% in Chad, 32.9% in Malawi, 50.4% in Mali, 38.2% in Mozambique and 31.7% in Nigeria (data from Demographic and Health surveys). For the developed countries, the average age of marriage for women is much higher. For instance, the mean age of marriage of women in the US was 26.9 years in 2011 (Pew Research Foundation, 2011), for Germany it was 30.9 years, and for Sweden 33.3 years.

2 Data

The data come from the fourth round of National Family Health Survey (NFHS-4) of India, 2015-16. NFHS, a nationwide cross-section demographic health survey for India, provides information on various topics such as population demographics, health and nutrition for India. It is conducted by the International Institute for Population Sciences (IIPS) in Mumbai administered under the Ministry of Health and Family Welfare (MoHFW), Government of India, and is a part of the global Demographic Health Survey (DHS) program.[7] The NFHS-4 survey was conducted between January 2015 and December 2016, and covered 601,509 households located throughout India. The sample is drawn using stratified random sampling (see IIPS and ICF, 2017 for more details on the survey methodology).

The NFHS-4 administered a separate woman's questionnaire to collect information from all eligible women aged 15-49 years in all the households. This questionnaire included questions on a variety of topics such as background characteristics, reproduction, prevalence of hysterectomy, menstrual hygiene, family planning, contacts with community health workers, maternal, child health, breast-feeding, nutrition, marriage, sexual activity, fertility preferences, husband's background, women's work, women's empowerment, HIV/AIDS, other health issues and domestic violence. The information on menstrual hygiene and related topics, including age at menarche, was collected from the women in the age group of 15-25 years. Note, to answer questions specifically on domestic violence, only one eligible woman per household was randomly selected.

The questions on domestic violence provide detailed information on physical, sexual, and emotional violence. Collecting valid and reliable data on domestic violence, however, poses serious challenges due to the sensitivity of the issue and the consequent difficulties in collecting correct and complete information, maintaining ethical concerns, ensuring safety of the respondent and interviewer, as well as protecting the women who disclose violence. However, as noted by Golder et al. (2016, p. 2), "all these issues are well addressed in

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[7]The DHS surveys for all countries are available at https://dhsprogram.com/

the NFHS surveys. It follows both Indian and international guidelines, viz. WHO ethical guidance for research on domestic violence against women, 2001, for the ethical collection of data on violence."[8] For instance, as noted previously, only one woman per household was selected for the interviews.[9] Selecting only one woman for the domestic violence module even when there are more women eligible for interview, allows the interviewed respondent to keep the information confidential. Next, there was no one else in the room when the interviews were conducted. Further, the respondents were informed that their answers would be kept confidential and would not be told to anyone else and that no one else in the household would be asked these questions. Note, the domestic violence module was specially designed to allow the interviewer to continue the interview only if privacy was obtained. If privacy could not be obtained, the interviewer was instructed to skip the module, thank the respondent, and end the interview.[10]

The domestic violence measures include binary variables on whether a woman had ever experienced any kind of less severe physical violence, severe physical violence, sexual violence and emotional violence from her intimate partner (spouse). Less severe physical violence is measured by acts of pushing, shaking, throwing something, twisting arm, pulling hair, slapping, punching with partner's fist or something else. Severe physical violence is measured by acts of kicking, beating, choking, burning, threatening or attacking with any kind of weapon. Sexual violence is measured by forced sexual acts, forced sexual relations resulting from the fear of what the partner would do otherwise, and humiliating sexual acts. Finally, emotional violence includes activities which caused women to face humiliation, insult, various kinds of threats from their partners to hurt the women or her closed ones. For each of the four categories of domestic violence, for a particular women, the binary variable takes a value

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[8]See http://www.who.int/gender/violence/womenfirtseng.pdf

[9]In households with more than one eligible woman, the woman administered the module was randomly selected through a specially designed sample selection procedure based on the "Kish Grid" which was built into the household questionnaire.

[10]For more on specificities about collection of data on domestic violence in NFHS, see NFHS data documentation (p. 496) available at http://rchiips.org/nfhs/NFHS-3%20Data/VOL-1/Chapter%2015%20-%20Domestic%20Violence%20(468K).pdf. Also see NFHS surveyor training manual (p. 8) at http://rchiips.org/nfhs/Manuals/DV_Training_Manual.pdf.

one if the woman reported to have faced at least any one kind of the underlying violences.

Of course, one could argue that when studying domestic violence it would have been ideal to use administrative data such as police reports or hospital records since these are objective measures of violence and are not subject to self-reporting bias. However, as noted by Erten and Keskin (2018, p. 67), "this kind of information is likely to be flawed, especially in a developing country setting in which only a selected group of women has access to hospitals or police stations after they experience a violent episode." Using surveys from 24 countries in the DHS program, Palermo et al. (2014) in fact show that only seven percent of women who experienced such violence made a formal report that would be captured in administrative data (e.g., police, medical, or social services). For India in particular, the situation seems to be more grim. According to a recent report of the *The Times of India* (December 6, 2017), comparison of the data from the NFHS-3 and the National Crime Records Bureau of India reveals that "less than 0.17% of women who face marital violence actually filed a case under Section 498A IPC [the section of the Indian Penal Code that deals with domestic violence]." This self selection in reporting domestic violence makes the use of administrative data unattractive. Moreover, it is even more difficult, if not impossible, to capture the exposure to emotional violence using administrative records.

For the analysis of the effect of women's age at marriage on the prevalence of domestic violence, we restrict ourself to the women who have non-missing information on the different categories of domestic violence, whose marital age is not less than 5 years[11] and menarcheal age is between 9 and 21 years, have valid information on age, spousal age, height, family attributes like caste, wealth, indicator for violence between parents in her natal home and place of residence (rural/urban), leaving us with a sample of 9,343 women.[12]

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[11] In our sample, year of marriage was known for 99.73 percent (9318 out of 9343) observations, we combine this information with the year of birth information to get the age of marriage. For the remaining cases where the year of marriage was unavailable, we use the age of marriage (reported only for those cases where the year of marriage is unknown) available in the data set.

[12] The normal menarcheal age is between 10 and 15 years. However, menarcheal age as low as 9 years is not unusual (see for e.g. https://timesofindia.indiatimes.com/city/goa/Girl-talk-Menarche-now-at-8-9-years/articleshow/34169175.cms). Similarly, menarcheal age above 15 years, and in fact, as high as 20-21 years is also not biologically impossible. Delayed puberty may be constitutional or due to pathologic

Table 1 provides descriptive statistics of our analytical sample. In our sample, 25% of the women have faced less severe physical violence, 6% have faced severe physical violence, 6% have faced sexual violence, and 11% have faced emotional violence.[13] The average age at marriage of women is 18.23 years and average age at menarche is 13.57 years. Figures 1 and 2 graph the distribution of the age at marriage and age at menarche respectively for our sample. Figure 3 graphs the proportion of women exposed to different types of domestic violence by their age at marriage.

3   Empirical Strategy

3.1   Econometric Model

To examine the impact of women's age at marriage on their exposure to domestic violence, we begin by estimating the following econometric model:

$$y_i = \beta_0 + \beta_1 MarriageAge_i + \beta_2 X_i + \varepsilon_i \tag{1}$$

where y_i denotes a particular category of domestic violence against woman i, $MarriageAge_i$ denotes the woman's age at marriage, X_i denotes the vector of individual and household level controls, and ε_i is the idiosyncratic error term that includes unobserved attributes like ability, social norms, discount rate, etc. Our parameter of interest is the coefficient β_1 which captures the effect of women's age at marriage on their exposure to domestic violence. If we obtain $\beta_1 < (>) 0$, this indicates that women's age at marriage has a negative (positive) impact on the probability of their exposure to domestic violence. Note, while estimating equation (1), we exclude women's educational attainment (which is likely to be endogenous)

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causes (Blondell et al. 1999). Undernourishment during childhood is, in fact, one major reason for delayed menarche. Also, intense physical activity during childhood may delay menarcheal age. In this context, based on a survey of dancers and athletes, Frisch et al. (1980) and Frisch et al. (1981) note that dancers and athletes who began their training at ages 9 or 10 years still had not menarche at ages 18–20 years.

[13] The proportion of women who have faced at least one of the four kinds of domestic violence in our sample is 28%.

from the estimation since educational attainment could be a channel through which women's age at marriage affects domestic violence. Consequently, the estimated coefficient β_1 should be interpreted as the *total* effect of women's age at marriage on domestic violence.

We could have consistently estimated β_1 via OLS and interpreted it as causal effect of women's age of marriage on the level of domestic violence if, conditioning on exogenous characteristics, age at marriage was uncorrelated with unobservable determinants of physical, sexual and emotional violence against women (or more formally, $\mathbb{E}[MarriageAge \cdot \varepsilon \mid X] = 0$). However, such an assumption may be violated for several reasons. First, omitted variables may affect both the age at marriage of the women and probability of physical, sexual and emotional violence. For instance, classic patriarchy norms require women to marry young to exchange obedience for protection from men (e.g. Kabeer 1988; Alam 2007; Yount and Li 2010), and to respect men's authority to punish disobedience. Thus, those women who come from families that strictly follow such patriarchal norms are likely to get married early as well as believe that husbands can be justified in beating their wives – a belief that places them at higher risk for domestic violence. Unobserved ability of women might also be correlated with marital age and domestic violence. Specifically, more able women might get married late as well as be less victims of domestic violence since they are likely to have more bargaining power and more outside options of divorcing and economically supporting themselves or re-entering the marriage market after the divorce. Both these instances suggests that $\mathbb{E}[MarriageAge \cdot \varepsilon \mid X] \neq 0$. As a result, OLS estimates would be biased and inconsistent.[14][15]

The second issue relates to the accuracy of the reported age of marriage. In the NFHS 2014-15, age at marriage was self reported. Inaccurate reports would generate measurement error in the explanatory variable. This could attenuate the estimates of the coefficient of interest. To address these concerns, we follow an instrument variable (IV) approach. We use

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[14]Note that both examples suggest that OLS estimates are likely to be biased downwards. In the first example, $\mathbb{E}[MarriageAge \cdot \varepsilon \mid X] < 0$ and the coefficient of (unobserved) patriarchy would be positive. In the second example, $\mathbb{E}[MarriageAge \cdot \varepsilon \mid X] > 0$, and the coefficient of (unobserved) ability would be negative.

