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Marriage Age Affects Educational Gender Inequality: International Evidence

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Marriage Age Affects Educational Gender Inequality: International Evidence[*]

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Abstract: This paper examines the effect of female age at marriage on female education and educational gender inequality. We provide empirical evidence that early female marriage age significantly decreases female education with panel data from 1980 to 2010. Socio-cultural customs serve as an exogenous identification for female age at marriage. We also show that effects of spousal age gaps between men and women significantly affect female education relative to male education. Each additional year between husband and wife reduces the female secondary schooling completion rate by 14 percentage points, the time women spend at university by 6 weeks, and overall affects female education significantly more negatively than male education. We also document that marriage age and conventional measures of gender discrimination do not act as substitutes.

Keywords: Marriage age, spousal age gap, female education, gender inequality
JEL Classification: J12, J16, I24, O47

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I. INTRODUCTION

Improving access to education for women is a central theme in economic development (United Nations, 2015). Not only are equal educational opportunities a pressing issue for the many disadvantaged women around the world; there is also evidence for the positive role of female human capital on economic development (Klasen 1999, 2002; Esteve-Volvart, 2000; Schultz, 2002; Sedgley and Elmslie, 2005; Todaro and Smith, 2014). Not only scholars and international institutions argue for positive overall effects of women's equality, even a report by McKinsey & Company (2015), a consultancy, suggests that $12 trillion could be added in 2025 to annual global GDP by bringing the gender parity level around the world "only" to the best-in-region country.

While we observe that the global educational gap is gradually shrinking, girls have still not caught up to boys and do not realize their full human capital potential (United Nations, 2015). The reasons for this educational gap may also relate to cultural customs and traditions that are not compatible with the idea of a highly educated female and male population. This paper contributes to that field of research by linking gender inequality in education with marriage age. Marriage, marital customs and traditions of founding a family are a central cultural feature of different societies. The timing for marriage and, in particular, marriage age of women with respect to men can lead to significant economic ramifications for investments in education and human capital of the different sexes[1]. Differences in education and human capital in turn affect overall economic development (Lucas, 1988; Barro, 2001). There is only comparatively scarce international evidence on economic consequences of early female marital age in particular regarding effects of age of marriage on educational achievements.

Our analysis attempts to fill this gap in the literature, as we examine whether the marriage age for women, i.e. at which age the bride gets married and how that compares to her husband's age, matters for female educational prospects. We document that women get married at relatively young age in many countries and almost everywhere around the world at a considerably younger age than men, i.e. wives are usually younger than husbands and there often exists a considerable spousal age gap. The marriage age of women and the phenomenon of wives being on average younger than husbands impacts educational investment and we empirical identify it as a relevant factor for determining female education.

[1] A recent article in The Economist, January 23rd 2016 mentions the story of Aisha Abduallai, a girl from Nigeria as an indicative example: "[…] so they [the parents] marry me off. He was 50 and I was 13. […] [Aishas] education ended abruptly."

We provide a basic economic framework to conceptualize how a woman's timing of marriage affects her educational decision. Societal expectations of marriage age signal the timing for child-rearing, as marriage is usually the first and still the socially most accepted institution for conceiving children. Anticipated family offspring affects future female labor force participation, since, for given societal conventions, wives tend to be more often in charge of raising children which impacts their educational pay-off in the job market. The timing of marriage is related to exogenous socio-cultural customs but influence individual decisions on marriage. The earlier a women gets married, the shorter her anticipated pay-off to educational investments such that educational investments are lower for younger marriage ages than for older marriage ages. We thus hypothesize that for countries where women get married younger, their achieved level of education is likely to be lower.

We employ a global panel data set from 1980-2010 to analyze the relationship between marriage age and educational achievements. Empirical results indicate that the absolute female age at marriage has a theory-consistent and highly significant effect on female education: Each year of marriage postponement for women is associated with a 3%-points higher female completion rate in secondary schooling, and to about three weeks, or 13% longer female tertiary education. To take account of endogeneity issues, we first employ fixed effects and different instrumentation strategies: We explain the culture-induced domestic female marriage age with a weighted average of the marriage age in adjacent countries and other instruments employed in the literature. Second, we investigate the effects of spousal age gaps, i.e. the female relative to the male marriage age. Our empirical results become even stronger: Each additional year difference between wife and husband reduces the female secondary schooling completion rate by 14%-points and the time women spend at university by 6 weeks. Finally, we employ a quasi difference-in-difference strategy to focus on differences between women and men regarding marriage age and educational achievement, i.e. we specifically examine spousal age gaps and educational gaps. This approach helps to eliminate potential confounding factors that affect the level of educational achievements jointly for women and men as we focus only on the differences between the two sexes. We show that spousal age gaps affect female education significantly more negatively than male education.

Numerous robustness tests support our main empirical findings. Further refinements and differential analyses suggest that gender parity in literacy, but not primary schooling, is affected by women's marriage age which is consistent with our theoretical considerations. The marriage age tradition of the parental generation also has an influence on current educational inequality. Importantly, we document that marriage age is no substitute measure for conventional

indicators of gender discrimination, i.e. female marriage age consistently and significantly affects educational achievements of women independently of existing levels of other gender discrimination in society.

The remainder of this paper is organized as follows: Section 2 discusses the related literature and our conceptual framework. The data and identification strategy is presented in Section 3. We present our main empirical results and instrumental variable strategies in Section 4, and discuss a set of robustness tests and refinements in Section 5. Section 6 offers concluding remarks.

II. Related Literature and Theoretical Considerations

Related Literature

This paper relates to three strands of literature. First, we complement the literature on educational attainment of women and men. As the importance of human capital for economic development is ever more highlighted (Lucas, 2015), numerous studies have investigated the impact of educational gender inequality on growth and found generally negative effects (among others, see Barro and Lee, 1994; Barro and Sala-i-Martin, 1995; Hill and King, 1995; Esteve-Volart, 2004; Easterly, 2007; Klasen and Lamanna, 2009). Nevertheless, lower education for women in comparison to men remains a widespread phenomenon (among others, see Alexander and Eckland, 1974; Marini, 1978; Hyde et al., 1990; Knowles et al., 2002; Guiso et al., 2008; Barro and Lee, 2013; Pekkarinen, 2012 surveys the literature). An important driver for this educational gender inequality is thought to relate to socio-cultural institutions. We show that educational attainment of women is systematically influenced by a core socio-cultural institution at the macro level, namely female age of marriage and the differences between female and male age of marriage. Morrison et al. (2007) argue that the impact of gender equality on human development at the macro level is less well understood than at the individual level.

Second, our paper adds to the literature on spousal age gaps, which suggests income prospects and fecundity, among others, as key explanatory variables[2]. Vella and Collins (1990) present a model that proposes a link between income difference and age difference, as males

[2] There are of course additional explanations in the literature. Edlund (1999), for example, lists unbalanced sex ratios, social status, and the functioning of capital markets (respectively ease of borrowing) as determinants of a spousal age gap. Li (2008) suggests that the gender life expectancy gap in favor of women tends to decrease the spousal age gap.

and females are willing to trade youth for income. H. Zhang (2014) develops a theoretical model which uses differential fecundity to explain the husband-wife age gap. Depending on the expected number of children, women have more or less urgency to plan ahead and marry early. The fecundity horizon is also the key explanatory variable in the model by Díaz-Giménez and Giolito (2013), who argue that the spousal age gap will persist even if gender wage gaps disappear. X. Zhang (2014) confirms in his empirical study that the asymmetric fecundity horizon and the demand for children are driving forces for the spousal age gap. Mansour and McKinnish (2014) suggest lower occupational wages drive up the spousal age gap. Anderberg et al. (2014) conclude with individual data that education leads to a smaller age gap, driven by the bride's later average age of marriage. In a case study on Indonesia, Utomo (2014) reports comparable findings, but limits her conclusion to a correlation between a higher level of the wife's education and a decreasing spousal age gap. Similar results are found by Carmichael (2011), Danziger and Neuman (1999), Gustafson and Fransson (2015), Glick et al. (2015), and Garenne (2004). Issues of endogeneity have been pointed out in strands of the literature (Casterline et al., 1986; Mensch et al., 2005; Lise and Seitz, 2007; van der Vleuten, 2013; Matz, 2013) and causal links may be running from marriage age due to societal conventions to female education outcomes. Our contribution explicitly addresses this possibility and our evidence suggests that societal conventions related to marriage timing can explain differences in female education. Moreover, analyzing the (absolute) age at marriage for women may overlook potential biases. If couples in a certain region habitually marry at younger ages than what the global average suggests, one might draw incorrect conclusions from examining absolute age levels only. We thus also analyze the relative marriage age (spousal age gap) and show that the spousal age gap affects female education significantly more than male education.

Third, we also contribute to the literature relating marriage to differential gender outcomes and discrimination. Sociological literature in this field alludes to societal expectations and gender discrimination associated with female marriage age and husband-wife age gaps (Blood and Wolfe, 1960; Freud, 1962; Banks and Arnold, 2001; Lehmiller and Agnew, 2008). This type of literature discusses the "internal complexity and the variety of social contexts" that shape husband-wife age differences (Pyke and Adams, 2010, p. 770), but does not only partly support its conclusions and hypotheses with empirical evidence. Our contribution adds to these analyses and provides international evidence which link societal expectations, resulting economic incentives, female age at marriage, and human capital investments. Thereby, we also directly contribute to the economics of marriage. Economic perspectives on marriage have received attention in academia (see Korenman and Neumark,

1990, 1991; Bhrolcháin, 1992; Saardchom and Lemaire, 2005; Fernández et al., 2005; Banerjee et al., 2013) following the seminal articles by Becker (1973, 1974) and a stream of literature connects gender inequality, human capital and marriage (see for example Mincer, 1974; Goldin and Katz, 2002; Goldin et al., 2006; Goldin, 2006; Iyigun and Walsh 2007; Chiappori et al., 2009). We specifically analyze effects of female age at marriage on female human capital.

We are interested in female education levels, because educational gender discrimination matters not only for the directly affected girls, but also for the nation on a macroeconomic level. Studies show that investments in the education of young females can lead to outstanding returns (Psacharopoulos, 1988; Dougherty, 2005). A more equal distribution of human capital in the population leads to more allocative efficiency of the work force (Lagerlöf, 2003). A better trained women's labor force and higher labor force participation also fuel growth through increased female productivity rates and earnings abilities (Dollar and Gatti, 1999). Seguino and Floro (2003) find that an increase in the women's wage share relative to that of men is associated with an increase in the domestic savings rate. Furthermore, beneficial generational effects have been proposed as children of more educated women display overall better well-being and higher productivity (Basu, 2002; Kabeer and Natali, 2013)[3].

Several received papers explore the effects of marriage age on diverse outcome variables. Rao (1993) suggests that spousal age gaps could be behind this century's rise in dowries in South Asia. Polachek and Xiang (2006) find that the husband-wife age gap increases the gender pay gap. Jensen and Thornton (2003) argue that women who marry young are more likely to experience domestic violence, whilst Lise and Seitz (2011) conclude that the spousal age gap has an economically and statistically insignificant effect on intra-household income allocation. Matz (2013) estimates a negative impact of the spousal age gap on Ethiopian household incomes as cooperation between spouses may be impeded by large age differences. Spousal age gaps are also considered to affect fertility levels and, consequently, population growth (Hajnal, 1965; Casterline et al., 1986; van Zanden, 2011). In general, the literature suggests that in countries with larger spousal age gaps, women have lower incentives in the labor market since their older husbands are likely to have accumulated more wealth and higher wages. Three papers of this strand are closely linked to our contribution: Foreman-Peck (2011) suggests from European historical evidence that later marriage sets up a virtuous cycle as it allows more female education and ultimately spurs economic growth. Field and Ambrus (2008) find for

[3] For theoretical literature on this topic, see for example Lagerlöf (2003), Galor and Weil (1996), Dollar and Gatti (1999), Knowles et al. (2002)

individuals in Bangladesh that each additional year that marriage is delayed for females is associated with an increase in years of their schooling and higher female literacy rate. Maertens (2013) based on her sample of three villages in India and argues that educational gender inequality can be traced back to female marriage timing. However, this literature does not examine spousal age gaps, the case study character is relevant but does not provide international evidence, and the impact of other "regular" gender discrimination variables is not explicitly examined. Thus, to the best of our knowledge this paper provides for the first time in the literature macro-evidence from international panel data via two alternative identification mechanisms, while also taking account of other gender discrimination variables. A final motivation to study how female education is affected by marriage age also lies in the fact that marriage age could potentially by regulated by age of marital consent laws and intensive public information campaigns may affect societal conventions in the long run too.

Conceptual framework for the effect of marriage age on female education

We consider a simple theoretical framework to better understand the economic rationale linking age at marriage and education of women. As argued in the literature (DiMaggio, 1994; Huntington, 1996; Inglehart and Welzel, 2005), we assume that cultural influences are robust, and cultural habits in a society adjust slowly over generations if at all, such that certain socio-cultural characteristics are given[4].

For our purpose, the most relevant cultural dimension are societal expectations and conventions on when to get married as a woman. These expectations belong to the decisive factors for the actual timing of a woman's marriage. Even if an individual young woman might not feel fully "ready" for marriage, established socio-cultural customs and resulting societal pressure may overrule personal sentiment. Societal norms and customs have also been repeatedly cited in the literature to explain observed female marriage age (Caldwell et al., 1983; Srinivas, 2000; Mason and Smith, 2003; Mensch et al., 2005; Maertens, 2013). Expected female marriage age due to societal expectations hence represents an important factor for female life planning, and affects the incentives for individuals. The known expectations on marriage age allow for nearly perfect foresight planning, so that we may assume economically rational, and hence identical behavior of all family members (the girl and her parents).