[15]In principle, there might be other potential omitted variables which are not orthogonal to age of marriage of the women and might be correlated with their exposure to domestic violence.

age of menarche as an instrument for women's age at marriage. This instrument is motivated by the observation that has been made by sociologists and anthropologists that parents become extremely anxious to get their daughter married once she has reached menarche, partly to avert any unwanted pregnancies (Caldwell et al. 1983; Srinivas 1984; Chari et al. 2017). As noted by Field and Ambrus (2008), a significant portion of the variation in timing of menarche is random, rendering it a good instrument for the age at marriage.[16] In what follows, we discuss our IV strategy in detail.

3.2 IV Strategy

The IV approach involves estimating a two stage model which is specified as follows:

$$MarriageAge_i = \alpha_0 + \alpha_1 MenarcheAge_i + \alpha_2 X_i + \eta_i \qquad (2)$$

$$y_i = \beta_0 + \beta_1 MarriageAge_i + \beta_2 X_i + \varepsilon_i \qquad (3)$$

The first stage is given by the equation (2), and equation (3) is the structural equation. The women's age at marriage, $MarriageAge_i$, is instrumented by $MenarcheAge_i$, their age at menarche, and y_i are the different categories of domestic violence against woman i. As above, X_i denotes a vector of individual and household level controls such as the woman's age, height, wealth, place of residence (urban/rural), spousal age, caste and district fixed effects.

We use a standard two stage estimation procedure (i.e., two stage least squares (TSLS)) and cluster standard errors at the district level.[17]

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[16]Studies of twins have found that random genetic variation is the single largest source of variations in menarche (see for e.g. Kaprio et al., 1995)

[17]Later we use alternative non-linear methods of estimation to assess the robustness of our baseline results. However, for our baseline analysis we use a linear approach since, as noted by Wooldridge (2010), "this procedure [IV-TSLS] is relatively straightforward and might provide a good estimate of the average effect." Angrist and Pischke (2009, p. 107) also argue "...while a nonlinear model may fit the CEF (conditional expectation function) for LDVs (limited dependent variable models) more closely than a linear model, when it comes to marginal effects, this probably matters little. This optimistic conclusion is not a theorem [but]...it

3.3 Examining IV Validity and Threats to Identification

In this section, we perform several checks to test the validity of the instrumental variable. First, we examine whether age at menarche predicts women's age at marriage which is the endogenous regressor. In line with the findings of Field and Ambrus (2008) in context of Bangladesh, and that of Sekhri and Debnath (2014) and Chari et al. (2017) in context of India, we find that age at menarche is significantly correlated with women's age at marriage. The results from the regression of women's age at marriage on age at menarche are presented in Table 2. Column (1) reports the coefficient of age at menarche without additional controls. The value of the coefficient is 0.216, and it is statistically significant at 1% level of significance. The F-Statistic for the regression model is 77.63. These results eliminate concerns about 'weak instruments'. Additionally, Figure 4 also presents the kernel density estimate of women's age at marriage by menarcheal age groups (early and late menarche)[18] revealing that the distributions of women's age at marriage is positively related to age at menarche.

Next, we examine the potential threats to the validity of this instrument. Medical literature suggests that severe malnutrition in early childhood might result in delayed onset of menarche (Sekhri and Debnath, 2014). Exposure to severe malnutrition could potentially also affect long term health of the women (for e.g. Stathopolu et al. (2003) note that acute malnutrition could result in stunting) and their labor market prospects, in turn reducing their options outside marriage. This suggest that malnutrition, by affecting long term health, could make women more vulnerable to physical, sexual and emotional violence. Consequently, as a proxy for severe malnutrition in childhood, we include adult height in the regression in column (2). As noted by Chari et al. (2017), if height is a sufficient statistic for health investments and if undernutrition that affects menarche is also severe enough to result in stunting, then conditioning on height is likely to eliminate any confounding factor

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seems to be fairly robustly true."

[18]The early menarche group consists of those women who attained menarche at the age of 14 or earlier. The late menarche group consists of those women who attained menarche after the age of 14.

related to health investments that affect both menarche and marriage conditions. We find that inclusion of height as an additional control changes the point estimates slightly (the standard errors remain unchanged). Even if height is not a sufficient statistic for health, since it is closely related to health (Strauss and Thomas 1989), the fact that controlling for height has very small effects on our results suggests that they are not driven by unobserved health inputs that also affect age at menarche.

As argued by Field and Ambrus (2008), sudden changes in diet might also impact maturation. Sekhri and Debnath (2014) in this context note that, agriculture and agriculture-related activities, that employ majority of the Indians, are extremely dependent on weather. Extreme weather conditions such as droughts and floods in the women's year of birth might adversely affect household income resulting in transitory but severe malnutrition. Therefore, females born during these extreme weather events may experience delayed age at menarche as they are more likely to be malnourished. We control for this possibility in our first stage regression. In column (3), in addition to height, we add age of the women to account for extreme weather events at the time of birth. Moreover, we also include controls for spousal age in column (3). The point estimates and standard errors are similar across columns (2) and (3). We condition all subsequent results on women's height, women's age, and spousal age.

It is thought that hard physical labor during childhood can have a negative effect on children's health and lead to a delay in menarche (Pellerin-Massicotte et al. 1997). Thus women who end up marrying late may also be less healthy, and this could have a direct effect on her emotional ability to resist domestic violence or her divorce-based outside options. However, as argued by Sekhri and Debnath (2014), the children who work in India are not involved in hard physical work such as construction. They note that detailed data on child labor collected from northern India show that more than 99 % of working girls of age 6 to 14 are engaged in domestic work while 0.001 % of them work for wage (Basu et al. 2010). As such, strenuous physical labor during early childhood is unlikely to render our instrument

endogenous.

Nevertheless, to address this concern it would be ideal to include controls for economic status of women's natal family such as parental education and income. However, unfortunately, we do not have information on these variables in our dataset. To circumvent this issue, we include controls for wealth level of women's spousal household (more specifically, indicators for which quintile of the wealth distribution the women's spousal household belongs) and a set of indicator variables for caste. The inclusion of the first variable can be justified on the grounds that a woman is likely to get married into a family which belongs to a more or less similar economic status as her natal family. As noted in a recent article in *The Economist* (November 25, 2017), "the idea that the best marriage partner is someone with the same family background and belonging to precisely the same social group seems to be rooted in the [Indian] subcontinent."[19] As such, it is likely that the women's natal family belongs to the same quintile of the wealth distribution to which the women's spousal household belongs, and hence the wealth variables are likely to serve as good proxies for the economic status of women's natal family. Finally, as noted by Nayar (2007), in the Indian context, caste might be considered as a proxy for socioeconomic status and poverty. Consequently, I include caste affiliation of women as an additional control as it is likely to serve as a good control for their natal family economic status. As evident from the results reported in Column (4), the inclusion of the proxies for women's natal family characteristics as additional controls does not change the point estimates of the coefficient of age at menarche significantly.[20]

It is noted by some studies that age of menarche is influenced by inter-parental violence that the women face in their childhood (see for e.g. Henrichs et al., 2014). The argument is that inter-parental violence – by acting as a stressor in childhood – may have biological

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[19]https://www.economist.com/news/special-report/21731491-parents-lose-control-over-marriage-indian-society-shaking-marriage-india

[20]Note, although not caste, but spouse's wealth level may be endogenous to marriage. For instance, parents who are in a hurry to marry their daughters might have a lower reservation quality of spouse, as reflected in their wealth. However, this is unlikely to cause the IV estimate of the effect of women's age at marriage on domestic violence inconsistent since age at menarche is unlikely to be correlated with spouse's wealth.

influences on endocrine development resulting in early menarche. Since, experience of inter-parental violence during childhood might also affect women's attitude towards domestic violence when she gets married, not controlling for this might render the age of menarche variable endogenous. As such, we report regression results that include a dummy variable indicating whether a woman reports to have had experienced any kind of inter-parental violence before marriage (in addition to the control variables used in Column (4)) in column (5). Reassuringly, the point estimate of the coefficient of age of menarche does not change significantly.

Age at menarche might also be potentially endogenous due to geographical factors such as temperature, rainfall, altitude, etc. (Field and Ambrus 2008; Chari et al. 2017). To address this issue, we control for place of residence (whether the household resides in an urban or a rural locality) and use district fixed effects to account for spatial variation in exposure to environmental factors that affect menarche. Note, we are able to control for district of residence of the married woman, and not her natal district since we do not have any information about the location of her natal family. This again, however, is not likely to be a problem because in India most marriages occur within the same district, so the district of residence of the married woman is also likely also her natal district (Fulford 2015). The results of the specification that include geographic controls, in addition to the controls included in Column (5), is presented in Column (6). The coefficient of age at menarche is still highly statistically significant and the first stage F-statistic is sufficiently high.