[4] This is closely in spirit with Cervellati and Sunde (2005), who develop a model for human capital accumulation based on expected lifetime.

Societal expectations and socio-cultural factors also apply to male marriage age. However, marriage age expectations affect a future wife much more than a future husband due to two important reasons: First, marriage represents the main socially accepted institution for conceiving children. We see that, globally and independent of cultural background, marriage is considered not an end in itself, but serves, as documented through a close temporal link, to begin childbearing.[5] For a global sample, Jensen and Thornton (2003) empirically document a continuous relationship for women between their marriage age and age at first birth, i.e. the older the bride is, the older she will become a mother. The authors explain this result as well with social norms, which emphasize the importance of child-birth taking place within marriage. Foreman-Peck (2011) also establishes the close link between marriage and the timing of first childbirth in a theoretical model. This pattern is even more reinforced still today in many cultures that are concerned with preserving a woman's virginity until marriage (Mensch et al., 2005). We hence assume that marriage has a signaling effect for conceiving children which is particularly strong for women.

Second, societal conventions differentiate between the time women and men dedicate to raising children and usually dictate that mothers do most of the job (OECD, 2011; Sinno and Killen, 2009; Bianchi et al., 2000; Levant et al., 1987). Even in very equal societies such as Sweden, women still use the majority of days for parental allowance (Statistics Sweden, 2014), and critical tasks such as giving birth are linked to females by nature. Wives hence tend to be more affected since global cultural customs put a higher emphasis on mothers to raise children than on fathers. This may in turn have a gender-specific effect on the labor market population. Mothers are not only the primary affected agent in the weeks and months before the date of delivery; the birth also indicates additional years of female work mostly dedicated to raising this child. The labor force of a man, in contrast, is less affected by becoming a father. Even in countries that may be regarded as most gender-egalitarian, the father's involvement in raising kids is usually confined to some weeks or a few months' time (Brandth and Kvande, 2015; OECD, 2011; Monna and Gauthier, 2008).

In essence, the foresight of expected marriage equaling expected offspring yields different incentive patterns for women versus men which should be empirically observable. The former know in advance that their labor force will be relatively more tied to raising

[5] Malthus (1830) already observed that a prudential restraint on marriage, i.e. a later marriage age, would lead to lower birth rates and therefore act as demographic control, since the timing for the first child is pushed backwards.

children, whereas the latter expect less of an effect on their labor force trajectory. Out of economic rationale, girls (as well as their parents) know the expected marriage age affects the number of years they can be employed (before a child is conceived). If girls get married very young, the projected participation in the labor market approaches zero (child birth is "imminent"), and later entry less likely due to a missing previous job experience. In line with our theoretical reasoning, Miller (2011) documents that women's careers benefit from delaying the first child. In addition, the higher the socially expected number of children, the more unlikely would be a potential return into the labor market after the birth of the first child.

Finally, with this incentive scheme of labor market prospects in mind, the socially expected female marriage age determines how much investments in education the girl initially plans to take. Related work has suggested that the level of educational investments depends on the expected returns (Foster and Rosenzweig, 2007; Ngyuen 2007). As women will usually be married not before their first menstrual period, we define human capital investments as forms of schooling beyond primary education. Also, we assume that individuals maximize their utility through efficient human capital investment. Hence, only the amount of human capital is invested into which is required for expected successful labor market participation. Human capital accumulation for "personal wisdom" but no economic pay-off is supposed to be irrelevant (or not differentially relevant for man and women). An expected young age for getting married then means that educational investments are less likely to pay off because returns from joining the labor market are not sufficient. We argue that this effect holds in general, since there are always costs attached to schooling. In large parts of the world, families face even dual costs in the form of direct expenses for sending girls to school, as well as the opportunity cost for not having them as labor support in the household (King and Hill, 1997; Glick and Sahn, 2000.) But also families in advanced economic countries with no formal schooling tuition will incur costs in the form of associated expenses such as school and learning materials, commuting and public transport, extracurricular activities etc.

An agent therefore considers sending girls to school as foregone investment from an economic point of view, if expected future returns from their education are not adequately realized through subsequent labor force participation. Assuming (nearly) perfect anticipation through stable intra-generational cultural customs, a societal expectation of young female marriage age will prevent agents from investing in the girls' education already ex ante. This means that the decision on female education is caused by her expected marriage age which is a socio-cultural convention. The mechanism is further reinforced by a negative relationship

between female marriage age and the fertility rate[6]. Kalemli-Ozcan et al. (1998) and Cervellati and Sunde (2007), among others, point to the fact that more educated parents face a higher opportunity cost of child-rearing. Given a low female marriage age environment and resulting little investments in female education, women are more likely to substitute child quantity for child quality. This may prolong their expected time period outside the labor market and further reduces incentives to invest in their education; it contrasts to a high female marriage age environment that is associated with fewer children and a shorter break from work. In summary, we suggest that socio-cultural customs for marriage age signal the timing for child-rearing, which primarily affects female labor force participation and hence the expected pay-off to female educational investments. Qualitatively, this means the earlier a woman gets married, the lower we expect her education to be, which forms the hypothesis to be tested[7].

III. DATA AND IDENTIFICATION STRATEGY

Data

According to our theoretical considerations we expect that the age at marriage of women affects their level of human capital. For our empirical work, we measure our outcome variable, namely gender-specific education levels, via two measures that are common in the literature (see for example Castelló-Climent and Hidalgo-Cabrillana, 2012; Barro and Lee, 2001, 2013): First, we consider first the accumulation of human capital measured via secondary school completion rates (Mankiw et al., 1992; Lorentzen et al., 2008). Second, we measure the stock of human capital by the average years of tertiary schooling achieved. Both data stem from the set by Barro and Lee (2013). We hypothesize that marriage rather affects later schooling attainment, because this is when marriage decisions mostly interfere. We will examine further outcome variable alternatives to proxy education and we also compile both absolute female values and gender-relative values where male are divided by female values and .

To empirically test our hypothesis, we employ the 2012 World Marriage Data by the United Nations (2013) that provide cross-country singulate mean age at marriage (SMAM) data separately for males and females. This allows us to calculate average values for three ten-year intervals per country from 1980 to 2010. This gender split also allows us to calculate a spousal age gap which captures the female age at marriage relative to the male to analyze

[6] In our panel data set, these two variables correlate significantly (r = -0.62).
[7] We summarize our conceptual framework schematically in figure 1 in the Appendix.

differences between women and men. We simply refer to the SMAM for men and women as the *Female Marriage Age*, respectively *Male Marriage Age*, which is formally defined as the average length of single life expressed in years among those who marry before age 50 (United Nations, 2012). The SMAM represents the most common and natural measure for marriage age[8]. In total, we have 86 different countries with data on gender-specific marriage age and educational outcomes for all three time intervals in our panel[9].

A number of control variables enter our empirical analysis. These are linked to our theoretical considerations and they are also commonly used in related literature (Danziger and Neuman, 1999, Garenne, 2004; Field and Ambrus, 2008; Carmichael, 2011; Díaz-Giménez and Giolito, 2013). As we propose that marriage serves as an institution for conceiving children, we want to ensure our estimates are not biased by fertility rates in a country. It is plausible that education for females differs across countries not because marriage happens in one country earlier, but because differences in the number of children per woman affects their educational decisions. By controlling for this variable, we eliminate cross-country differences in the average number of children a woman raises, which otherwise may have an unobservable effect on our core relationship between *Female Marriage Age* and female education. We also include the rate of urbanization in a country to capture socio-economic advancement, and the share of Muslim population as control for religious differences that may impact gender roles. Furthermore we employ four population gender ratios that potentially affect a balanced marriage market and could be a reason for age differences. Finally, we consider effects from legal origin differences, from the share of women engaged in the labor market as well as from national income levels[10].

Table 1 provides descriptive statistics for our key variables, broken down by decade. Differences in marriage age are profound: In the latest decade (2000-2010) for example, the *Female Marriage Age* in one country was more than double the age of another country (16 years in Niger versus 33 years in Jamaica). Over the last 30 years, both *Female* and *Male Marriage Age* have globally increased by on average two years.

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[8] In cases of quick and dynamics changes, the SMAM might be prone to measurement errors (Preston et al., 2001). However, upon data inspection we find no evidence that this could be problematic here.

[9] See the Appendix (table 15) for a detailed list of the countries employed for the panel. The cross-section we estimate later in this paper has a larger sample of up to 135 countries.

[10] We are aware that labor market characteristics as well as income levels are potentially endogenous. However, we want to ensure that cross-country differences in female labor force participation and per capita incomes do not bias our results. Not including these variables does not materially influence the coefficient of interest.

Table 1: Descriptives

	1985	1995	2005
Female Marriage Age	22.81	24.17	24.76
	(2.98)	(3.48)	(3.60)
Male Marriage Age	26.35	27.63	28.24
	(2.50)	(2.78)	(2.87)
Spousal Age Gap	3.54	3.46	3.48
	(1.60)	(1.51)	(1.38)
Spousal Age Gap Ratio	1.16	1.15	1.15
	(0.09)	(0.09)	(0.08)
Fertility	3.99	3.51	2.97
	(1.84)	(1.77)	(1.57)
Urbanization	50.09	53.41	55.36
	(23.52)	(23.99)	(23.45)
Share of Muslim population	0.19	0.21	0.22
	(0.34)	(0.34)	(0.34)
Sex ratio at birth	1.05	1.05	1.05
	(0.01)	(0.02)	(0.02)
Sex ratio under 5 mortality	1.09	1.08	1.08
	(0.16)	(0.15)	(0.18)
Sex ratio under 15 mortality	1.10	1.09	1.10
	(0.17)	(0.16)	(0.19)
Cum. pop. married at 40	0.98	0.98	0.98
	(0.36)	(0.04)	(0.05)
French Legal Origin	0.40	0.47	0.43
	(0.49	(0.50)	(0.50)
Female Labor Force Participation	40.52	42.28	50.24
	(17.50)	(14.59)	(15.69)
Log GDP per Capita	8.46	8.54	8.77
	(1.17)	(1.28)	(1.28)
Female Secondary Schooling Completion	13.94	17.32	24.19
	(11.36)	(12.25)	(15.21)
Secondary Schooling Completion Ratio	1.57	1.42	1.29
	(0.99)	(0.81)	(1.00)
Average Female Years Tertiary Education	0.17	0.24	0.39
	(0.17)	(0.23)	(0.34)
Average Years Tertiary Education Ratio	1.94	1.88	1.40
	(0.94)	(1.50)	(0.79)
Gender Parity Index in Literacy	0.81	0.83	0.89
	(0.21)	(0.21)	(0.16)
Primary Schooling Completion Ratio	1.33	1.16	1.38
	(0.85)	(0.49)	(2.66)

Notes: This table lists mean and (standard deviation) for the main variables of this paper, where each column shows the ten-year simple average value for the given decade. The variables are: (i) the *Female Marriage Age* (SMAM); (ii) the *Male Marriage Age* (SMAM); (iii) the Spousal Age Gap, calculated as difference between *Male* and *Female Marriage Age*; (iv) the ratio of *Male* over *Female Marriage Age*; (v) the fertility rate; (vi) the level of urbanization in percent; (vii) the share of muslim population per country; (viii)-(x) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (xi) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (xii) dummy if the country's legal origin is based on French system; (xiii) the percentage of females in the national labor force; (xiv) the log of per capita GDP in PPP terms. (xv) the percentage of females that completed secondary attainment as highest school degree; (xvi) the percentage of males that completed secondary attainment as highest school degree divided by that percentage of females; (xvii) the average years of tertiary schooling for females; (xviii) the average years of tertiary schooling for males divided by that of females; (xix) the Gender Parity Index (females divided by males) for adult literacy; (xx)) the percentage of males that completed primary attainment as highest school degree divided by that percentage of females. See the Appendix for more detailed variable definitions and sources.

This goes hand in hand with a decline in fertility rates (Foreman-Peck, 2011); women have on average one child less in the 2000s than in the 1980s). The spousal age gap displays a stable pattern of around three and a half years, which is consolidating as reflected in the decreasing standard deviation. In all countries observed, men marry on average later than women. The age gap between husband and wife in the 2000s ranges from an average 1.1 years in Ireland to 8.8 years in Niger. The share of the Muslim population (based on McCleary and Barro, 2006), has remained rather constant and, for the entire sample, closely reflects actual shares of the world population. We also observe stable trends for the gender ratios (boys over girls) regarding birth and subsequent mortality rates: More boys than girls are born globally, but they also suffer from a higher mortality rate than girls in childhood and adolescence. Finally, labor participation rate rose in our time window from 40 to 50 percent, and income (Feenstra, Inklaar, and Timmer, 2015) as well as urbanization levels have grown (UNESCO, 2013), in line with common findings.

Our outcome variables follows a common trend: Females have not only significantly improved their levels of education, but also reduced educational inequality relative to males[11]. All three categories that compare education along gender indicate that about 50 percent of the gap between boys and girls could be closed between the 1980s and the 2000s[12]. This general trend towards educational inequality reduction is in line with literature findings (e.g., Todaro and Smith, 2014). Still, within that trend line large discrepancies remain: whereas in Benin still five times more men than women finish tertiary education and less than half of the women are literate relative to men, the Dominican Republic reports equal gender literacy and a one and a half times female to male ratio for average years of tertiary education.

Identification Strategy

We begin by estimating effects of the female age at marriage on education in country *c* and time *t* with the following equation with a regression control approach:

$$(1) \qquad Educ_{ct} = \mu + \alpha\,(\text{Female Marriage Age})_{ct} + \beta X_{ct} + \varepsilon_{ct},$$

where Educ is our gender-specific educational outcome variable of interest, and Female Marriage Age denotes the *Female Marriage Age* variable as defined earlier. X is a vector of

[11] Table 1 already includes summary statistics for the Gender Parity Index (GPI) in Adult Literacy for comprehensiveness reasons.