The next concern that we need to address is whether our instrument is exogenous given that we are not controlling for education which is a potential determinant of women's exposure to domestic violence. One might argue that a woman's educational attainment as measured by her years of schooling, is correlated with her age at menarche. More specifically, menarche itself might be a barrier to schooling (as often cited in the popular media). If this is the case, then leaving out education from the set of control variables will violate the condition that $\mathbb{E}[MenarcheAge \cdot \varepsilon | X] = 0$, and the IV regressions will not yield consistent

estimates of the parameters of interest.

While this is possible, Field and Ambrus (2008) in their seminal paper provide robust evidence that menarcheal age has no direct impact on women's schooling using data from Bangladesh. Oster and Thornton (2011) although document a statistically significant effect of menstruation on school attendance for girls in Nepal, this effect is extraordinarily small. Specifically, they estimate that girls miss a total of only 0.4 days in a 180 day school year (although 47 percent of the girls in their study reported missing some school due to menstruation in the past year). Further, Oster and Thornton (2011) show that improved sanitary technology has no effect on reducing this small gap: girls who randomly received sanitary products were no less likely to miss school during their period. Grant et al. (2013) conduct a study in Malawi to examine the individual and the school level factors associated with menstruation-related school absenteeism. In line with the findings of Field and Ambrus (2008) and Oster and Thornton (2011), they find no evidence that menstrual periods account for female absenteeism. Thus, even though it is often believed that menstruation causes girls to be absent from school, these findings indicate that in reality it is unlikely to be the case.

Nevertheless, to address the concern that our instrument might potentially be endogenous due to omission of schooling from our model, we do the following. First, we plot the average years of schooling of women by different menarcheal age in Figure 5. We find no evidence of an upward trend in the relationship between schooling and age at menarche. Second, we present the kernel density estimate of women's years of schooling by terciles of menarcheal age in Figure 6. The figure reveals that the population distributions, and not just averages, are remarkably similar across all subsamples. This is not what we would have expected to find if menarcheal age was correlated with years of schooling. This suggests that not controlling for educational attainment of women is unlikely to confound our analysis. We provide further assessment of the possible correlation between women's age at menarche and educational attainment in the section on robustness checks.[21]

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[21] Note, Sekhri and Debnath (2014) and Chari et al. (2017) also implicitly assume that age of menarche is not correlated with women's education. Both the papers investigate the impact of marital age of the mother

The final concern is whether our set of dependent variables are misclassified or not. Given that our dependent variables are binary in nature, if these are misclassified (in the sense that the women do not always correctly report their exposure to domestic violence), this necessarily leads to nonclassical measurement error and the IV approach that we use in this paper might not yield consistent estimates of the effect of age at marriage on domestic violence. However, we believe this is unlikely to be a major issue in our context. This is firstly because, as noted previously, NFHS takes several precautions in data collection to avoid misclassification error in the domestic violence variables following both Indian and international guidelines. Further, a recent work by Aguero and Frisancho (2017) examines self-reporting bias in domestic violence data by applying the methodology of list experiments (e.g., Blair and Imai, 2012; Karlan and Zinman, 2012; Glynn, 2013) as well as DHS direct questions to a sample of women of Lima, Peru. On average, they find no significant differences in reporting of physical and sexual violence across direct and indirect methods. This implies that misreporting. bias in domestic violence questions may not be as serious an issue as it is generally thought to be.

Note, even if our domestic violence variables are misclassified, based on a recent paper by Meyer and Mittag (2017), we can argue that the parameter estimates although might be inconsistent are nevertheless informative about the true effect of women's age at marriage. Specifically, Meyer and Mittag (2017), building on previous work of Hausman et al. (1998), show that if misclassification is conditionally random (that is, conditional on the true value of the dependent variable, misclassification is independent of the covariates), the (inconsistent) estimates are attenuated towards zero. Even if misclassification is not conditionally random, Meyer and Mittag (2017) argue that there still is a robust tendency for the estimates to be attenuated.[22] This implies that, even if our dependent variables are misclassified, our

on child health and education outcomes. Marital age is instrumented by menarcheal age, but mother's education is not controlled for. Given that mother's education is conjectured to a determinant of child outcomes, mother's education becomes of the part of the error term in the second stage regressions, which must be assumed to be uncorrelated to menarcheal age, for their second stage parameter estimates to be consistent.

[22]However, it can be overturned if misclassification is very strongly related to the covariates (they refer to

estimates of the effect of women's age at marriage on domestic violence are likely to represent the lower bound of the true effects.

4   Results

4.1   OLS Results

The OLS estimates of the effect of women's age at marriage on domestic violence are presented in Table 3. Columns (1), (4), (7) and (10) report the coefficient of age at marriage from the regression equations where we do not include controls for demographic characteristics or district fixed effects. Columns (2), (5), (8) and (11) report the coefficient of age at marriage from the regressions where we include controls for demographic characteristics but not district fixed effects. Finally, Columns (3), (6), (9) and (12) report the coefficient of age at marriage from the regressions where we include controls for demographic characteristics as well as district fixed effects. While these estimates are not causal, nevertheless they are likely to serve as useful benchmarks with which we would be able to compare our IV estimates.

Examining the results of regression models without any demographic controls or district fixed effects, we find that a year of delay in marriage is associated with a decrease in the probability of women's exposure to less severe physical violence by 3 percentage points, severe physical violence by 0.9 percentage points, sexual violence by 0.8 percentage points, and emotional violence by 1.4 percentage points respectively. These effects are statistically significant at 1% level of significance. When we include controls for only demographic characteristics, and controls for demographic characteristics as well as district fixed effects, the estimates of the coefficients of age at marriage on different categories of domestic violence remain roughly unchanged. Overall, thus, the OLS results appear to be suggesting that the net effect of women's age at marriage on domestic violence is negative. To examine whether this effect is causal or purely arises due to omitted characteristics such has family norms

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these as "extreme cases").

and/or ability, we use the IV approach.

4.2   IV Results

We next turn to the IV results in Table 4. Based on the specifications in which we do not include controls for demographic characteristics and district fixed effects, we find that a delay in marriage of women by a year leads to a 8 percentage point decline in the probability of less severe physical violence, 4 percentage point decline in the probability of severe physical violence, 2 percentage point decline in the probability of sexual violence, and 4 percentage point decline in the probability of emotional violence. The effects of women's age at marriage on less severe physical violence, severe physical violence and emotional violence are statistically significant at 1% level of significance. The effect of women's age at marriage on sexual violence is significant at 5% level.

When we include controls for demographic characteristics, these estimates change slightly: a one year delay in women's marriage now leads to a 7 percentage point decline in probability of less severe physical violence, a slightly over 4 percentage point decline in probability of severe physical violence, a 1 percentage point decline in probability of sexual violence, and a 3 percentage point decline in probability of emotional violence. However, now, although the effects of women's age at marriage on less severe physical violence and severe physical violence are statistically significant at 5% level of significance, the effects on sexual violence and emotional violence are no longer statistically significant.

Our preferred IV specifications are the ones that are reported in Columns (3), (6), (9) and (12). Based on our preferred specifications, we find that the magnitude of the effect of women's age at marriage on less severe and severe forms of physical violence remain almost unchanged compared to the magnitude of that obtained from the specifications that include only demographic controls. Specifically, a one year delay in marriage of women causes the probability of less severe and severe physical violence to decrease by 7 percentage points and 4 percentage points respectively. These effects continue to remain statistically significant at 5%

level of significance as well. The effects of women's age at marriage on sexual violence and emotional violence, however, are now much smaller in magnitude (around 0.4 percentage points) compared to the specifications that included demographic characteristics but not district fixed effect. Moreover, these effects continue to remain statistically insignificant.[23]

Thus, our results indicate that a one year increase in women's age at marriage nationwide would reduce the prevalence of less severe physical violence from 25% of women to 18%, and that of severe physical violence from 6% to 2%. If one is willing to extrapolate these result from our sample to the entire India, the implications of our finding are extremely striking. Given that female population in India as per the 2011 Census is 586 million of whom 50% are married,[24] our findings imply that a nationwide delay in women's age at marriage by a year would cause the number of women exposed to less severe physical violence to fall from 73 million to 53 million, and the number of women exposed to severe physical violence to fall from 18 million to 6 million.

In sum, thus, our IV results suggest that a year of delay in marriage causes a significant reduction in women's exposure to less severe as well as severe forms of physical violence, but has no impact on sexual violence or emotional violence.

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[23]It is worth noting that the IV estimates of age at marriage, in general, are larger than the corresponding OLS estimates. This might be because of omitted factors like classical patriarchy or ability of women. As discussed previously, if the omitted factor is classical patriarchy, the covariance between the omitted factor and marriage age would be negative and the coefficient of unobserved patriarchy should be positive implying the sign of the bias to be negative. For the case of omitted ability, the covariance is likely to be positive and the coefficient of unobserved ability should be negative again rendering the sign of the bias as negative. IV estimates could be larger than OLS estimates might be due to measurement error in age at marriage as well. Measurement error in marriage will tend to attenuate the OLS coefficients but not the IV ones. Further, as pointed out by Chari et al. (2017), it is also important to note that the local average treatment effect interpretation of an instrumental variable estimate implies that we are estimating the causal effect of marriage and for the subpopulation whose marriage timing is affected by the instrument, i.e., menarche. It is possible that causal effects for this subpopulation are larger than those for the population as a whole which might be the reason why we find the coefficient estimates from the IV regressions to be larger than those from the OLS regressions.