[12] In that time period, the gap between boys and girls shrank by 51 percent for completed secondary attainment, by 43 percent for average years of tertiary schooling, and by 58 percent for literacy rates.

the control variables introduced before and fixed effects, which we include to mirror our conceptual framework. We then estimate effects in a panel setting with fixed effects over three ten-year timespans from 1980, which represents the earliest sensible data set available, up to 2010. Throughout this paper, we will make modifications to equation 1, which will be presented in detail as they are introduced.

We noted endogeneity concerns when regressing female education levels on female age at marriage. Three approaches are used to mitigate this issue: (1) We include fixed effects regularly in our regression estimates. (2) We introduce a new instrumental variable that tries to identify the effect of socio-cultural customs, and (3) we apply a quasi difference-in-difference strategy as a complementary examination.

We provide a new instrument related to socio-cultural customs to ensure effects of *Female Marriage Age* on education can be causally interpreted. Specifically, we instrument the domestic *Female Marriage Age* with an average *Female Marriage Age* of neighboring countries. This is the econometric mirroring of our conceptual framework presented earlier, which argues that shared socio-cultural expectations, which are stable within a generation and exogenously given, are closely associated with the actual timing of female marriage. This feature is suitable beyond national borders, since these expectations are much more determined through a common culture sphere than along formal borders. On the other hand, cross-country marriages that could cause endogeneity concerns represent exceptions. Hence, taking the neighboring *Female Marriage Age* from culturally closely associated nations constitutes a meaningful and relevant instrumental approach. The exclusion restriction requires that the average *Female Marriage Age* from neighboring countries impacts domestic female education levels only through the average domestic *Female Marriage Age*. While we cannot directly test this assumption, we believe it is valid, especially since any formal domestic legislation on female schooling or female marriage age is confined to the national border, and thus should not impact our instrument.

We compile our basic instrument by following Jetter et al. (2016) in our base specification, i.e. we weigh all values of adjacent countries by the length of shared borders for an average "neighboring value". Adjacent countries with missing values are omitted for the weighted average calculation, which also means that islands are excluded from this sample altogether as they share no direct land border. Domestic *Female Marriage Age* and the *Female Marriage Age* of neighboring countries are highly correlated ($r = 0.8$ in our panel), which documents the relevance of our instrument. Related literature also proposes to use neighboring values as instrument to establish exogeneity. Maertens (2013) uses the stated ideal age of

marriage of neighboring households within the same subcaste as instrument for an Indian case study. Similar to this micro-setting, here we employ neighboring values on a country level. This yields the following first-stage regression equation:

(2) Female Marriage $Age_{ct} = \gamma + \lambda NEIGHBOR_{ct} + \theta X_{ct} + \varepsilon_{FemaleMarriageAgect}$,

where $NEIGHBOR_{ct}$ refers to the average weighted neighbor value of the *Female Marriage Age* in adjacent countries of country *c* in time *t*.

IV. EMPIRICAL RESULTS

Baseline results

Figure 2 provides the central motivation for our paper and displays the unconditional relationship between each outcome variable and *Female Marriage Age* for the three time periods. All scatterplots in the first three columns display a significant positive relationship between *Female Marriage Age* and female education levels, i.e. the later a woman gets married, the higher her education. As we move from the 1980s to the 2000s, the association becomes stronger for both secondary and tertiary education. The fourth column presents first differences, where for each country the changes in female education from the 1980s to the 2000s are plotted against the changes in *Female Marriage Age*, i.e. we evaluate whether changes in the age of marriage are associated with changes in female education over time, thus holding country characteristics constant. We observe that first differences in marriage age correlate most strongly with changes in advanced education. Changes in female secondary schooling show a weaker but still positive correlation with changes in women's marriage age over time.

Next we run OLS regressions based on equation (1) for our panel as summarized in table 2. Effects are estimated for secondary and tertiary schooling of women (for now, we focus on absolute female education levels), and we include step-wise additional controls as well as fixed effects to help reduce omitted endogeneity issues.

Figure 2: Scatter plots of Female Marriage Age against education variables

Table 2: Panel for level of female education

1980-2010 (OLS) Dependent variable =	Female Secondary Schooling Completion			Average Female Years Tertiary Education		
	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	86	85	81	86	85	81
Observations	258	255	243	258	255	243
Female Marriage Age	2.22	0.82	1.14	0.05	0.02	0.02
	(0.26)***	(0.34)***	(0.50)**	(0.01)***	(0.01)***	(0.01)***
Fertility		-4.03	-3.64		-0.02	0.01
		(1.11)***	(1.84)*		(0.01)**	(0.02)
Urbanization		0.08	-0.01		0.01	0.01
		(0.05)	(0.18)		(0.001)***	(0.01)
Share of Muslim population		3.04	46.41		-0.08	0.11
		(3.46)	(16.76)***		(0.06)	(0.29)
Sex ratio at birth		-3.67	-12.23		-0.89	-2.69
		(31.96)	(44.16)		(0.85)	(1.31)**
Sex ratio under 5 mortality		-38.47	-17.80		-2.75	-2.21
		(36.39)	(49.42)		(0.76)***	(0.81)***
Sex ratio under 15 mortality		35.54	3.18		2.73	2.07
		(38.24)	(49.10)		(0.82)***	(0.88)**
Cum. pop. married at 40		-41.92	-16.52		-1.55	-0.94
		(21.55)**	(26.25)		(0.35)***	(0.42)**
French Legal Origin		-4.69			0.04	
		(1.64)***			(0.04)	
Female Labor Force Participation			-0.08			0.01
			(0.09)			(0.001)**
Log GDP per Capita			6.12			0.17
			(2.40)***			(0.04)***
Continent dummies	no	yes	no	no	yes	no
Fixed effects	no	no	yes	no	no	yes
R-squared	0.27	0.41	0.47	0.44	0.58	0.67

Notes: The dependent variable in column (1)-(3) is the percentage of the female population with a completed secondary education. Columns (4)-(6) estimate the average years of female tertiary schooling. The regressors are: (i) The female *Marriage Age* (SMAM); (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v)-(vii) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (ix) dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. French Legal Origin omitted in columns (3) and (6) because of inclusion of fixed effects. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

The empirical results support our theoretical predictions. *Female Marriage Age* has a positive and highly significant impact on female education, robust to inclusion of additional controls and fixed effects[13]. Taking the most stringent specification in columns (3) and (6), each additional year a woman delays marriage means that the share of all females in the country who complete secondary schooling, rises by 1.14 percentage points. Average years of tertiary

[13] Based on highly significant p-values of a Hausman test for both our outcome variables, which serves to analyze whether the unique errors (ε_i) are correlated with the regressors (see Appendix, table 11), we continue with regularly controlling for fixed effects in our model.

education are likewise increased by 0.02 years, which equals about one week more time spent at university or roughly a tenth of a semester. Among the additional controls, fertility rates and per capita income levels tend to matter for both outcome variables. Per capita income levels and female labor force participation are likely endogenous variables in our model, but need to be taken into consideration to ensure that other covariates are not biased from omitted variables. For this reason, we estimate one model without these two controls, and compare it to the specification with all controls: results are very similar. We also include a control variable for imbalances in the marriage market (*cum. pop. married at 40*, i.e. the cumulative ratio of married males over married females at age 40). It might be that the bridal marriage age is determined not so much based on socio-cultural expectations, but is more directly related to the widely debated issue of "missing women" (Sen, 1990; Anderson and Ray, 2010), which affects marriage market characteristics. If there are women missing on the marriage market due to unbalanced overall population ratios, men would likely have to choose and marry young females as long as they are still available. This would bias the female marriage age downwards. Such a missing women effect could also result in a "marriage squeeze" (Edlund, 2002; Grossbard-Shechtman, 1993), as relatively more men do not marry because the unbalanced marriage market leaves them without a matching partner. Against this backdrop, we proxy for a distorted marriage market with this ratio as we would expect a balanced ratio for a population with normal distribution of sexes.[14]

We also note that the Female Labor Force Participation in a country is associated with tertiary education levels. Other covariates are either non-significant, or they have a differential effect on the two outcome variables. Most importantly, *Female Marriage Age* effects remain robust and highly significant throughout all specifications.

Instrumental Variable Evidence and Spousal Age Gaps

Although the initial association between female age at marriage and female education levels appears statistically and economically relevant, we try to ensure that the relationship between the two variables can be causally interpreted. Hence, in table 3 (Panel A) we proceed to instrumental variables estimates, where the average of the *Female Marriage Age* of adjacent countries, weighted by shared land border, serves as our instrument.

[14] We also tested an alternative specification with the ratio of cumulative percentage of married men over married women at the age of 30 as control variable. Results turn out to be very similar.

Table 3: Panel for level of female education, absolute and relative (Spousal Age Gap) Female Marriage Age

	Linear Regression								*Generalized Method of Moments (GMM Arellano-Bond)*					
1980-2010									Female Secondary Schooling			Average Female Years		
Dependent variable =	Female Secondary Schooling Completion				Average Female Years Tertiary Education				Completion			Tertiary Education		
Panel A: Female Marriage Age (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Number of countries	71	70	66	66	71	70	66	66	71	70	66	71	70	66
Observations	213	210	198	198	213	210	198	198	142	140	132	142	140	132
Female Marriage Age	3.21	2.09	2.12	3.88	0.07	0.04	0.04	0.04	3.61	3.62	3.23	0.07	0.06	0.05
	(0.05)***	(0.67)***	(0.78)***	(1.17)***	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.58)***	(1.25)***	(1.23)***	(0.01)***	(0.02)***	(0.02)**
Fertility		-3.98	-4.04	-4.01		-0.01	-0.01	-0.01		-3.29	-3.59		-0.01	-0.01
		(0.88)***	(0.96)***	(1.54)***		(0.01)	(0.02)	(0.02)		(1.42)**	(1.39)***		(0.03)	(0.02)
Urbanization		0.03	-0.04	-0.22		0.01	0.01	-0.01		-0.12	-0.15		0.01	-0.01
		(0.07)	(0.09)	(0.18)		(0.001)***	(0.01)	(0.01)		(0.22)	(0.22)		(0.01)	(0.01)
Share of Muslim population		4.04	4.44	63.01		-0.05	0.04	0.09		46.09	37.21		0.17	0.01
		(3.84)	(4.52)	(22.58)***		(0.07)	(0.08)	(0.30)		(17.47)	(17.18)**		(0.30)	(0.29)
Sex ratio at birth		-3.67	-27.29	1.70		-0.12	-0.11	-1.09		14.64	-29.19		-0.39	-1.01
		(58.43)	(62.03)	(100.74)		(1.00)	(1.01)	(1.34)		(75.29)	(78.79)		(0.68)	(0.69)
Sex ratio under 5 mortality		28.68	48.73	112.85		-1.56	-1.20	-1.38		52.42	54.82		-1.19	-0.92
		(42.45)	(43.76)	(60.77)*		(0.72)**	(0.69)*	(0.81)*		(51.32)	(48.52)		(0.98)	(0.87)
Sex ratio under 15 mortality		-32.01	-51.86	-140.22		1.52	1.14	1.27		-69.57	-68.22		0.99	0.83
		(45.98)	(47.34)	(70.74)**		(0.78)**	(0.76)	(0.94)		(59.38)	(55.63)		(1.19)	(1.06)
Cum. pop. married at 40		-48.13	-42.67	11.83		-1.64	-1.59	-1.19		8.21	9.81		-0.33	-0.42
		(25.46)*	(28.48)	(42.52)		(0.43)***	(0.46)***	(0.57)**		(46.61)	(47.50)		(0.82)	(0.75)
French Legal Origin		-6.23	-5.98			-0.01	0.02							
		(2.27)***	(2.51)**			(0.04)	(0.04)							
Female Labor Force Participation			0.05	-0.10			0.01	-0.01			-0.08			0.01
			(0.06)	(0.10)			(0.001)***	(0.001)**			(0.12)			(0.01)
Log GDP per Capita			1.42	3.06			0.05	0.11			4.28			0.11
			(1.92)	(3.05)			(0.03)*	(0.04)***			(2.17)**			(0.03)***
Continent dummies	no	yes	yes	no	no	yes	yes	no	no	no	no	no	no	no
Fixed effects	no	no	no	yes	no	no	no	yes	yes	yes	yes	yes	yes	yes
First stage F-test statistics	274.96	52.93	41.05	19.07	274.96	52.93	41.05	19.07						
R-squared	0.33	0.52	0.50	0.40	0.34	0.59	0.61	0.69						