[24]http://www.censusindia.gov.in/vital_statistics/srs_report/9chap%202%20-%202011.pdf

4.3 Robustness Checks

4.3.1 Alternative Methods of Estimation

While our baseline results are obtained using the IV-TSLS approach, it is worthwhile to check the sensitivity of our findings to using an alternative non-linear method of estimation since our outcome variables are binary in nature. Towards that end, we repeat our analysis using a Probit approach. Specifically, we estimate Probit models using the maximum likelihood method (IV-Probit) as well as the control function (CF) approach proposed by Rivers and Vuong (1988), and later developed by Blundell and Powell (2004) and Wooldridge (2010, 2015). Results are reported in Panels A and B of Table 5.

Our results remain qualitatively unchanged. Specifically, our preferred specifications (those which include both demographic controls as well as district fixed effects) indicate that a delay in women's marriage by a year causes the probability of their exposure to less severe and severe physical violence to fall significantly. The effect of women's age at marriage on sexual as well as emotional violence continue to remain statistically insignificant as before. This is reassuring, and indicates that our results our robust to the choice of estimation method.[25]

4.3.2 Falsification Test

Our IV strategy rests on the assumption that the women's age at marriage is the only channel through which age at menarche affects prevalence of domestic violence (in other words, the exclusion restriction is valid). If this assumption is correct, then a significant relationship between age at menarche and domestic violence should not exist when we restrict our sample

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[25]When we include district fixed effects in Columns (3), (6), (9) and (12), our sample size reduces since Stata drops observations from several districts for which the districts perfectly predicts the failure or success. (i.e., for those districts no women reports to have faced domestic violence or all women have reported to face domestic violence). While IV-TSLS can produce consistent estimates of the parameters even with several districts in which there is no variation in the outcome variable, MLE cannot do so and hence these districts need to be dropped. However, the fact that thse observations are dropped just means they are not contributing any information to help identify the other parameters in the model. Implicitly, these observations are also not helping us estimate the coefficients beyond the fixed effects in our baseline IV-TSLS model either. So, the results across the two are still comparable.

to the women who got married before attaining menarche because menarche could not have impacted their marriage timing.

To assess the validity of the IV estimates, we undertake this falsification test: we test the reduced form effect of age at menarche on the different forms of domestic violence for the subsample of women who got married before attaining menarche. Results of this test are reported in Table 6. Columns (1), (3), (5) and (7) report the OLS coefficients of age at menarche from the regressions based on the subsample of women who got married before attaining menarche. For comparison purpose, we also present the coefficients of age at menarche from the regressions based on the subsample of women who did not get married before attaining menarche in Columns (2), (4), (6) and (8).

As evident, the coefficients of age at menarche from the regressions based on the subsample that includes only those women who got married before attaining menarche turn out to be statistically insignificant. This implies that there exists no systematic relationship between age at menarche and domestic violence for this subsample of women. The coefficients of age at menarche from the regressions with less severe violence and severe violence as outcome variables, on the other hand, are statistically significant for the subsample of women who got married after attaining menarche (see Columns (2) and (4)). This is consistent with our IV results that women's age at marriage has a significant causal impact on less severe and severe forms of physical violence.

In sum, thus, the results of this falsification exercise suggest that our instrument is likely to satisfy the exclusion restriction, and therefore increases our confidence in the empirical strategy that we have used.

4.3.3 Measurement Error in Age at Menarche?

We have noted that women's age at marriage can be subject to reporting bias. In a similar vein, one could raise concerns about measurement error in the age at menarche. If age at menarche contains measurement error, this might cause the IV estimates of the coefficient

of age at marriage to be inconsistent.

While recall error in age at marriage is possible since we use self-reported survey data, Must et al. (2002) provide compelling evidence to show that this is unlikely to be a reason for severe concern. They use the US Newton Girls Study (1965–1975), a prospective study of development in a cohort of girls followed through menarche, to assess the accuracy and precision of recall of several early menstrual characteristics. In 1998–1999, around 60% of the original 793 Newton Girls Study participants completed a mailed questionnaire to assess the accuracy of recall for age and body size at menarche, usual cycle length during the first 2 years, and age at regularity. They found recalled and original age at menarche to be highly correlated. Original mean menarcheal age did not differ significantly from recalled mean menarcheal age. On average, women recalled their menarche as being 0.95 months (i.e., less than a month) earlier than their original menarche. In fact, in context of India, recall error in age at menarche is likely to be even less of a concern since Garg et al. (2001) and Sharma et al. (2006) note that menarche is a major event for girls in India, and girls of both low and high caste report knowing little or nothing about menstruation before it began, but afterwards learning of taboos about eating and mobility during menstrual periods. These changes in lifestyle imply that respondents are likely to recall its timing with fair degree of accuracy (Chari et al. 2017).[26] We have already graphed the distribution of reported age at menarche in Figure 2. It does not show any heaping at key ages (e.g. school leaving ages) that might be suggestive of significant recall error.

Note, even if age at menarche contains measurement error, this will cause the IV estimate of the coefficient of age at marriage to be inconsistent only if reporting bias in age of marriage is correlated with that in age at menarche. This might be the case if respondents use the former as a point of reference to recollect the latter. To explore this issue, ideally we would like to follow Field and Ambrus (2008) and compare the distribution of reported age of

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[26]Ellis (2004, 921) based on a survey also note, "both adolescent girls and adult women are generally willing and able to report accurately on their ages at menarche...and retrospective reports may be more reliable than those obtained during puberty".

marriage and age at menarche for two subsamples of women: (i) women with mothers who never attended school, and (ii) women with mothers who had at least some schooling before the onset of puberty. The idea here is to isolate a group of families who have a preexisting preference for later marriage unrelated to their daughter's maturation. Since menarche is exogenous to this preference, a significant difference in reported age of onset across these types would suggest either recall bias or strategic misreporting.

However, the data that we use do not have information on the educational attainment of women's mothers. As an alternative, we plot the distribution of women's age at marriage and menarche age by their report of whether they have witnessed domestic violence in natal home in Figure 7. It is likely that the households in which domestic violence is (not) prevalent are households that belong to the (higher) lower socioeconomic status, and these households might have a preexisting preference for earlier (later) marriage of their daughters. So for women who come from households in which they have witnessed domestic violence between their parents, their age at marriage might be lower compared to the others. However, the age at menarche for these women should not be different from the others. Reassuringly, we find that the distribution of women's age at marriage differs across the two subsamples, but not the age at menarche. This provides suggestive evidence that the measurement error in age at marriage and age at menarche are unlikely to be correlated.

As an additional check, we also use data from the Indian Human Development Survey (IHDS) 2012, which is nationally representative household level survey conducted between 2011 and 2012 by the National Council of Applied Economic Research (NCAER) and the University of Maryland and plot the distribution of women's marriage age and menarche age for those with mothers who never attended school, and those with mothers who had some level of schooling in Figure 8. As evident, we find that the distribution of women's age at marriage differs across the two subsamples, but not the age at menarche. This indicates that the sampled women are unlikely to link the two events – marriage and menarche. If we are willing to extrapolate these results for women in India in general, measurement error in age

at marriage and menarche age are unlikely to be correlated for the women in our sample (note that, our sample was administered only a couple of years after the IHDS 2012, and it is not very different from IHDS in terms of breadth and scope).

4.3.4 Further Examination of the Correlation between Menarche Age and Educational Attainment

As discussed previously, our IV estimates of the effect of women's age at marriage on domestic violence could be inconsistent if age at menarche is correlated with age at marriage. While previous literature as well as our graphical analysis (presented previously) suggests that this is unlikely to be the case, in this section we reexamine the issue. Note that the main reason why educational attainment could be impacted by women's age at menarche is as follows: once a girl starts menstruating, she might stop attending school, eventually dropping out of it. This might be because of lack of sanitation facilities in school or because social norms dictate that a girl who attains puberty should no longer be going to school. As such, the women whose educational attainment might have been impacted with age at menarche, they must have had dropped out of school soon after they had reached that age (i.e., age at menarche). It is presumable that if a woman was enrolled in school for a significant period of time post-menarche (say, at least more than a year), her schooling attainment is unlikely to have been determined by her age at menarche. This is because if she could have made it to school right after attaining menarche despite lack of adequate sanitation facilities in her school or social taboos, it is unlikely that these factors later on would suddenly serve as impediments for her to attend school. As such, if we could find a subsample of women who had been enrolled in school for at least a year or two after attaining menarche, for this subsample of women at least, age at menarche is unlikely to have affected their educational attainment, and hence the IV estimate of the effect of age at marriage on domestic violence based on this subsample would likely be consistent.

However, finding this subsample of women is difficult given our data. This is because

although we have information on age at menarche and years of education of women, we do not have information on the age at which they dropped out of school. To circumvent this problem, we try to back out the school leaving age of women from their reported years of education. Specifically, we assume that a women starts her formal schooling at 6 years of age (which according to the World Bank is the minimum age for starting formal schooling for most countries in the world including India[27]) and add the total number of years of education to this. This gives us the lower bound of the age at which the women have dropped out of school. We call this the lower bound because it is perfectly possible that a woman had started schooling at an age higher than 6.[28] Further, there might have been gaps in her schooling after she starts going to school. In fact, she might be even repeating grades. For example, suppose a woman reports that she has 5 years of education. As per our estimate, her school leaving age is around 11 years. However, if this woman had started schooling at 8 years of age and further stops going to school for one year after 2 years of starting to go to school, her true age when she drops out of school was actually around 14 years (she starts going to school when she is 8 years old, goes to school till she 10 years, takes a gap of a year, returns back to school and goes to school for another three years).

Using this method, we calculate the lower bound of the age of women at which they had dropped out of school in our sample. We then create a subsample consisting of those women for whom the difference between the school dropout age that we calculate and the age at menarche is at least one year. In other words, these are the women who were in school for at least one year post-menarche. Note that, these women form the subset of all the women who were enrolled in school for at least one-year post menarche. This is because, given that we consider the lowest possible age at which the women had dropped out of school, we exclude those women who might have been in school for at least one year post-menarche, but as per our calculation of her school leaving age, they had dropped out of school before completion of a year after menarche.

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[27]https://data.worldbank.org/indicator/SE.PRM.AGES

[28]Although it is very unlikely that a woman begins her formal schooling before she turns 6.

For this subsample of women, we estimate our baseline regression model instrumenting age at marriage by age at menarche. The results are reported in columns (1) – (4) of **Table 7**. We also estimate the regression model for the subsample of women who have been in school for at least 2 years post-menarche (i.e., the difference between the lower bound of their school leaving age and age at menarche is at least 2 years). For this subsample, age at menarche is more unlikely to be have determined the educational attainment of the women. These results are reported in columns (5) – (8). Reassuringly, we find that for both these subsamples, the effect of age at marriage on less severe and severe forms of physical violence are negative as well as statistically significant. This is in consonance with our baseline results. This suggests that not including educational attainment in our baseline specification is unlikely to have rendered our estimates of the effect of age at marriage on less severe and severe forms of physical violence to be inconsistent.

4.4   Discussion of Underlying Mechanism

Our results indicate that women's age at marriage is inversely related to their exposure to physical violence. As discussed before, this could be either because women who marry early are likely to be unassertive, naive, emotionally depressed and socially isolated (due to their inability to adapt to a new environment) and have lesser bargaining power within marriage making them less resistive to domestic violence (*age-related behavioral channel*) or because these women are relatively less educated limiting their options outside marriage (*educational channel*). In this section, we examine whether our results are driven by the age-related behavioral effect or the educational effect. Towards that end, in our baseline regression given by equations (2) and (3) we include women's education (i.e., completed years of schooling) as an additional regressor. If education is indeed an important channel, when it is included in the baseline equation, the magnitude of the effect of age at marriage on domestic violence should decrease. Note that, the estimated coefficient of age at marriage from this exercise is likely to consistent as long our instrument is uncorrelated with education. However, the

coefficient of education is not necessarily consistently estimated because education is likely to be endogenous. Thus, although this exercise is preliminary, we believe it is still useful and informative.

Table 8 reports the results of this exercise for the less severe and severe forms of physical violence. As evident, the coefficients of age at marriage in none of the specifications is smaller in magnitude compared to the baseline specification. This indicates education is unlikely to be a channel through which women's age at marriage affects domestic violence. Rather the results that we have obtained in this paper seem to entirely be arising due to direct age-related behavioral attributes of the women (independent of education).[29] While we would have liked to pin down exactly which behavioral attribute is at play (i.e., whether it is psychological depression, inability to adapt to the new environment, lesser bargaining power within marriage or something else that makes relatively young brides more vulnerable to domestic violence), given the data limitations, we are not able to do so. This is a limitation of our study, which we hope would be addressed in future work.

It is worth noting that the finding that education does not affect physical violence, although might appear contradictory to conventional wisdom, is actually consistent with the recent findings of Erten and Keskin (2018). In a carefully designed study, Erten and Keskin (2018) exploit a change in the compulsory schooling law in Turkey to estimate the causal effects of education on the prevalence of domestic violence. By employing a regression discontinuity design, they find that the reform increased women's schooling by one year to one-and a-half years and improved their labor market outcomes (with particularly strong effects for women raised in rural areas). However the increase in education among the

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[29]We also estimate the baseline regression model for the subsample of women who are illiterate. If education is the channel through which age at marriage impacts domestic violence, we should not expect to see any effect of age at marriage for domestic violence for this subsample. Compared to the baseline specification, we find that the magnitude of the estimate of the effect of age at marriage on severe physical violences remains almost unchanged, while that that of the effect of age at marriage on less severe violence falls slightly (but does not become even close to zero). Although these effects are imprecisely estimated, since the magnitude of the coefficients of age at marriage does not decrease substantially compared to the baseline specification, this again suggests that education is unlikely to be a factor (at least a major one) mediating the relationship between age at marriage and physical violence. The results of this exercise are not reported in the paper but are available from the authors upon request.

women lead to no change in self-reported physical violence.

5   Conclusion

Domestic violence affects one in three women in their lifetime. It remains a crucial problem with adverse health and economic consequences in both developed and developing countries. The cost of domestic violence to an economy in terms of victim's suffering, medical expenses, lost productivity and judiciary expenses is massive. In this paper, we examine the causal impact of age at marriage on domestic violence against women using newly available nationally representative household data from India. We focus on four types of domestic violence against women: less severe physical violence, severe physical violence, sexual violence, and emotional violence. The main empirical challenge in identifying the causal effect of age at marriage on prevalence of domestic violence is that marriage age might be endogenous due to omitted variables and/or measurement error. To address this issue, we use an empirical strategy that utilizes variation in age at menarche to obtain exogenous variation in women's age at marriage. We find that a one-year delay in marriage of women causes a significant decline in less-severe and severe forms of physical violence but has no impact on sexual or emotional violence. Further, we show that the effect of women's marital age on physical violence arises independent of women's educational attainment, which indicates that direct age-related behavioral attributes (e.g. emotional maturity, bargaining power, ability to adapt, etc.), and not education, are probably driving the inverse relationship between women's marital age and physical violence.

Our findings confirm the relevance of conditional cash transfer programs and other social policies that seek to delay marriages of women in India (e.g. "Kanyashree Prakalpa" program in West Bengal, "Apni Beti Apna Dhan" program in Haryana, etc.) in reducing the prevalence of domestic violence. Future work should focus on testing that external validity of our findings by replicating our study for not only other developing nations, but also

for developed nations since domestic violence is a major public health issue worldwide. In addition, it would also be interesting to examine the different behavioral channels through which women's age at marriage impacts physical violence more closely. This would be useful for fine-tuning the existing marital delay policies as well as for designing newer and more innovative ones, in order to reduce domestic violence.

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Figure 1. Distribution of women's age at marriage
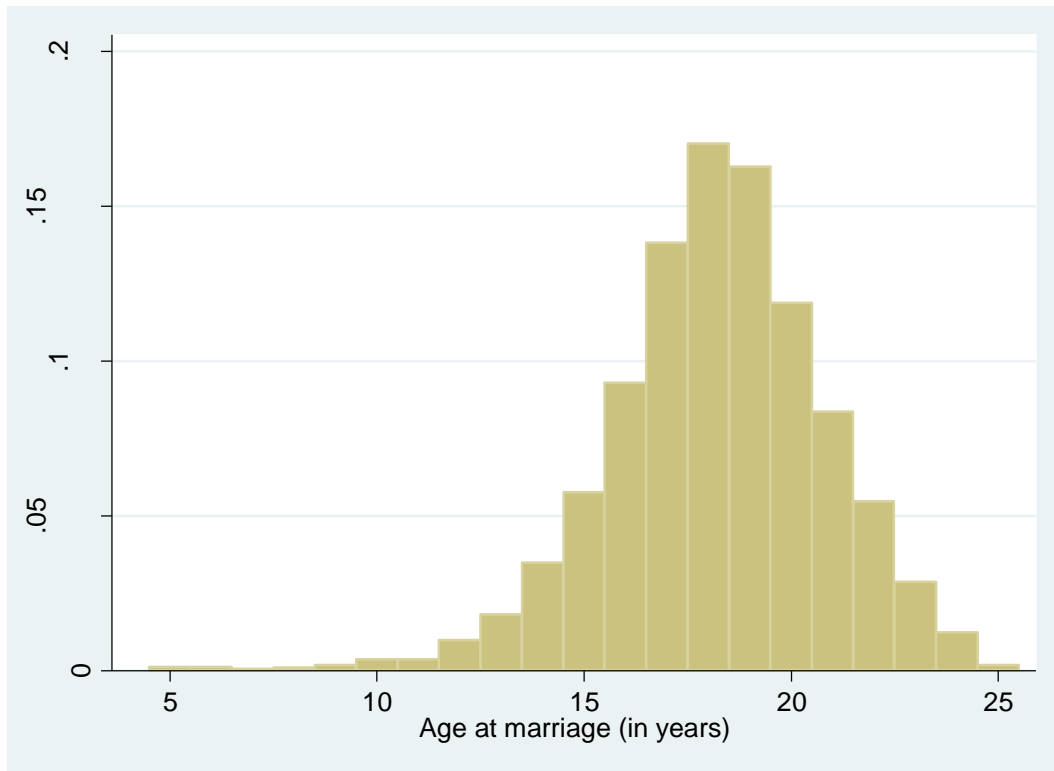
Figure 2. Distribution of age at menarche