	Linear Regression								*Generalized Method of Moments (GMM Arellano-Bond)*					
1980-2010 Dependent variable =	Female Secondary Schooling Completion				Average Female Years Tertiary Education				Female Secondary Schooling Completion			Average Female Years Tertiary Education		
Panel B: Spousal Age Gap (OLS)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(13)	(14)	(15)
Number of countries	86	85	81	81	86	85	81	81	86	85	81	86	85	81
Observations	258	255	243	243	258	255	243	243	172	170	162	172	170	162
Spousal Age Gap	-3.51	-0.46	-0.60	-0.66	-0.09	-0.02	-0.01	-0.04	-0.76	-0.13	-0.31	-0.04	-0.03	-0.04
	(0.65)***	(0.23)**	(0.79)	(1.11)	(0.01)***	(0.01)**	(0.01)	(0.02)**	(0.39)**	(0.08)*	(1.05)	(0.01)***	(0.01)***	(0.01)***
Fertility		-4.70	-4.14	-4.29		-0.04	-0.01	-0.01		-4.59	-4.06		-0.05	0.02
		(0.66)***	(0.76)***	(1.05)***		(0.01)***	(0.01)	(0.02)		(1.54)***	(1.55)***		(0.01)***	(0.01)
Urbanization		0.12	0.03	-0.01		0.01	0.01	0.01		0.17	0.14		0.01	0.01
		(0.05)**	(0.07)	(0.16)		(0.001)	(0.001)**	(0.01)		(0.17)	(0.16)		(0.001)**	(0.01)
Share of Muslim population		2.78	2.77	44.21		-0.06	0.02	0.25		15.74	11.96		-0.16	-0.16
		(3.40)	(3.84)	(20.65)**		(0.07)	80.07)	(0.32)		(12.14)	(14.02)		(0.22)	(0.25)
Sex ratio at birth		-18.51	-8.22	-28.22		-1.03	-0.42	-3.09		35.67	-1.87		-2.32	-2.91
		(53.79)	(57.34)	(86.71)		(1.00)	(1.02)	(1.35)**		(42.59)	(50.66)		(1.70)	(1.68)*
Sex ratio under 5 mortality		-68.89	-42.53	-55.03		-3.43	-2.58	-2.87		-93.37	-64.88		-3.46	-2.43
		(30.96)**	(33.43)	(40.72)		(0.56)***	(0.58)***	(0.64)***		(33.67)**	(36.77)*		(0.88)***	(0.77)***
Sex ratio under 15 mortality		69.76	42.95	48.79		3.52	2.62	2.84		93.98	64.28		3.57	2.51
		(32.03)**	(34.51)	(43.28)		(0.58)***	(0.60)***	(0.68)***		(35.56)**	(38.72)*		(0.93)***	(0.83)***
Cum. pop. married at 40		-54.55	-50.25	-33.61		-1.94	-1.76	-1.22		-61.23	-44.79		-1.66	-1.14
		(19.77)***	(20.37)***	(25.19)		(0.36)***	(0.35)***	(0.39)***		(24.25)**	(22.18)**		(0.37)	(0.37)***
French Legal Origin		-5.18	-4.66			0.04	0.08							
		(2.11)***	(2.26)**			(0.04)	(0.04)*							
Female Labor Force Participation			0.04	-0.06			0.01	0.01			-0.06			0.01
			(0.06)	(0.09)			(0.001)***	(0.001)**			(0.08)			(0.01)
Log GDP per Capita			3.49	7.60			0.10	0.21			5.38			0.16
			(1.47)**	(2.26)***			(0.03)***	(0.04)***			(2.21)**			(0.04)***
Continent dummies	no	yes	yes	no	no	yes	yes	no	no	no	no	no	no	no
Fixed effects	no	no	no	yes	no	no	no	yes	yes	yes	yes	yes	yes	yes
R-squared	0.20	0.52	0.50	0.11	0.26	0.59	0.59	0.44						

	Linear Regression								*Generalized Method of Moments (GMM Arellano-Bond)*					
1980-2010 Dependent variable =	Female Secondary Schooling Completion				Average Female Years Tertiary Education				Female Secondary Schooling Completion			Average Female Years Tertiary Education		
Panel C: Spousal Age Gap (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(13)	(14)	(15)
Number of countries	71	70	66	66	71	70	66	66	71	70	66	71	70	66
Observations	213	210	198	198	213	210	198	198	142	140	132	142	140	132
Spousal Age Gap	-9.15	-0.83	-0.54	112.30	-0.19	-0.09	-0.09	1.14	-6.59	-9.77	-22.51	-0.14	-0.07	-0.25
	(1.25)***	(0.40)**	(2.95)	(255.31)	(0.02)***	(0.05)**	(0.06)*	(2.66)	(1.07)***	(4.64)**	(15.69)	(0.03)***	(0.04)**	(0.19)
Fertility		-3.76	-3.56	-26.96		-0.01	0.01	-0.24		-4.27	-4.08		-0.05	-0.08
		(0.90)***	(0.91)***	(46.59)		(0.02)	(0.02)	(0.49)		(2.52)*	(6.00)		(0.03)	(0.06)
Urbanization		0.15	0.11	1.45		0.01	0.01	0.02		-0.12	-0.88		0.01	-0.01
		(0.07)**	(0.09)	(3.89)		(0.01)***	(0.01)	(0.04)		(1.35)	(0.45)		(0.01)	(0.01)
Share of Muslim population		2.50	4.07	-704.20		0.03	0.09	-7.67		78.79	169.92		-0.02	1.52
		(3.78)	(3.91)	(1687.95)		(0.07)	(0.07)	(17.62)		(307.24)	(114.21)		(1.46)	(1.37)
Sex ratio at birth		-25.76	-36.83	532.05		0.06	0.17	4.27		63.76	42.77		-0.40	-2.40
		(52.16)	(56.34)	(1481.59)		(0.99)	(1.06)	(15.47)		(145.18)	(134.47)		(1.14)	(2.13)
Sex ratio under 5 mortality		-46.08	-17.95	89.21		-1.87	-1.31	-1.61		-80.65	-1.44		-3.48	-1.86
		(34.88)	(39.28)	(425.02)		(0.66)***	(0.74)*	(4.43)		(76.01)	(98.41)		(0.98)***	(1.23)
Sex ratio under 15 mortality		50.77	22.21	93.39		2.12	1.57	3.63		63.63	-34.15		3.70	1.69
		(35.23)	(39.18)	(408.90)		(0.67)***	(0.74)	(4.27)		(156.10)	(123.42)		(1.04)***	(1.54)
Cum. pop. married at 40		-71.89	-67.66	-471.59		-2.86	-2.78	-6.07		-79.00	-53.58		-1.97	-1.43
		(27.92)***	(28.91)**	(910.76)		(0.53)***	(0.55)***	(9.51)		(77.95)	(54.81)		(0.46)***	(0.64)**
French Legal Origin		-6.40	-6.44			0.02	0.03							
		(2.03)***	(2.06)***			(0.04)	(0.04)							
Female Labor Force Participation			0.09	-0.17			0.01	0.01			-0.06			0.01
			(0.06)	(0.75)			(0.001)**	(0.01)			(0.17)			(0.01)
Log GDP per Capita			1.52	-6.55			0.04	0.02			12.71			0.23
			(1.56)	(38.88)			(0.03)	(0.41)			(7.58)*			(0.10)**
Continent dummies	no	yes	yes	no	no	yes	yes	no	no	no	no	no	no	no
Fixed effects	no	no	no	yes	no	no	no	yes	yes	yes	yes	yes	yes	yes
First stage F-test statistics	76.06	19.68	15.54	8.91	76.06	19.68	15.54	8.91						
R-squared	0.24	0.55	0.54	0.03	0.25	0.57	0.57	0.03						

Notes: The dependent variable in column (1)-(4) and (9)-(11) is the percentage of the female population with a completed secondary education. Columns (5)-(8) and (12)-(14) estimate the average years of female tertiary schooling. The regressors are: (i) The *Female Marriage Age* (SMAM) in Panel A, and the Spousal Age Gap (*Male* minus *Female Marriage Age*); (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v)-(vii) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (ix) dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. French Legal Origin omitted in columns (4), (8), and (9)-(14) because of inclusion of fixed effects, respectively first differences. The GMM estimator in Panel B uses as instrument the regressor itself to mirror the linear OLS scenario. Panels A and C use as instrument the weighted average of the absolute, respectively relative Female Marriage Age of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

The domestic *Female Marriage Age* is strongly affected by established societal expectations, which a country shares with its neighbors through common cultural heritage. Thereby, we account for concerns of causality and endogeneity between marriage age and education.

We then take an additional step to tackle omitted variable bias. So far we have analyzed our key variable of interest, the marriage age for women, as absolute values through the *Female Marriage Age*. We accounted for national differences by the inclusion of country fixed effects as well as cultural variables such as Muslim population shares. However, our absolute perspective might still overlook particular social customs regarding marriage age that would bias results. Also, *Male Marriage Age* correlates highly with *Female Marriage Age* so that results so far could capture effects simply from marrying young per se, rather than from *Female Marriage Age*. Hence, we take the difference between the *Marriage Age* of husband and wife to obtain a spousal age gap (SAG) per country. This should even better to reduce biases in case women in one part of the world get married earlier than somewhere else, irrespective of education levels. It likewise considers how men behave in terms of timing for marriage. As all of our observations display a higher average age for men than for women at marriage, spousal age gaps are consistently positive values. For our regression analyses in table 3, we examine spousal age gap effects in a simple OLS regression (Panel B), and then again instrument the domestic SAG with neighboring values, where for consistency reasons we now use the SAG of adjoining countries weighted by shared border length (Panel C).

Finally, we seek further evidence by employing Generalized Method of Moments (GMM) techniques. These allow for a more flexible estimation than least squares methods and further address potential endogeneity issues. The specific method chosen is the one-step Arellano-Bond dynamic panel estimator, which is based on the idea that our instrumental variables approach so far does not exploit all of the information available in the sample (Arellano and Bond, 1991). It thereby also recognizes fixed effects. In this GMM context, we may construct more efficient estimates of the dynamic panel data model, especially for our panel which is characterized by few time periods with many individual cases (countries). However, as the model employs all available lags of the specified variables in levels dated t-1 or earlier, our panel is reduced from three to two independent observation points per country.

All results confirm a strong and significant relationship according to our theoretical considerations: In panel A, the IV procedure increases the coefficients increase in comparison to before, i.e. *Female Marriage Age* explained by societal conventions has a greater impact on female education. Estimated effects more than double in size in comparison to the OLS results.

Hence, estimates that do not explicitly address causality (table 2) tend to bias down marriage age effects. First stage F-test statistics in the linear model indicate very good identification of our instrument, which is always a highly significant predictor for spousal age gaps. The IV results also remain robust to the inclusion of a set of control variables: in our most comprehensive GMM specification (columns 9 to 14), each year a woman postpones marriage translates into a 3.2 percentage points higher female completion rate in secondary schooling. For tertiary education, one year of marriage delay equals nearly three weeks longer tertiary schooling for women. Our sample average in the 2000s amounts to only one semester of total university attendance for women; reducing those twenty weeks by three because of one year earlier marriage means corresponds to a cut by 13 percent.[15]

Moving on to panel B, the relative M*arriage Age* effects (spousal age gap) appear to have a slightly more robust impact on tertiary than on secondary education. The latter is no longer significant in either linear or GMM specification if all controls and fixed effects are added to the model. In any case, coefficients are now consistently negative which is in accordance with our theoretical considerations: The earlier a woman gets married relative to the husband, i.e. the larger the spousal age gap, the lower her education. In absolute size the effects are smaller than before. This may reflect the fact that effects from simply "marrying young" in a country and year are now removed, since we only analyze the gender-specific impact from women marrying relatively younger than the husband. Also, the lack of instrumentation in panel B is likely to again bias coefficients downwards due to reverse causality.

We therefore employ our described instrument (in this case the average spousal age gap of neighboring countries weighted by length of border shared) again in panel C. Revisiting the strength of our instrument, the first stage F-test values display mostly robustness with regards to common threshold levels (Staiger and Stock, 1997)[16]. However, we note that once all controls and fixed effects are included, the coefficients of spousal age gap in the second stage can no longer be estimated precisely enough to maintain significance levels. This suggests that fixed effects capture a lot of the rather invariant spousal age gap regressor, which does not fluctuate much over time. Still the direction remains unambiguous and coefficients are larger than in panel B. We attribute this again to better identification and resolved reverse causality

[15] This numbers tend to be smaller compared to experience for Bangladesh and India: Field and Ambrus (2008) estimate that one additional year of delayed marriage results in 2.6 more months of total education in Bangladesh, while Maertens (2013) estimates up to 8.5 months for rural India. We would reconcile the numbers such around three weeks of that total additional time can be attributed to tertiary education.

[16] See table 12 in the Appendix for detailed first stage results.

issues, consistent with the observations we made when contrasting OLS and IV estimates for absolute *Female Marriage Age*. In our preferred GMM specification with only exogenous controls and fixed effects, one additional standard deviation of the spousal age gap variable (1.4 years) leads to a 14 percentage point lower secondary schooling completion rate for girls. It analogously translates into about six weeks less of female tertiary education. In the 2000s, Germany and Albania displayed roughly such a gap auf 14 percentage points in female educational levels in secondary and tertiary schooling and a spousal age gaps of approximately 1.4 years (4.0 years in Albania versus 2.7 years in Germany).

Effects on Female Relative to Male Education

Our paper so far has identified negative effects of marriage age of women as well as of spousal age gaps on female education levels. Our theoretical considerations attribute a negative impact on females only, since men's career prospects are generally not constrained by children and founding a family. The following analysis tests more explicitly if spousal age gaps affect male and female education differently.

For this purpose, we go back to equation (1), but employ a re-coded variable as regressor, namely the ratio of *Male* over *Female Marriage Age* (spousal age gap ratio). Analogously, our outcome variable for secondary and tertiary education is now coded as male over female values per country. We hence have a quasi diff-in-diff specification, employing relative levels on both sides of the equation, as gender ratios in education levels are explained with gender ratios in marital age gaps. Estimating relative female education serves to identify the direct educational gender gap independent of the many other characteristics that potentially influence a country's level of education. Nonetheless, we also include a set of control variables to strengthen our findings, and we address endogeneity in the usual way by taking neighboring countries' values as instruments[17].

Table 4 reports econometric results of how gender differences in marital age gap translate into gender differences in education. There is strong evidence for a gender-discriminating effect of spousal age gaps, since larger age gaps also increase the educational gap between men and women. This lends strong support to our hypothesis that women's education is relatively more influenced by marriage timing than men's.

[17] See table 13 in the Appendix for detailed first stage results.

Table 4: Panel for relative male-to-female education levels (ratio)

1980-2010								
Dependent variable =	Secondary Schooling Completion Ratio				Average Years Tertiary Education Ratio			
Panel A: Spousal Age Gap Ratio (OLS)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of countries	86	85	81	81	86	85	81	81
Observations	258	255	243	243	258	255	243	243
Spousal Age Gap Ratio	5.32	4.51	1.64	0.85	7.52	4.47	5.38	4.98
	(1.32)***	(2.74)*	(0.88)*	(1.75)	(1.97***	(2.26)**	(2.67)**	(3.43)
Fertility		0.16	0.18	0.25		0.25	0.21	0.23
		(0.07)**	(0.05)***	(0.07)***		(0.07)***	(0.08)***	(0.11)**
Urbanization		-0.01	0.01	-0.01		-0.01	0.01	-0.01
		(0.01)	(0.01)	(0.01)		(0.01)	(0.01)	(0.02)
Share of Muslim population		-0.22	0.15	-1.66		-0.64	-0.85	-2.67
		(0.27)	(0.15)	(1.20)		(0.53)	(0.57)	(1.61)*
Sex ratio at birth		2.23	3.34	-4.39		-0.39	0.13	-6.21
		(2.00)	(1.29)***	(5.64)		(3.74)	(3.45)	(3.43)*
Sex ratio under 5 mortality		-0.85	-0.14	0.64		2.52	0.33	0.88
		(1.68)	(1.28)	(1.75)		(1.89)	(1.99)	(2.63)
Sex ratio under 15 mortality		1.10	0.60	-0.49		-2.71	-0.52	-1.55
		(1.67)	(1.28)	(1.84)		(1.91)	(1.98)	(2.72)
Cum. pop. married at 40		-0.45	-0.68	0.08		0.45	-0.16	1.68
		(1.32)	(0.69)	(0.95)		(1.57)	(1.61)	(1.75)
French Legal Origin		0.23	0.05			0.13	0.07	
		(0.18)	(0.10)			(0.21)	(0.23)	
Female Labor Force Participation			0.01	-0.01			-0.01	-0.02
			(0.01)	(0.01)*			(0.01)*	(0.01)
Log GDP per Capita			-0.10	0.10			-0.11	-0.03
			(0.06)	(0.11)			(0.13)	(0.22)
Continent dummies	no	yes	yes	no	no	yes	yes	no
Fixed effects	no	no	no	yes	no	no	no	yes
R-squared	0.20	0.30	0.54	0.28	0.24	0.33	0.38	0.23
Panel B: Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of countries	71	70	66	66	71	70	66	66
Observations	213	210	198	198	213	210	198	198
Spousal Age Gap Ratio	7.34	5.24	3.62	-54.17	8.47	9.29	10.71	-36.53
	(1.29)***	(2.84)*	(1.49)***	(118.00)	(0.90)***	(2.75)***	(2.64)***	(91.95)
Fertility		0.27	0.20	1.21		0.14	0.12	0.91
		(0.09)***	(0.04)***	(1.96)		(0.07)**	(0.08)	(1.39)
Urbanization		-0.01	0.01	-0.03		0.01	0.01	-0.03
		(0.01)	(0.01)	(0.08)		(0.01)	(0.01)	(0.08)
Share of Muslim population		-0.22	0.18	15.69		-0.59	-0.66	11.19
		(0.35)	(0.18)	(37.20)		(0.33)*	(0.32)**	(29.21)
Sex ratio at birth		4.87	4.45	-20.09		-2.07	1.87	-18.91
		(5.19)	(2.58)*	(38.84)		(4.38)	(4.46)	(27.37)
Sex ratio under 5 mortality		-3.82	-1.96	3.83		2.43	0.07	4.11
		(3.51)	(1.81)	(12.92)		(2.84)	(3.11)	(9.22)
Sex ratio under 15 mortality		4.75	2.62	-10.30		-2.35	-0.01	-9.53
		(3.56)	(1.83)	(23.76)		(2.89)	(3.14)	(17.21)
Cum. pop. married at 40		1.35	0.01	16.40		1.05	0.30	14.34
		(2.48)	(1.19)	(35.60)		(1.92)	(2.02)	(26.45)
French Legal Origin		0.27	0.04			-0.17	-0.17	
		(0.18)	(0.09)			0.16	(0.15)	
Female Labor Force Participation			0.01	0.01			-0.01	0.01
			(0.01)*	(0.03)			(0.01)	(0.03)
Log GDP per Capita			-0.14	0.37			-0.02	-0.02
			(0.07)	(0.82)			(0.13)	(0.49)
Continent dummies	no	yes	yes	no	no	yes	yes	no
Fixed effects	no	no	no	yes	no	no	no	yes
First stage F-test statistics	216.92	54.75	48.60	5.18	216.92	54.75	48.60	5.18
R-squared	0.21	0.34	0.58	0.01	0.30	0.40	0.44	0.01

Notes: The dependent variable in column (1)-(4) is the ratio of the male over female population share with a completed secondary education. Columns (5)-(8) estimate the ratio of the male over female average years of tertiary schooling. The regressors are: (i) The *Female Marriage Age* (SMAM) in Panel A, and the Spousal Age Gap (*Male* minus *Female Marriage Age*); (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v)-(vii) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (ix) dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. French Legal Origin omitted in columns (4) and (8) because of inclusion of fixed effects. Panel B uses as instrument the weighted average of the absolute, respectively relative Female Marriage Age of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Consistent with previous results, estimated effects using instruments are again considerably larger when we directly compare all significant spousal age gap ratio regressors of the OLS with the equivalent IV specifications. Our preferred and highly significant IV specification with key controls (columns (3) and (7)) suggests that switching from the same age of both husband and wife to a scenario where the husband is twice as old (a switch in the ratio from one to two) leads to a more than three times higher completion rate for boys than girls in secondary schooling, and a nearly eleven times longer time spent at university for male than for female adolescents. Results indicate that robustness cannot be held when including fixed effects in the model on top of other controls at conventional significance levels. This is likely again due to the rather invariant spousal age gap ratio which is consequently absorbed into fixed effects so that its stand-alone explanatory power decreases.

Nonetheless, the estimates clearly support the conclusion that educational gender gaps are exacerbated by marriage age. Spousal age gaps do not only have a negative effect on female education, but this effect is also significantly larger than what we observe for male education. Women's education suffers not only in absolute levels, but also relatively more than men's when an age gap between husband and wife opens up.

V. Robustness Tests and Refinements

Alternative Instruments

In this section we run a number of additional specifications to further check the robustness of our results so far. We begin by employing two alternative instruments to confirm that the conclusions drawn so far do not depend on a particular choice of instrumental variable.

On the one hand, we use as instrument the average female marriage age of five neighboring countries. If a country has less than five neighboring countries with a shared land border, we include countries in the same (cultural) region to always obtain a balanced group of five. While this is a mathematically less deterministic approach than our base instrument, it has the advantage of including more countries (especially islands), and of shaping the exposure to neighboring values towards countries that have similar cultural customs.

In a second check we proceed to another alternative instrument to corroborate our findings through an entirely different channel. The origin of different gender roles and gender treatment as a result of agricultural practices and physiological differences between men and women has recently received renewed interest. Following Boserup (1970), Alesina et al. (2013)

present findings that link the suitability of a location for cultivating crops that benefitted from plow adoption to unequal gender norms today. As these "plow-positive" crops required more body strength and force, men assumed the natural role of performing such work. Women, in return, adopted primarily roles within the domestic household. The authors argue that these labor division practices transformed into norms about the natural role of each gender[18]. These persist as cultural beliefs even in today's time, i.e. after the economy has advanced from a traditional agricultural structure. Assuming that such a views on gender roles are also mirrored in today's marriage age patterns, plow-positive and plow-negative environments represent relevant instruments for our analysis[19].

Traditionally, education and schooling were a privilege reserved to very few in society, who were not representative of the agricultural workforce. It is implausible to think that girls and boys, respectively their parents, would have decided on marriage age back then as a consequence of schooling, simply because there was virtually no schooling. Few cases of mandatory schooling were limited to basic primary education, which would not interfere with adolescence and related marriage decision. Widespread education only appeared in Europe and North America when industrialization began – hence precisely once the economy moved away from its traditional agricultural character (Mulhern, 1959; Barnard, 1969; Cordasco, 1976; Maynes, 1985; Too, 2001). In other, less developed parts of the world, general schooling has only emerged in the second half of the twentieth century (Lockheed and Verspoor, 1992). In summary, education appeared only relatively recently in time, and hence could not have possibly influenced traditionally anchored gender roles and the associated female marriage age. In contrast, the cultural heritage of agricultural economic reasons on gender roles is likely important in the decision-making of when a woman should get married. Thus, we believe that plow-positive and plow-negative environments could serve as valid instruments. Note that we cannot run this model with fixed effects since our invariant instrument variables would be omitted from the analysis. We therefore estimate a random effects model, but include continent dummies as additional control to proxy geographical fixed effects.

[18] The line or argument is supported by Gimbutas (2007) who finds that prior to the invention of the plow, societies tended to be matriarchal and more equal. Hodder (2005) argues similarly.

[19] This relationship can be evidenced still today, as plow usage and female age of marriage are positively correlated in our current sample ($r = 0.30$).

Table 5: Panel for level of female education using alternative instruments

Instrument employed	*Average of 5 neighboring countries*				*Plow-environment*			
Panel A: Spousal Age Gap (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980-2010 Dependent variable =	Female Secondary Schooling Completion		Average Female Years Tertiary Education		Female Secondary Schooling Completion		Average Female Years Tertiary Education	
Number of countries	86	81	86	81	86	81	86	81
Observations	258	243	258	243	258	243	258	243
Spousal Age Gap	-6.79	7.77	-0.15	-0.10	-7.76	-0.19	-0.17	-0.12
	(1.03)***	(11.37)	(0.02)***	(0.16)	(1.77)***	(0.29)	(0.04)***	(0.05)**
Additional Controls	no	yes	no	yes	no	yes	no	yes
Fixed Effects	no	yes	no	yes	no	no	no	no
First stage F-test statistics	161.20	2.02	161.20	2.02	25.43	5.98	25.43	5.98
R-squared	0.20	0.32	0.26	0.33	0.20	0.49	0.26	0.51
Panel B: Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980-2010 Dependent variable =	Secondary Schooling Completion Ratio		Average Years Tertiary Education Ratio		Secondary Schooling Completion Ratio		Average Years Tertiary Education Ratio	
Number of countries	86	81	86	81	86	81	86	81
Observations	258	243	258	243	258	243	258	243
Spousal Age Gap Ratio	11.85	20.64	20.73	200.37	5.66	2.47	6.61	-1.49
	(3.64)***	(36.03)	(5.81)***	(1558.84)	(1.90)***	(2.83)	(2.13)***	(7.51)
Additional Controls	no	yes	no	yes	no	yes	no	yes
Fixed effects	no	yes	no	yes	no	no	no	no
First stage F-test statistics	17.03	0.44	17.03	0.44	29.02	5.77	29.02	5.77
R-squared	0.21	0.01	0.25	0.01	0.20	0.54	0.24	0.30

Notes: The dependent variable in panel A, column (1)-(2) and (5)-(6) is the percentage of the female population with a completed secondary education. Columns (3)-(4) and (7)-(8) in panel A estimate the average years of female tertiary schooling. The dependent variable in Panel B column (1)-(2) and (5)-(6) is the ratio of the male over female population share with a completed secondary education. Columns (3)-(4) and (7)-(8) in panel B estimate the ratio of the male over female average years of tertiary schooling. The Spousal Age Gap is the *Male* minus *Female Marriage Age* and the Spousal Age Gap Ratio the *Male* over *Female Marriage Age*. Additional Controls are i) the total fertility rate; (ii) the level of urbanization in percent; (iii) the share of muslim population per country; (iv)-(vi) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (vii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (viii) dummy whether the country's legal origin is based on French system; (ix) the percentage of females in the national labor force; (x) the log of per capita GDP in PPP terms; and (xi) six continent dummies for columns (6) and (8). Columns (1)-(4) use as instrument the average of the spousal age gap, respectively the spousal age gap ratio, of five neighboring countries; columns (5)-(8) use as instrument plow-positive and plow-negative environment (Alesina et al., 2013). See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Table 5 summarizes the empirical results for spousal age gap effects on female education, when the former is instrumented with our two alternative variables presented. Coefficients closely correspond to the preferred instrument as used in tables 3 and 4, but the estimates are comparatively less precise. Given the known strength of our other control variables for impacting female education, full robustness is difficult to achieve when employing this relatively weaker instrument and including all covariates. Overall, the additional IV results using our alternative instruments are nonetheless economically meaningful. In particular, the sign of coefficients is as expected in 14 out of 16 cases (negative for spousal age gaps, and positive for spousal age gap ratio), suggesting that spousal age gaps causally and negatively affect female education.

Alternative measures for educational gender inequality

We introduce additional outcome variables designed to explicitly measure educational gender inequality. We adopt the gender parity in literacy (GPI) index by UNESCO (2013). Literacy rates also serves as category of human capital beyond formal educational attainment

measures. The latter are criticized for ignoring human capital accumulated outside schooling (Barro and Lee, 2013). As this variable is not available for our panel data, we move to a cross-section analysis, taking the latest time interval averaging the years 2000-2010. We also look at primary schooling completion rates of boys relative to girls. So far we analyzed secondary and tertiary schooling, since this is when we would expect marriage decisions to interfere most. Put differently, we would expect boys and girls to plan primary schooling independent of anticipated marriage age so that its explanatory power should be low in this case.