Age at menarche (in years)
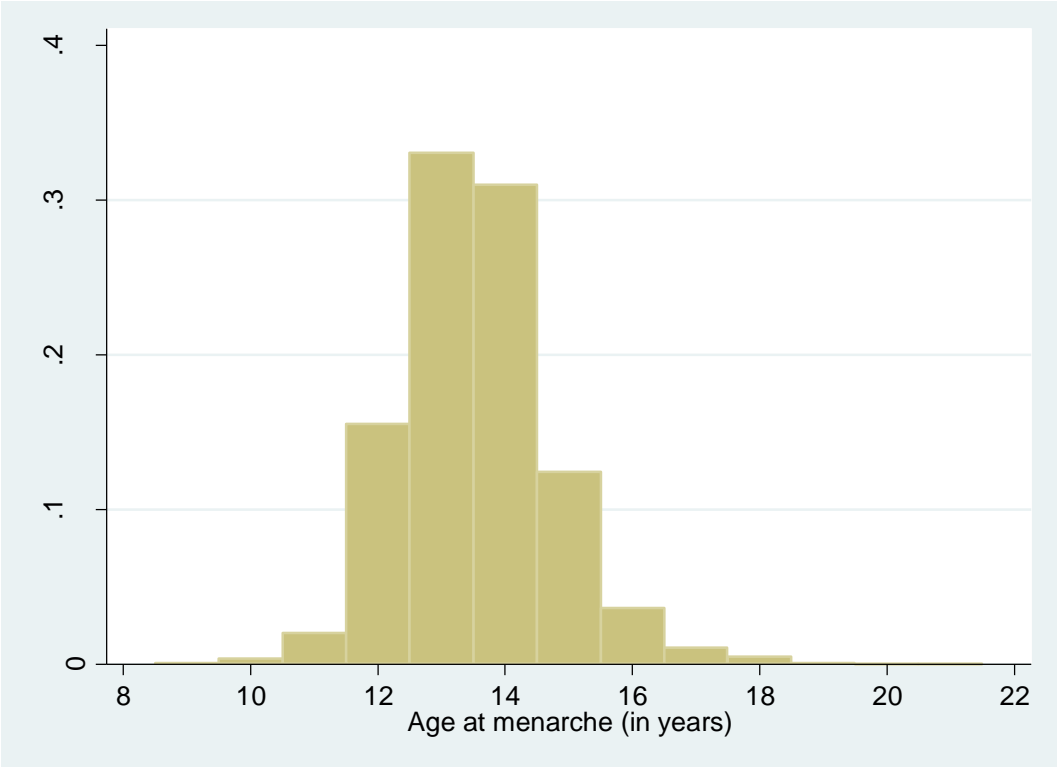
Figure 3. Prevalence of domestic violence by age at marriage
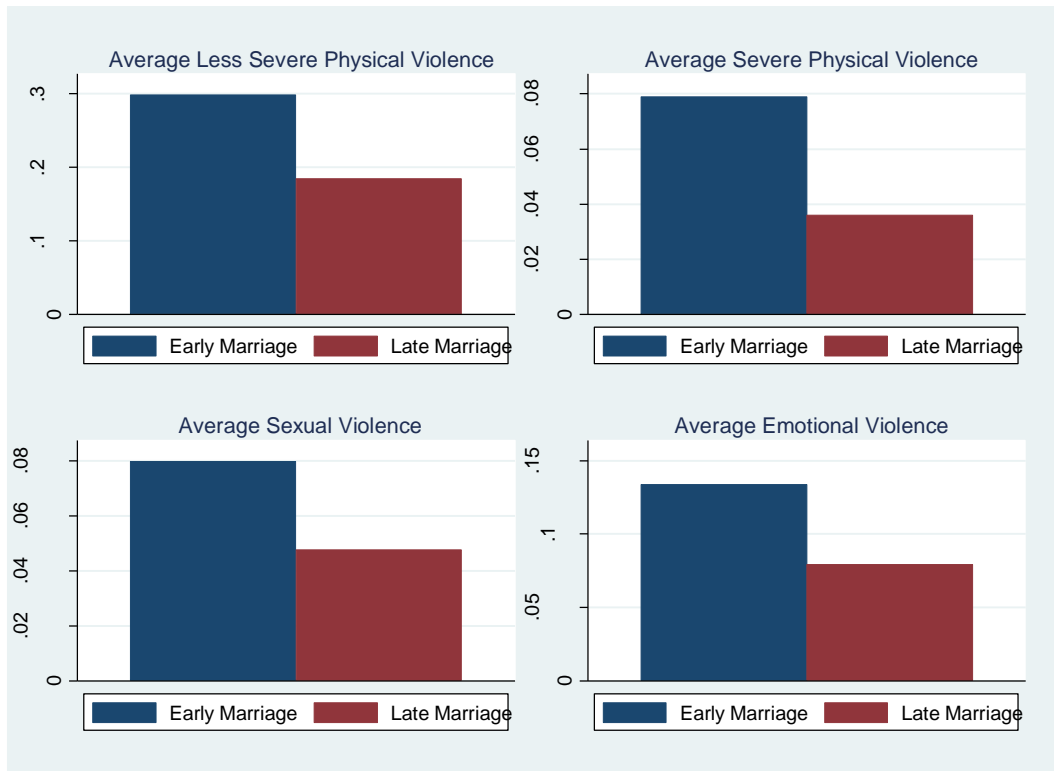
Notes: Early marriage group includes those women who got married before they were 19 years old. Late marriage group includes the rest.

Figure 4. Distribution of women's age at marriage by age at menarche
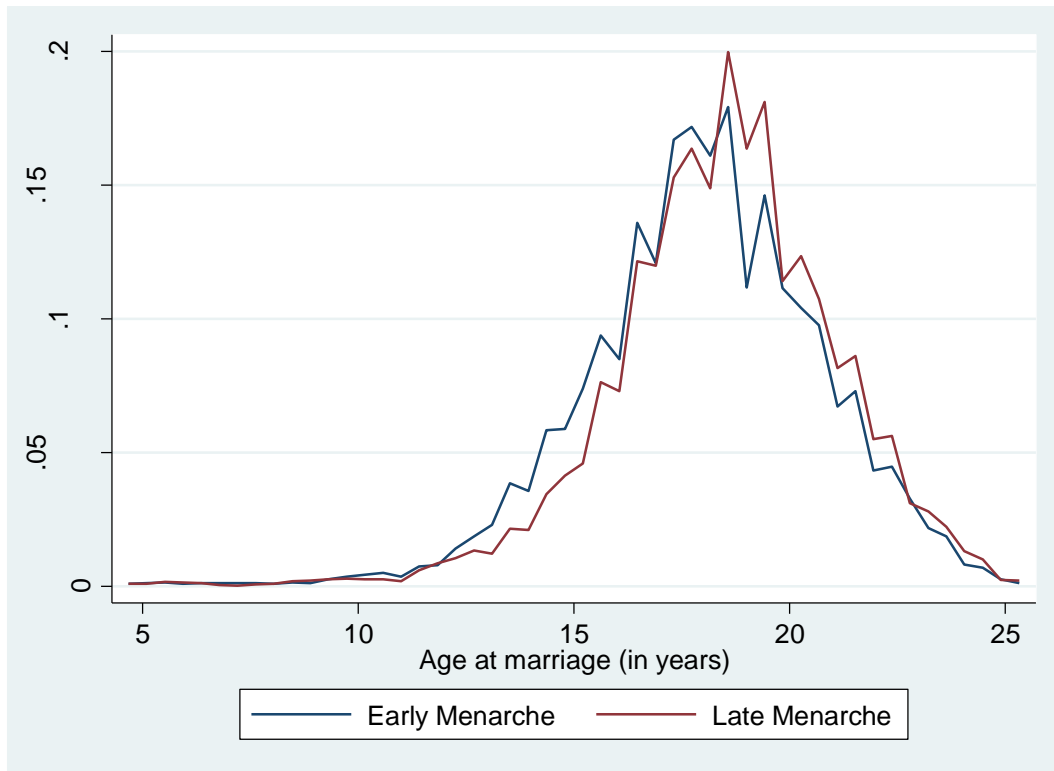
Notes: Early menarche group includes those women who attained menarche before 14 years of age. Late menarche group includes the rest.