Table 6 lists the results for the GPI, respectively primary schooling outcome variable, where OLS, IV, and the quasi diff-in-diff method are each summarized in panels A through C. For the GPI we adopt the UNESCO coding, which calculates this variable as female over male literacy rates and is inverse to the ratios of primary schooling in columns (4) to (6) (and likewise inverse to the secondary and tertiary schooling ratios we analyzed before). Therefore, we would expect a negative sign for the GPI, as a relatively younger women (i.e. a larger spousal age gap variable) should reduce literacy equality by lowering the numerator. The findings indicate indeed clear evidence for the negative impact of spousal age gaps on gender parity in literacy. Coefficients are always significant at the one percent level, and also large in absolute terms. The estimates suggest for example that one additional year between husband and wife has a larger effect on equal literacy levels between men and women than an increase in income levels by one log unit. In the IV specification with full controls, an increase of the spousal age gap by one year leads to a reduction of the gender parity in literacy by ten percentage points – roughly the difference between Iran and Italy. Lastly, also the spousal age gap ratio is highly significant and negative. This means that a one unit change in the spousal age gap ratio causes a roughly two times inverse effect on the female-to-male literacy ratio.

Marriage age effects on the pure attainment measure of primary schooling are mixed and not robust which is actually in line with our expectations: primary schooling is basic education and not yet systematically influenced by marriage decisions. The findings also indicate that primary schooling does not fully explain differences in literacy rates as measure by the GPI. This suggests that more time is required, i.e. enrollment into secondary schooling, to reach proper literacy. We have documented earlier that marriage age does affect female secondary schooling.

Table 6: Cross-section for Alternative Education Outcome Variables

2000s

Dependent variable =	Gender Parity in Literacy (GPI)			Primary Schooling Completion Ratio		
Panel A: Spousal Age Gap (OLS)	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	135	129	111	133	131	119
Spousal Age Gap	-0.08	-0.02	-0.03	0.44	0.07	-0.04
	(0.01)***	(0.01)***	(0.01)***	(0.17)***	(0.26)	(0.04)
Fertility		-0.06	-0.05		0.97	0.17
		(0.01)***	(0.01)***		(0.27)***	(0.04)
Urbanization		0.01	0.01		0.01	-0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Share of Muslim population		-0.07	-0.04		-0.18	0.29
		(0.03)**	(0.04)		(0.93)	(0.15)*
Sex ratio at birth		-0.74	-0.57		5.95	1.54
		(0.42)*	(0.48)		(13.68)	(1.87)
Sex ratio under 5 mortality		-0.87	-0.22		-7.23	-0.29
		(0.46)*	(0.59)		(10.99)	(1.65)
Sex ratio under 15 mortality		0.85	0.26		8.36	0.44
		(0.46)*	(0.60)		(11.07)	(1.65)
Cum. pop. married at 40		0.21	0.39		0.07	-0.88
		(0.23)	(0.31)		(7.33)	(0.99)
French Legal Origin		-0.04	-0.03		0.82	0.08
		(0.02)**	(0.02)		(0.57)	(0.08)
Female Labor Force Participation			0.01			-0.01
			(0.01)			(0.01)
Log GDP per Capita			0.03			0.02
			(0.02)			(0.06)
Continent dummies	no	yes	yes	no	yes	yes
R-squared	0.43	0.68	0.65	0.04	0.10	0.32
Panel B: Spousal Age Gap (IV)	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	109	106	96	114	113	103
Spousal Age Gap	-0.12	-0.11	-0.10	0.27	-1.76	-0.02
	(0.01)***	(0.04)***	(0.03)***	(0.27)	(0.93)*	(0.07)
Fertility		-0.02	-0.03		1.54	0.12
		(0.02)	(0.02)*		(0.43)***	(0.04)***
Urbanization		-0.01	-0.01		-0.04	-0.01
		(0.01)	(0.01)		(0.03)	(0.01)
Share of Muslim population		0.11	-0.10		2.54	0.22
		(0.08)	(0.07)		(1.86)	(0.16)
Sex ratio at birth		-0.19	0.03		28.57	2.39
		(0.64)	(0.62)		(18.85)	(1.67)
Sex ratio under 5 mortality		-1.23	-0.25		-1.20	0.45
		(0.66)*	(0.80)		(14.58)	(1.62)
Sex ratio under 15 mortality		1.41	0.41		3.70	-0.32
		(0.67)**	(0.78)		(14.52)	(1.59)
Cum. pop. married at 40		-0.54	-0.22		-11.67	-0.53
		(0.53)	(0.46)		(11.75)	(1.02)
French Legal Origin		-0.06	-0.04		1.35	0.09
		(0.03)	(0.03)		(0.74)*	(0.07)
Female Labor Force Participation			0.01			0.01
			(0.01)			(0.01)
Log GDP per Capita			0.03			0.01
			(0.02)			(0.05)
Continent dummies	no	yes	yes	no	yes	yes
First stage F-test statistics	101.94	10.88	15.98	111.40	14.04	19.96
R-squared	0.35	0.52	0.58	0.04	0.01	0.41
Panel C: Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	109	106	96	132	130	118
Spousal Age Gap Ratio	-2.05	-1.90	-1.59	3.28	-51.46	-4.02
	(0.21)***	(0.68)***	(0.48)***	(4.30)	(24.87)**	(1.83)**
Fertility		-0.01	-0.03		2.08	0.22
		(0.02)	(0.02)*		(0.64)***	(0.05)***
Urbanization		-0.01	-0.01		-0.05	-0.01
		(0.01)	(0.01)		(0.03)	(0.01)
Share of Muslim population		0.01	0.01		3.49	0.48
		(0.06)	(0.05)		(2.09)*	(0.19)***
Sex ratio at birth		0.10	0.04		39.49	3.43
		(0.64)	(0.56)		(24.18)*	(2.18)
Sex ratio under 5 mortality		-0.42	0.41		8.43	1.07
		(0.60)	(0.67)		(16.60)	(1.86)
Sex ratio under 15 mortality		0.43	-0.36		-6.17	-0.92
		(0.60)	(0.67)		(16.48)	(1.86)
Cum. pop. married at 40		-0.01	0.27		-17.15	-1.63
		(0.30)	(0.34)		(12.71)	(1.12)
French Legal Origin		-0.04	-0.02		1.15	0.10
		(0.03)	(0.03)		(0.80)	(0.08)
Female Labor Force Participation			0.01			-0.01
			(0.01)			(0.01)
Log GDP per Capita			0.01			-0.01
			(0.02)			(0.06)
Continent dummies	no	yes	yes	no	yes	yes
First stage F-test statistics	89.34	9.54	18.86	106.78	7.94	16.82
R-squared	0.39	0.51	0.60	0.04	0.01	0.25

Notes: The dependent variable in columns (1)-(3) is the Gender Parity in Literacy Index (GPI), and in (4)-(6) the ratio of male over female primary schooling completion rates. The regressors are: (i) Spousal Age Gap (*Male* minus *Female Marriage Age*), respectively Spousal Age Gap Ratio (*Male* over *Female Marriage Age*), ; (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v)-(vii) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of tota female population); (ix) dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. Panels B and C use as instrument the weighted average of the spousal age gap (ratio) of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. ***, ** and * denote statistical significance at the 1, 5 and 10% level.

Additional Controls and Test on Unobservables

We aim to find out whether effects remain robust if we include a set of additional controls, in particular gender discrimination variables. These, however, are not available for the entire timeframe of our panel so that data restrictions also suggest a cross-section, averaging the years 2000-2010. We summarize in table 7 the estimates from our IV and quasi diff-in-diff specification, extended by a comprehensive list of covariates which have been proposed in the literature for gender discrimination in education (Cohen and Soto, 2007; Ross, 2008; Barro and Lee, 2013). The objective is to check whether the effect of spousal age gaps can in fact be closely replicated by employing commonly used variables of gender discrimination.

First we add as variable the legal minimum marriage age for women. It might be that our proposed causal relationship is biased from legal restrictions on marriage age which are different for each country. This could be particularly relevant towards the later stages of education when minimum marriage age laws potentially act as additional barrier against marring young and quitting education. The empirical results cannot support such a hypothesis. However, the fact that the inclusion of this control does not render the spousal age gap ratio insignificant strengthens the main results of this paper. There is additional potential for educational gender equality through mitigating spousal age gaps, on top of what current marriage age legislation already attempts to mitigate.

We then consider the Gender Inequality Index (UNDP, 2013) which measures gender inequality along three dimensions and reaches values of zero for total equality. This also leaves our core relationship between spousal age gaps and educational inequality unaffected. A further gender discrimination variable tested deviates from an aggregate index perspective. We control for the percentage of agreement among females to a question from the 2014 Gallup World Poll[20]. Women are asked whether they "believe that women in this country are treated with respect and dignity". This survey variable on gender equality sentiment per country represents a different perspective on discrimination than aggregate indices. Nonetheless, our results remain robust to the inclusion of this variable as well.

[20] We take the values from the dataset comprising the 2014 Social Progress Index (Porter et al., 2014).

Table 7: Cross-section for educational gender inequality with discrimination controls

2000s																							
Dependent variable =	Secondary Schooling Completion Ratio								Average Years Tertiary Education Ratio								Gender Parity in Literacy (GPI)							
Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Number of countries	118	113	113	105	105	105	105	90	118	113	113	105	105	105	105	90	110	103	101	93	99	99	99	75
Spousal Age Gap Ratio	4.30	3.44	4.29	5.02	4.34	4.37	4.29	4.60	10.44	10.28	10.67	12.15	10.65	10.93	10.80	14.91	-1.59	-1.46	-1.69	-1.69	-1.54	-1.60	-1.55	-1.40
	(2.16)**	(2.02)*	(2.27)**	(2.27)**	(2.24)**	(2.27)**	(2.22)**	(2.36)**	(5.11)**	(5.24)**	(5.34)**	(5.38)**	(5.09)**	(5.22)**	(5.12)**	(6.54)**	(0.61)***	(0.66)**	(0.80)**	(0.71)**	(0.60)***	(0.63)***	(0.61)***	(0.94)
Minimum Legal Marriage Age for Women		-0.04						-0.02		0.11						0.25		0.01						0.01
		(0.03)						(0.04)		(0.07)						(0.10)***		(0.01)						(0.01)
Gender Inequality Index (GII)			0.26					0.51			-1.23					-1.68			0.01					-0.13
			(0.50)					(0.83)			(1.03)					(1.77)			(0.17)					(0.27)
Women Treated with Respect				-0.01				-0.01				0.01				0.01				-0.01				0.01
				(0.01)				(0.01)				(0.01)				(0.01)				(0.01)				(0.01)
Women's economic rights					0.04			-0.15					0.27			0.04					-0.03			-0.01
					(0.10)			(0.17)					(0.19)			(0.42)					(0.04)			80.07)
Women's political rights						0.11		0.24						0.20		0.21						-0.02		-0.09
						(0.07)		(0.13)*						(0.13)		(0.23)						(0.03)		(0.05)*
Women's social rights							0.06	0.13							0.10	0.01							-0.02	-0.03
							(0.08)	(0.15)							(0.15)	(0.31)							(0.02)	(0.05)
Additional Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
First stage F-test statistics	10.73	10.98	9.39	9.73	10.68	10.23	10.50	6.90	10.73	10.98	9.39	9.73	10.68	10.23	10.50	6.90	16.45	13.50	9.49	12.79	15.75	14.03	12.88	5.26
R-squared	0.24	0.34	0.25	0.16	0.24	0.24	0.25	0.28	0.29	0.30	0.25	0.10	0.27	0.25	0.25	0.04	0.60	0.63	0.57	0.60	0.61	0.60	0.61	0.67

Notes: The dependent variable in column (1)-(8) is the ratio of the male over female population share with a completed secondary education. Columns (9)-(16) estimate the ratio of the male over female average years of tertiary schooling, and columns (17) - (24) estimate the Gender Parity in Literacy Index (GPI). The regressors are: (i) The Spousal Age Gap (*Male* minus *Female Marriage Age*); (ii) the minimum legal age of marriage for women without parental consent, taken from the United Nations Statistics Division ; (iii) the Gender Inequality Index from the United Nations Development Programme (UNDP); (iv) the percentage of female respondents answering yes to the question, "Do you believe that women in this country are treated with respect and dignity, or not?", and taken from Gallup World Poll; (v)-(vii) three female discrimination measures as taken from the CIRI Human Rights Data Project; (viii) is a vector of additional controls: the total fertility rate; the level of urbanization in percent; the share of muslim population per country; the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); dummy whether the country's legal origin is based on French system; the percentage of females in the national labor force; the log of per capita GDP in PPP terms; six continent dummies.Spousal Age Gap Ratio is instrumented by the weighted average of the spousal age gap ratio of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Finally, we test three control variables for female discrimination as measured through the Cingranelli-Richards (CIRI) Human Rights Dataset. These have no material impact on our variable of interest. Even when all discrimination variables are included simultaneously (specifications 8, 16, and 24), our core relationship remains very stable, and significant in two out of three cases. However, in those specifications we note serious finite sample bias as reflected in low first stage F-values. Overall, results remain robust, and the coefficients for secondary and tertiary education are also in line with the panel estimates presented earlier (table 4, panel B).

The robustness is examined along a further dimension, namely potential endogeneity arising from omitted variable bias. Following Oster (2014), we run a test which exploits the variation of the coefficient β_1 of our key variable of interest (spousal age gap ratio) when including observed control variables in the regression. The objective is to minimize potential omitted variable bias. The method by Oster suggests that if the inclusion of observed covariates increases the explanatory power (R-squared) of the model substantially, but changes β_1 only marginally, then potential unobserved variables should not much affect the coefficient either, since the included controls capture already what the researcher considered as most relevant for a potential bias. This allows to determine the so-called identified set, which we calculate under the most conservative assumptions of equal selection between observed and unobserved controls ($\tilde{\delta} = 1$) and a maximum potential value for R-squared (Rmax = 1). If this set excludes zero, we may conclude that results are robust to potential omitted variable bias. We run the analysis for the cross-section of the 2000s.

Results, presented in table 8, are reassuring for all three outcome variables. The identified set remains fully robust, as zero is excluded for all three specifications. We conclude that effects of unobserved controls are highly unlikely to have a sizeable impact on the observed effect of spousal age gaps on gender inequality in secondary schooling, tertiary education, and adult literacy.

Table 8: Oster (2014) tests: Potential bias from unobservables in cross-section

Dependent variable =	Secondary Schooling Completion Ratio	Average Years Tertiary Education Ratio	GPI Adult Literacy
Uncontrolled $\dot{\beta}_1$	2.848	8.462	-2.054
Controlled $\tilde{\beta}_1$	4.297	10.439	-1.588
Uncontrolled $\dot{R}^2$	0.078	0.277	0.391
Controlled $\widetilde{R^2}$	0.244	0.288	0.604
Identified set [$\tilde{\beta}_1$, β_1*']	[4.297, 10.934]	[10.439, 138.404]	[-1.588, -0.72019]
Zero excluded from identified set?	yes	yes	yes

Notes: This procedure of assessing potential bias from unobserved variables by looking at movements in coefficients for spousal age gap, and the R-squared when including observed covariates has been developed by Oster (2014). It is based on previous work by Altonji et al. (2005, 2008). The uncontrolled $\dot{\beta}_1$ is calculated without including any additional controls except spousal age gap, while the controlled $\tilde{\beta}_1$ for the panel can be found in columns (3) and (6) of table 6; the controlled $\tilde{\beta}_1$ for the cross-section (2000s) employs all regular control variables of table 7 (columns (1), (9), and (17)). β_1*´ is calculated with an assumed value of $\tilde{\delta}$ = 1, and Rmax = 1.

Generational Effects of Marriage Age

Based on an intra-generational perspective, we have previously argued that societal expectations at a given period regarding the "ideal timing" for marriage act as underlying mechanism. Now we want to investigate whether there might be an alternative channel to current societal expectations, namely the traditional legacy of parental marriage age. This would imply intergenerational effects from spousal age gaps on education which we could not capture thus far. In that line of thought, the hypothesis here tests whether the age gap between husband and wife also affects their children's education by disadvantaging the daughters. This is because in addition to current societal expectations, female children would be expected to time their marriage also based on the parents' tradition, so that returns from educational investments in girls would depend on that factor as well. This would ultimately suggest that children's education is partly pre-determined by the spousal age gap of their parents.

For our inter-generational extension, individual-level data which would directly link the spousal age gap of the actual parents to their daughters' education levels are not available. We have to resort to a 20-year lag of the average national spousal age gap ratio as explanatory variable, which proxies a one generation timeframe. We then measure effects on female education levels, keeping our regular instrumentation specification in addition to the built-in time lag. Data availability for marriage age allows to estimate this specification only for education levels in the 2000s, using parental marriage age data from the 1980s.

Results are given in table 9. The estimates indicate a clearly significant robust effect from the parental generation marriage age pattern to current educational gender inequality. Doubling

the age gap between "mother and father" is associated with a three times higher inequality between "son and daughter" in secondary schooling, and even ten times higher inequality in tertiary education; literacy inequality would be increased by a factor of 1.2. The figures confirm findings by Sekhri and Debnath (2014) on the role of parental marriage age for children's education, but we add the perspective that parental marriage age also impacts educational equality between boys and girls. In summary, spousal age gaps do not only affect the education within a generation, but also potentially impact educational gender equality of the children's generation[21].

Table 9: Cross-section for educational gender inequality effects from parental generation

2000s	Secondary Schooling		Average Years Tertiary		Gender Parity in Literacy	
Dependent variable =	Completion Ratio		Education Ratio		(GPI)	
Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	87	79	87	79	76	68
Spousal Age Gap Ratio Parental Generation	4.22	2.98	6.69	9.78	-1.60	-1.21
	(1.12)***	(1.60)*	(1.67)***	(4.43)**	(0.17)***	(0.68)*
Additional Controls	no	yes	no	yes	no	yes
First stage F-test statistics	88.98	16.86	88.98	16.86	98.44	11.04
R-squared	0.01	0.37	0.20	0.09	0.54	0.72

Notes: The dependent variable in column (1)-(2) is the ratio of the male over female population share with a completed secondary education. Columns (3)-(4) estimate the ratio of the male over female average years of tertiary schooling, and columns (5) - (6) estimate the Gender Parity in Literacy Index (GPI). The regressors are: (i) The Spousal Age Gap ratio (*Male* over *Female Marriage Age*), and Additional Controls: (ii) the minimum legal age of marriage for women without parental consent, taken from the United Nations Statistics Division ; (iii) the Gender Inequality Index from the United Nations Development Programme (UNDP); (iv) the percentage of female respondents answering yes to the question, "Do you believe that women in this country are treated with respect and dignity, or not?", and taken from Gallup World Poll; (v)-(vii) three female discrimination measures as taken from the CIRI Human Rights Data Project; (viii) is a vector of additional controls: the total fertility rate; the level of urbanization in percent; the share of muslim population per country; the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); dummy whether the country's legal origin is based on French system; the percentage of females in the national labor force; the log of per capita GDP in PPP terms; six continent dummies.Spousal Age Gap Ratio is instrumented by the weighted average of the spousal age gap ratio of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Marriage Age Effects on Further Aspects of Gender Inequality

Finally, in table 10, we investigate whether spousal age gaps affect further spheres of gender inequality. We first re-visit educational gender inequality and address the notion that measurement issues of human capital focusing on school attainment are increasingly regarded critically (Hanushek, 2015). The quality of education has been proposed as another important and complementary variable to quantitative enrollment rates, as it measures the effectiveness of accumulating human capital (Castelló-Climent and Hidalgo-Cabrillana, 2012; Hanushek and Woessmann, 2009)[22]. We hence employ the PISA 2006 data set for our latest time interval as

[21] We also ran an alternative specification using ten year lags of spousal age gaps. Here, effects are similar. In general, previous spousal age gaps predict spousal age gaps for the next decade highly significantly, but with a coefficient of ca. 0.6, so direct effects decrease in absolute terms over time.

[22] Barro and Lee (2013) note that educational attainment and human capital quality measures show high correlation, but still the latter appears more diverse for countries with similar levels of educational

alternative outcome variable. We then attempt to estimate the ratio of national test scores of boys over girls. Results suggest that there is no robust relationship between test scores and spousal age gaps. Thus, spousal age gaps are an important determinant for how long a young female attends schooling in the first place. Once this tollgate of gender discrimination has been passed, there is no empirical evidence that the subsequent quality of education received should differ between genders depending on the marriage age. Admittedly though, the sample size is limited, and results may show selection bias since the test scores are only collected for girls who could enroll to school, i.e. girls who suffered less from educational gender inequality in the first place.

For our remaining two outcome variables that measure further aspects of gender inequality and female discrimination, we find strong and robust effects. Spousal age gaps are associated with a significant increase in teenage pregnancies that is also large in absolute size and robust to fertility levels in a country. Similarly, larger husband-wife age gaps decrease female participation in politics as measured through the proportion of seats in parliament. Based on this additional evidence of spousal age gaps affecting gender inequality we are confident that the core argument of this paper – the causal link from marriage age to educational gender inequality – is no accidental empirical finding, but part of a broader robust pattern.

Table 10: Further gender inequality effects from spousal age gaps

2000s	Quality of Schooling (PISA scores) male relative to female		Adolescent births		Women in Politics	
Dependent variable =						
Spousal Age Gap Ratio (IV)	(1)	(2)	(3)	(4)	(5)	(6)
Number of countries	49	48	150	133	139	120
Spousal Age Gap Ratio	-0.33	-0.07	474.15	228.38	-56.39	-54.28
	(0.15)**	(0.31)	(42.52)***	(79.63)***	(12.99)***	(27.04)**
Additional Controls	no	yes	no	yes	no	yes
First stage F-test statistics	36.06	8.69	69.68	22.39	80.16	24.20
R-squared	0.01	0.54	0.51	0.84	0.07	0.36

Notes: The dependent variable in column (1)-(2) is the ratio of the male over female student performance on the science scale for the PISA test 2006. Columns (3)-(4) estimate the number of births to women with age 15–19 per 1,000 women with age 15–19. Columns (5)-(6) are the proportion of seats in parliament held by women, measured in 2000. The variable ranges from 0 to 100. The regressors are: (i) The Spousal Age Gap ratio (*Male* over *Female Marriage Age*), and Additional Controls: (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v)-(vii) the sex ratio at birth (males over females), and the mortality rate of boys over the mortality rate of girls under 5, and under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (ix) dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. Spousal Age Gap Ratio is instrumented by the weighted average of the spousal age gap ratio of adjoining countries with a common border, where weights are according to relative length of shared border. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

attainment. Guiso et al. (2008) explicitly relate the achievement gap between boys and girls in PISA text exams with indicators of a gender-equal culture. However, Fryer and Levitt (2010) show that results are not robust to including a group of Middle Eastern countries.

VI. Concluding Remarks

Bridging the gender gap in education is a key challenge in the world, as women on average still receive less schooling than men, which affects their livelihoods as well as the growth prospects of a country. Equal opportunities for women and economic development are closely interrelated, but the interrelationships are often too weak to be self-sustaining so that public policies are needed (Duflo, 2012). One specific societal aspect that falls under potential policy intervention relates to the minimum marriage age. Entering marriage early as a girl or young woman is widely associated with a lack of gender equality.

This paper investigates how marriage age influences female education and educational gender inequality. Specifically, we answer the question whether getting married younger as a woman, both in absolute perspective and in comparison to the husband's age, leads to worse female education. Since marriage is usually the first and often the only socially accepted institution for conceiving children, the anticipated marriage age also proxies the expected age of first birth for women. Hence, the earlier a woman on average expects to get married, the shorter will be her anticipated pay-off to educational investments. Acting rationally, that investment will be adjusted downwards already ex ante, so that in essence lower female marriage age leads to lower female education.

We proceed to empirically support our hypothesis by estimating marriage age effects on various measures of female education. Specifically, we apply a global cross-country panel data set from 1980-2010, in which we instrument the domestic female marriage age with an average of the marriage age in adjacent countries weighted by shared land border. The absolute female age at marriage has indeed a highly significant effect on female education: In our preferred specification, each year of marriage postponement for women leads to a three percentage points higher female completion rate in secondary schooling, and to about three weeks longer female tertiary education. We then move to examining spousal age gap effects, i.e. female relative to male marriage age, with similarly robust effects in our panel. Each additional year between husband and wife lowers the female secondary schooling completion rate by 14 percentage points, and cuts the time women spend at university by six weeks. Finally, quasi diff-in-diff specifications indicate that spousal age gaps affect female education significantly more negatively than male education. Numerous robustness checks confirm our findings on spousal age gaps.

We then move to a cross-section for refinement analyses. Estimates suggest that gender parity in literacy is strongly affected by spousal age gaps, but pure primary schooling

attainment is not. Moreover, the marriage pattern of the parental generation also influences the children's educational gender inequality. Importantly, we document that marriage age and conventional measures of gender discrimination do not act as substitutes.

Building up human capital through sufficient education is a key mechanism to empower women. In addition to compulsory schooling laws, our results suggest that governments have the regulation of minimum marriage age at their disposal to influence how much schooling young females receive. A lower barrier for marriage age in our framework would set a minimum threshold of "guaranteed" pay-off to educational investments, since a drop-out of women out of the labor market due to first birth is not expected beforehand. We recognize that our macro-perspective does not allow to account for individual differences in skills and ability, which may make further education unsuitable independent of marriage plans. Furthermore, there are of course more dimensions than human capital where gender equality is critical, such as access to markets and decision-making power within the household, political empowerment, health, and many more. But with the documented gender-specific negative impact of a young female marriage age on female education, the case for a more rigorous enforcement of minimum marriage age laws around the world appears to be justified.