Figure 5. Relationship between women's average years of schooling and age at menarche
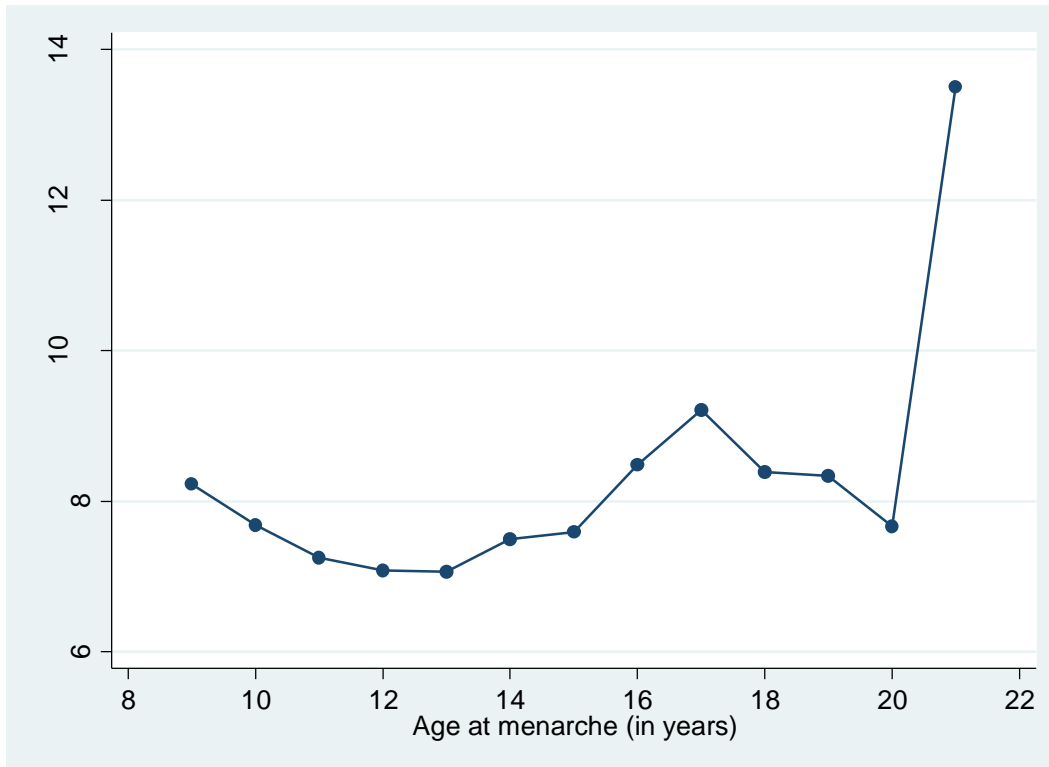
Figure 6. Kernel density estimates of women's years of schooling by terciles of age at menarche
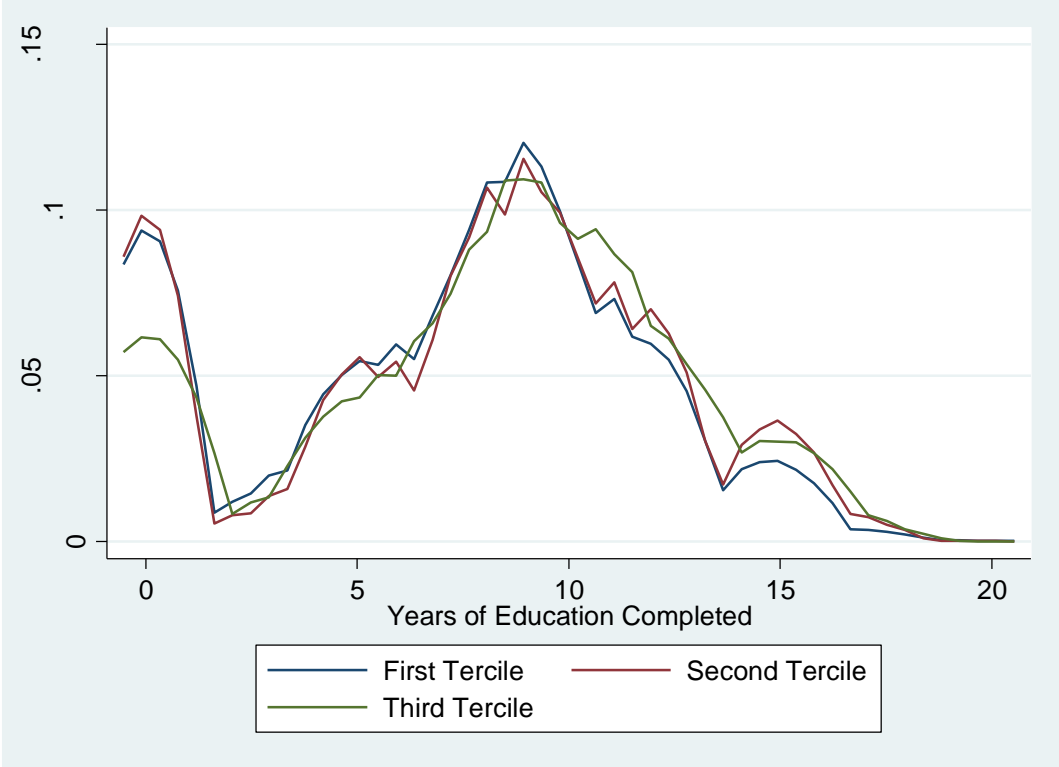
Figure 7. Kernel density estimates of women's age at marriage and age at menarche by domestic violence status in natal household
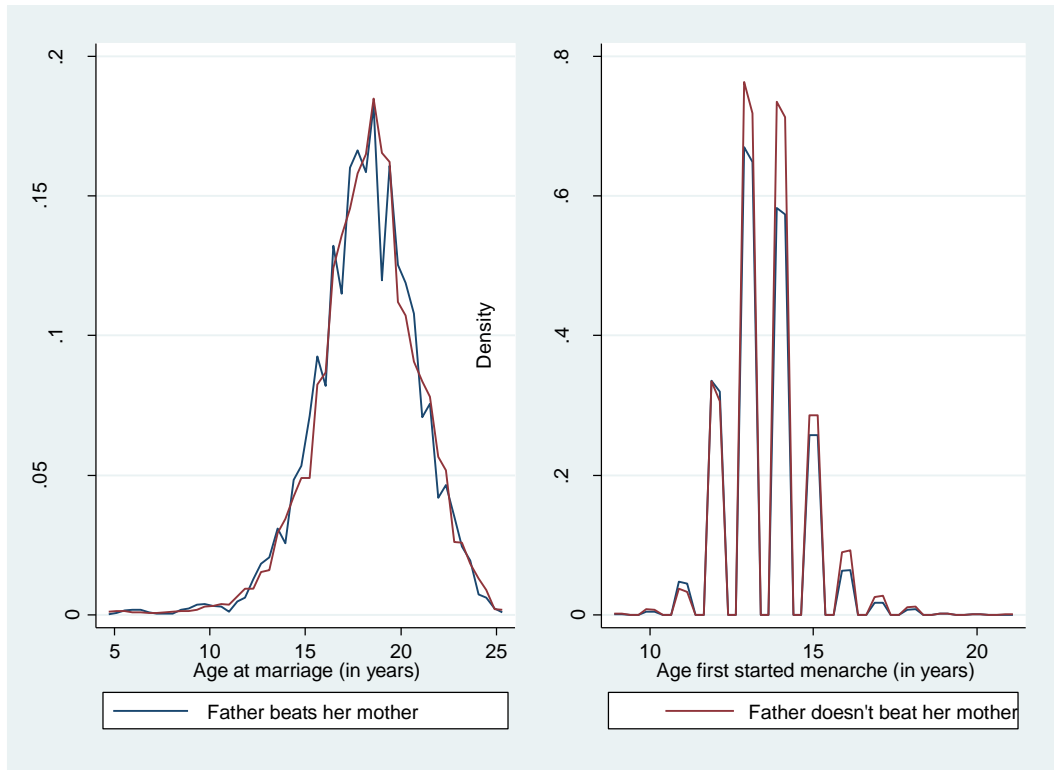
Figure 8. Kernel density estimates of women's age at marriage and age at menarche by educational attainment of mothers, IHDS 2012 data
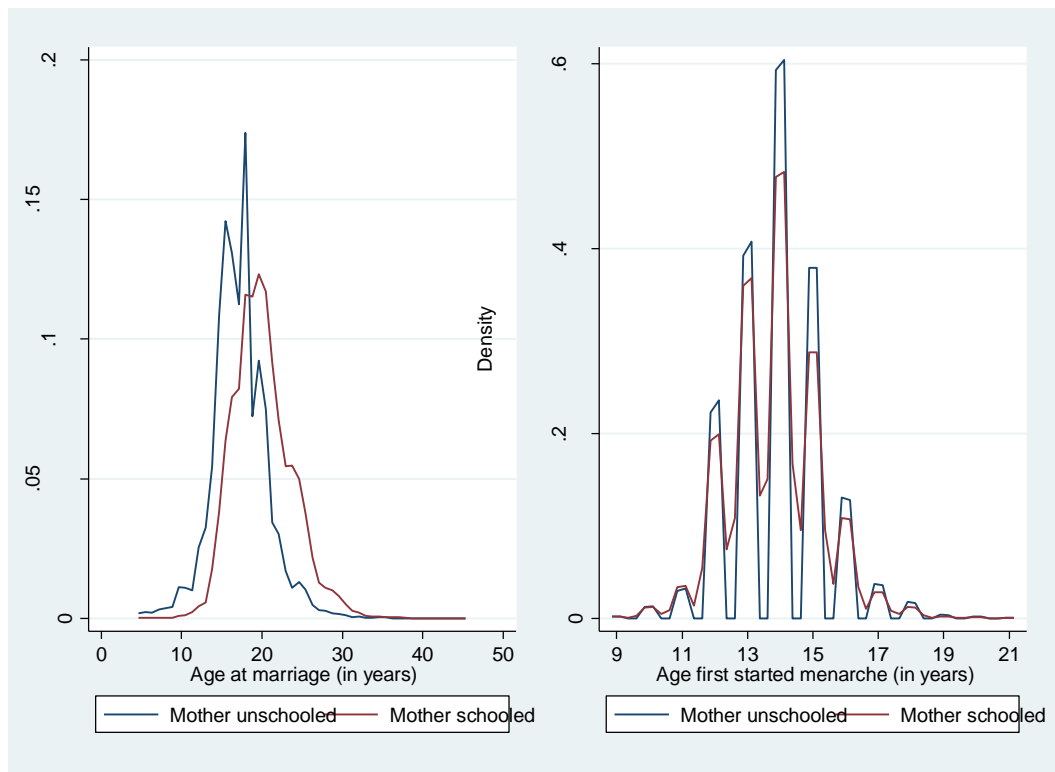
Table 1. Summary Statistics

	Mean	SD
Domestic Violence Outcomes		
Less Severe Physical Violence	0.25	0.43
Severe Physical Violence	0.06	0.24
Sexual Violence	0.06	0.25
Emotional Violence	0.11	0.31
Demographic Characteristics		
Age at Marriage	18.23	2.63
Age at Menarche	13.57	1.21
Age	21.65	1.99
Spousal age	26.47	4.39
Height (in cm)	151.75	5.96
Years of Education Attained	7.39	4.63
Wealth Indicators		
Poorest	0.22	0.42
Poorer	0.25	0.43
Middle	0.23	0.42
Richer	0.18	0.38
Richest	0.12	0.33
Caste Indicators		
Scheduled Caste (SC)	0.21	0.41
Scheduled Tribe (ST)	0.18	0.39
Other Backward Caste (OBC)	0.43	0.50
Other Castes	0.17	0.38
Seen domestic violence among parents	0.22	0.41
Place of Residence (=1 if Urban)	0.77	0.42
N	9,343	

Table 2. OLS estimates of the effect of age at menarche on age at marriage

	[1]	[2]	[3]	[4]	[5]	[6]
Age at Menarche	0.216***	0.194***	0.161***	0.128***	0.128***	0.127***
	(0.024)	(0.024)	(0.023)	(0.022)	(0.022)	(0.024)
F-statistic	77.63	67.51	193.78	131.31	131.31	27.44
Observations	9,343	9,343	9,343	9,343	9,343	9,343

Notes: Estimation via OLS. The outcome variable is women's age at marriage. Regression reported in column (1) does not include any controls. In column (2) regression we include women's height as a control. In column (3) regression the control variables are women's height, age, and spousal age. In column (4), controls include women's height, age, spousal age, wealth dummies, and women's caste affiliation. In column (5), controls include women's height, age, spousal age, wealth dummies, women's caste affiliation, and indicator for whether women have seen domestic violence among their parents. In column (6), we include place of residence i.e. rural or urban locality and district fixed effects in addition to all controls used in column (5). Standard errors reported in the parentheses are clustered at the district level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 3. OLS estimates of the effect of age at marriage on domestic violence

	Less Severe Physical Violence			Severe Physical Violence			Sexual Violence			Emotional Violence		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Age at Marriage	-0.026***	-0.024***	-0.022***	-0.009***	-0.008***	-0.008***	-0.008***	-0.007***	-0.006***	-0.014***	-0.013***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Demographic Controls	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
District Fixed Effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343

Notes: Estimation via OLS. The outcome variables are different categories of domestic violence. Demographic controls include women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation. Standard errors reported in the parentheses are clustered at the district level. ***p < 0.01, **p <0.05, *p < 0.1.

Table 4. IV estimates of the effect of age at marriage on domestic violence

	Less Severe Domestic Violence			Severe Domestic Violence			Sexual Violence			Emotional Violence		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Age at Marriage	-0.076***	-0.068**	-0.068**	-0.037***	-0.043**	-0.042**	-0.022**	-0.013	0.004	-0.037***	-0.028	-0.004
	(0.019)	(0.030)	(0.031)	(0.010)	(0.017)	(0.019)	(0.011)	(0.018)	(0.020)	(0.013)	(0.021)	(0.023)
Demographic Controls	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
District Fixed Effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
First stage F statistic	77.63	32.83	27.44	77.63	32.83	27.44	77.63	32.83	27.44	77.63	32.83	27.44
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Kleibergen Paap rK LM statistic	65.41	30.40	27.42	65.41	30.40	27.42	65.41	30.40	27.42	65.41	30.40	27.42
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Observations	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343

Notes: Estimation via TSLS. The outcome variables are different categories of domestic violence. Demographic controls include women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation. Standard errors reported in the parentheses are clustered at the district level. ***p < 0.01, **p <0.05, *p < 0.1.

Table 5. Estimates of the effect of age at marriage on domestic violence, Alternative estimation methods

Panel A. IV Probit Estimates: Marginal Effects

	Less Severe Physical Violence			Severe Physical Violence			Sexual Violence			Emotional Violence		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Age at Marriage	-0.066***	-0.062***	-0.070***	-0.049***	-0.056**	-0.074***	-0.024*	-0.014	0.013	-0.037***	-0.025	-0.007
	(0.012)	(0.021)	(0.023)	(0.014)	(0.022)	(0.027)	(0.015)	(0.021)	(0.031)	(0.014)	(0.023)	(0.026)
Demographic Controls	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
District Fixed Effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	9,343	9,343	8,504	9,343	9,343	5,367	9,343	9,343	5,471	9,343	9,343	7,081

Panel B. Probit Estimates using the control function approach: Marginal Effects

	Less Severe Physical Violence			Severe Physical Violence			Sexual Violence			Emotional Violence		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Age at Marriage	-0.035***	-0.031***	-0.082**	-0.014***	-0.008***	-0.074**	-0.015***	-0.012***	0.017	-0.020***	-0.018***	-0.006
	(0.004)	(0.005)	(0.035)	(0.002)	(0.003)	(0.032)	(0.002)	(0.003)	(0.034)	(0.003)	(0.004)	(0.031)
Demographic Controls	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
District Fixed Effects	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Observations	9,343	9,343	8,504	9,343	9,343	5,367	9,343	9,343	5,471	9,343	9,343	7,081

Notes: The outcome variables are different categories of domestic violence. Demographic controls include women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation. Standard errors reported in the parentheses are clustered at the district level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 6. Falsification test

	Less Severe Physical Violence		Severe Physical Violence		Sexual Violence		Emotional Violence	
	Marriage before Menarche	Marriage not before Menarche	Marriage before Menarche	Marriage not before Menarche	Marriage before Menarche	Marriage not before Menarche	Marriage before Menarche	Marriage not before Menarche
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Age at Menarche	0.0035	-0.012***	-0.038	-0.007***	0.010	-0.000	-0.027	-0.003
	(0.059)	(0.004)	(0.045)	(0.002)	(0.041)	(0.002)	(0.047)	(0.003)
Observations	317	9,026	317	9,026	317	9,026	317	9,026

Notes: Estimation via OLS. The outcome variables are different categories of domestic violence. Regressions reported in columns (1), (3), (5) and (7) are based on the subsample of women who got married before attaining menarche. Regressions reported in columns (2), (4), (6) and (8) are based on the rest of the women. All specifications include demographic controls such women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation, as well as district fixed effects. Standard errors reported in the parentheses are clustered at the district level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7. IV estimates of the effect of age at marriage on domestic violence for subsample of women who have been in school post-menarche

	In school for at least one year post-menarche				In school for at least two years post-menarche			
	Less Severe Physical Violence	Severe Physical Violence	Sexual Violence	Emotional Violence	Less Severe Physical Violence	Severe Physical Violence	Sexual Violence	Emotional Violence
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Age at Marriage	-0.140***	-0.042*	0.014	-0.005	-0.127**	-0.042*	-0.006	0.01
	(0.052)	(0.024)	(0.025)	(0.033)	(0.054)	(0.025)	(0.025)	(0.035)
Demographic Controls	Y	Y	Y	Y	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
First stage F statistic	12.52	12.52	12.52	12.52	10.85	10.85	10.85	10.85
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.001]	[p=0.001]	[p=0.001]	[p=0.001]
Kleibergen Paap rK LM statistic	14.39	14.39	14.39	14.39	13.15	13.15	13.15	13.15
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Observations	3,804	3,804	3,804	3,804	2,867	2,867	2,867	2,867

Notes: Estimation via TSLS. The outcome variables are different categories of domestic violence. Demographic controls include women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation. Standard errors reported in the parentheses are clustered at the district level. ***p < 0.01, **p <0.05, *p < 0.1.

Table 8. IV estimates of the effect of age at marriage on domestic violence controlling for education

	Less Severe Physical Violence	Severe Physical Violence	Sexual Violence	Emotional Violence
	[1]	[2]	[3]	[4]
Age at Marriage	-0.069*	-0.046*	0.007	0.000
	(0.037)	(0.024)	(0.024)	(0.027)
Level of Education Attained	0.001	0.004	-0.003	-0.004
	(0.006)	(0.004)	(0.004)	(0.004)
Demographic Controls	Y	Y	Y	Y
District Fixed Effects	Y	Y	Y	Y
First stage F statistic	20.57	20.57	20.57	20.57
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Kleibergen Paap rK LM statistic	20.93	20.93	20.93	20.93
	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Observations	9,343	9,343	9,343	9,343

Notes: Estimation via TSLS. The outcome variables are different categories of domestic violence. Demographic controls include women's height, age, spousal age, wealth dummies, indicator for whether women have seen domestic violence among their parents, and women's caste affiliation. In addition to these, we also control for the level of education attained by the women. Standard errors reported in the parentheses are clustered at the district level. ***p < 0.01, **p <0.05, *p < 0.1.