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APPENDIX

(NOT INTENDED FOR PUBLICATION)

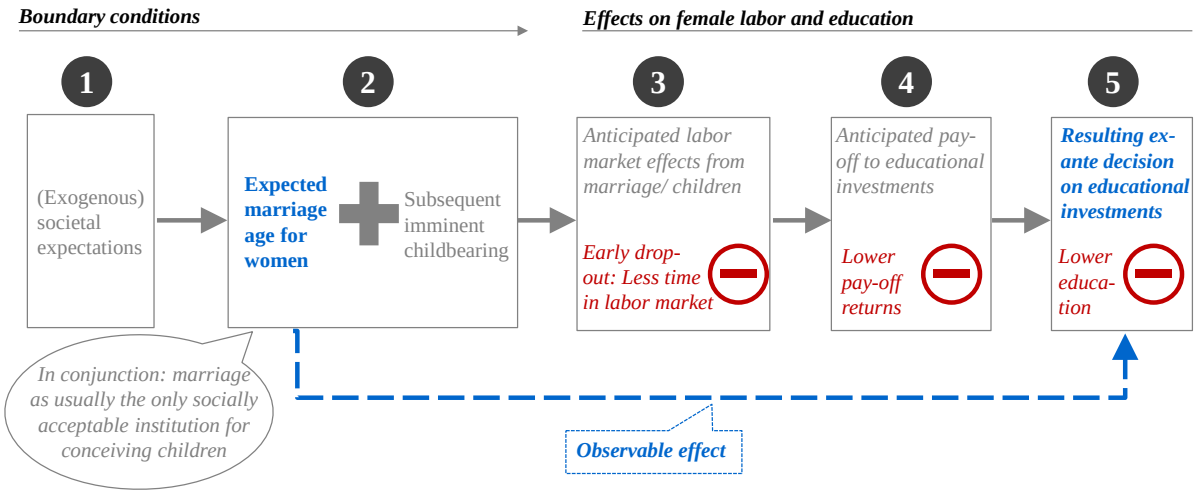

Figure 1: Conceptual framework for female marriage age effects on female education

Table 11: Hausman Test

1980-2010 (OLS)								
Dependent variable =	Female Secondary Schooling Completion				Average Female Years Tertiary Education			
	Fixed	Random	Difference	St. Error	Fixed	Random	Difference	St. Error
Female Marriage Age	1.1477	0.8334	0.3143	0.2322	0.0238	0.0230	0.0008	0.0029
Fertility	-3.5572	-3.3160	-0.2412	0.7745	0.0132	0.0136	-0.0004	0.0105
Urbanization	-0.0043	0.0268	-0.0311	0.1438	0.0023	0.0024	-0.0001	0.0021
Share of Muslim population	46.0170	2.4950	43.5220	18.3068	0.0924	0.0266	0.0659	0.2853
Sex ratio at birth	-4.4022	-6.9957	2.5935	2.0934	-0.0861	-0.0879	0.0018	<0.0001
Sex ratio under 5 mortality	-18.0639	-13.2141	-4.8498	25.3503	-2.2736	-1.7060	-0.5676	0.3036
Sex ratio under 15 mortality	3.3904	3.6200	-0.2300	29.9149	2.0977	1.3733	0.7244	0.3811
Cum. pop. married at 40	-17.0570	-30.9666	13.9097	14.4322	-1.0577	-1.2918	0.2341	0.1691
French Legal Origin	*n/a (omitted because of collinearity)*							
Female Labor Force Participation	-0.0798	0.0375	-0.1173	0.0617	0.0031	0.0042	-0.0011	0.0008
Log GDP per Capita	5.9773	1.9485	4.0288	1.6563	0.1564	0.0827	0.0737	0.0220
Chi-Square (p-value)	26.50 (0.003)				57.12 (<0.001)			

Table 12: First stage of panel for level of female education, absolute and relative

1980-2010 (IV First Stage)								
Dependent variable =	Female Marriage Age (Panel A)				Spousal Age Gap (Panel C)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of countries	71	70	66	66	71	70	66	66
Observations	213	210	198	198	213	210	198	198
Female Marriage Age of Bordering Countries	0.79	0.51	0.46	0.42				
	(0.05)***	(0.07)***	(0.07)***	(0.10)***				
Spousal Age Gap of Bordering Countries					-0.25	-0.15	-0.13	0.01
					(0.03)***	(0.03)***	(0.03)***	(0.03)
Fertility		-0.28	-0.29	-0.42		0.09	0.02	0.19
		(0.16)*	(0.17)*	(0.26)*		(0.07)	(0.08)	(0.09)**
Urbanization		0.04	0.02	0.01		-0.02	-0.02	-0.01
		(0.01)***	(0.02)	(0.04)		(0.01)***	(0.01)***	(0.01)
Share of Muslim population		-0.28	-0.21	-4.05		1.26	0.94	6.69
		(0.79)	(0.90)	(4.14)		(0.25)***	(0.28)***	(1.41)***
Sex ratio at birth		-4.91	1.17	-4.84		1.65	-4.21	-4.89
		(11.95)	(12.35)	(19.57)		(4.65)	(4.78)	(6.64)
Sex ratio under 5 mortality		-19.71	-16.25	-17.84		-2.03	-0.40	-0.41
		(7.36)***	(7.61)**	(9.80)*		(3.25)	(3.40)	(3.32)
Sex ratio under 15 mortality		22.39	18.86	23.24		3.91	2.35	-1.28
		(7.75)***	(8.00)**	(10.73)**		(3.36)	(3.49)	(3.64)
Cum. pop. married at 40		-10.22	-13.04	-15.74		-7.18	-6.56	3.76
		(4.69)**	(4.74)***	(6.39)**		(2.14)***	(2.16)***	(2.17)
French Legal Origin		-0.54	-0.48			0.56	0.45	
		(0.47)	(0.50)			(0.14)***	(0.15)***	
Female Labor Force Participation			-0.01	-0.01			-0.01	0.01
			(0.01)	(0.02)			(0.01)	(0.01)
Log GDP per Capita			0.84	0.79			-0.06	0.11
			(0.33)***	(0.53)			(0.13)	(0.18)
Continent dummies	no	yes	yes	no	no	yes	yes	no
Fixed effects	no	no	no	yes	no	no	no	yes
F-test	274.96	52.93	41.05	19.07	76.06	19.68	15.54	8.91
Angrist-Pischke F-statistics (p-value)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.64
Anderson LM test (p-value)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.64
Cragg-Donald Wald F statistic	274.96	52.93	41.05	19.07	76.06	19.68	15.54	8.91
Stock-Yogo critical values 10%					16.38			
Stock-Yogo critical values 25%					5.53			
R-squared	0.57	0.64	0.66	0.60	0.27	0.69	0.68	0.24

Notes: The dependent variable in column (1)-(4) is the *Female Marriage Age*. Columns (5)-(8) estimate the Spousal Age Gap (*Male* minus *Female Marriage Age*). The regressors are: (i) The weighted average of the *Female Marriage Age* of adjoining countries with a common border, where weights are according to relative length of shared border; (ii) the weighted average of the Spousal Age Gap of adjoining countries with a common border, where weights are according to relative length of shared border; (iii) the total fertility rate; (iv) the level of urbanization in percent; (v) the share of muslim population per country; (vi) the sex ratio at birth (males over females); (vii) the mortality rate of boys over the mortality rate of girls under 5, and (viii) under 15 years, respectively; (ix) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (x) a dummy whether the country's legal origin is based on French system; (xi) the percentage of females in the national labor force; (xii) the log of per capita GDP in PPP terms; (xiii) six continent dummies. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Table 13: First stage of panel for relative male-to-female education levels (ratio)

1980-2010 (IV First Stage) Dependent variable =	Spousal Age Gap Ratio (Panel B)			
	(1)	(2)	(3)	(4)
Number of countries	71	70	66	66
Observations	213	210	198	198
Spousal Age Gap Ratio of Bordering Countries	0.84	0.54	0.50	-0.06
	(0.06)***	(0.07)***	(0.07)***	(0.13)
Fertility		0.01	-0.01	0.02
		(0.01)	(0.01)	(0.01)***
Urbanization		-0.01	-0.01	-0.01
		(0.001)***	(0.001)***	(0.01)
Share of Muslim population		0.06	0.04	0.32
		(0.01)***	(0.02)***	(0.08)***
Sex ratio at birth		-0.06	-0.40	-0.27
		(0.25)	(0.25)	(0.40)
Sex ratio under 5 mortality		0.16	0.16	0.09
		(0.16)	(0.17)	(0.19)
Sex ratio under 15 mortality		-0.11	-0.09	-0.21
		(0.17)	(0.17)	80.21)
Cum. pop. married at 40		-0.20	-0.12	0.30
		(0.11)	(0.11)	(0.12)**
French Legal Origin		0.02	0.02	
		(0.01)***	(0.01)**	
Female Labor Force Participation			-0.01	0.01
			(0.01)	(0.01)
Log GDP per Capita			-0.01	0.01
			(0.01)	(0.01)
Continent dummies	no	yes	yes	no
Fixed effects	no	no	no	yes
F-test	216.92	54.75	48.60	5.18
Angrist-Pischke F-statistics (p-value)	<0.001	<0.001	<0.001	0.61
Anderson LM test (p-value)	<0.001	<0.001	<0.001	0.61
Cragg-Donald Wald F statistic	216.92	54.75	48.60	5.18
Stock-Yogo critical values 10%			16.38	
Stock-Yogo critical values 25%			5.53	
R-squared	0.52	0.75	0.74	0.28

Notes: The dependent variable is the Spousal Age Gap Ratio (*Male* over *Female Marriage Age*). The regressors are: (i) The weighted average of the Spousal Age Gap Ratio of adjoining countries with a common border, where weights are according to relative length of shared border; (ii) the total fertility rate; (iii) the level of urbanization in percent; (iv) the share of muslim population per country; (v) the sex ratio at birth (males over females); (vi) the mortality rate of boys over the mortality rate of girls under 5, and (vii) under 15 years, respectively; (viii) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (ix) a dummy whether the country's legal origin is based on French system; (x) the percentage of females in the national labor force; (xi) the log of per capita GDP in PPP terms; (xii) six continent dummies. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Table 14: First stage of panel of female education using alternative instruments

1980-2010 (IV First Stage)								
Dependent variable =	Spousal Age Gap (Panel A)				Spousal Age Gap Ratio (Panel B)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of countries	86	81	86	81	86	81	86	81
Observations	258	243	258	243	258	243	258	243
Spousal Age Gap of 5 Neighboring Countries	0.81	-0.15						
	(0.06)***	(0.11)						
Spousal Age Gap Ratio of 5 Neighboring Countries					0.03	0.01		
					(0.01)***	(0.01)		
Plow-positive environment			-0.20	-0.11			-0.02	-0.01
			(0.30)	(0.24)			(0.02)	(0.01)
Plow-negative environment			2.72	1.48			0.15	0.08
			(0.49)***	(0.45)***			(0.03)***	(0.03)***
Fertility		0.14		0.09		0.01		0.01
		(0.08)*		(0.07)		(0.001)***		(0.01)***
Urbanization		-0.03		-0.01		-0.01		-0.01
		(0.01)***		(0.001)**		(0.01)*		(0.001)**
Share of Muslim population		8.03		0.81		0.36		0.05
		(1.48)***		(0.28)***		(0.07)***		(0.02)***
Sex ratio at birth		-3.97		1.87		-0.07		0.16
		(6.36)		(4.63)		(0.32)		0.26
Sex ratio under 5 mortality		4.44		4.37		0.25		0.25
		(3.00)		(2.86)		(0.16)		(0.16)
Sex ratio under 15 mortality		-6.33		-4.15		-0.35		-0.26
		(3.17)**		(2.93=		(0.17)**		(0.16)
Cum. pop. married at 40		2.68		-2.60		0.27		-0.06
		(1.85)		(1.77)		(0.10)***		(0.10)
French Legal Origin				0.25				0.01
				(0.16)				(0.01)
Female Labor Force Participation		-0.01		-0.01		0.01		-0.01
		(0.01)		(0.01)		(0.01)		(0.01)
Log GDP per Capita		0.39		-0.01		0.01		-0.01
		(0.17)		(0.12)		(0.01)		(0.01)
Continent dummies	no	yes	no	yes	no	yes	no	yes
Fixed effects	no	yes	no	no	no	yes	no	no
F-test	161.20	2.02	25.43	5.98	17.03	0.44	29.02	5.77
Sargan-Hansen statistic (p-value)			0.08	0.14			0.97	0.16
Angrist-Pischke F-statistics (p-value)	<0.001	0.14	<0.001	0.002	<0.001	0.49	<0.001	0.002
Anderson LM test (p-value)	<0.001	0.14	<0.001	0.002	<0.001	0.50	<0.001	0.003
Cragg-Donald Wald F statistic	161.20	2.02	25.43	5.98	17.03	0.44	29.02	5.77
Stock-Yogo critical values 10%	16.38	16.38	19.93	19.93	16.38	16.38	19.93	19.93
Stock-Yogo critical values 25%	5.53	5.53	7.25	7.25	5.53	5.53	7.25	7.25
R-squared	0.39	0.26	0.16	0.53	0.07	0.37	0.21	0.57

Notes: The dependent variable in column (1)-(4) is the Spousal Age Gap (*Male* minus *Female Marriage Age*). Columns (5)-(8) estimate the Spousal Age Gap Ratio (*Male* over *Female Marriage Age*). The regressors are: (i) The average of the Spousal Age Gap of five neighboring countries, respectively the (ii) the Spousal Age Gap Ratio of five neighboring countries; (iii)-(iv) plow-positive and plow-negative environment based on Alesina et al. (2013); (v) the total fertility rate; (vi) the level of urbanization in percent; (vii) the share of muslim population per country; (viii) the sex ratio at birth (males over females); (ix) the mortality rate of boys over the mortality rate of girls under 5, and (x) under 15 years, respectively; (xi) the cumulative percentage of married men at the age of 40 (out of total male population) divided by the cumulative percentage of married women at the age of 40 (out of total female population); (xii) a dummy whether the country's legal origin is based on French system; (xiii) the percentage of females in the national labor force; (xiv) the log of per capita GDP in PPP terms; (xv) six continent dummies. See the Appendix for more detailed variable definitions and sources. Robust Standard Errors are reported in parentheses. *** ,** and * denote statistical significance at the 1, 5 and 10% level, respectively.

Table 15: Overview of countries per time period with data on marriage age

Panel 1980-2010 (tables 2-5)	Cross-section 2000s (table 6)
86	*135*
Argentina	Afghanistan
Australia	Albania
Austria	Algeria
Bahrain	Antigua and Barbuda
Bangladesh	Argentina
Belgium	Armenia
Belize	Aruba
Botswana	Azerbaijan
Brazil	Bahrain
Brunei Darussalam	Bangladesh
Cameroon	Belarus
Canada	Benin
Chile	Bhutan
China	Bolivia (Plurinational State of)
Colombia	Bosnia and Hercegovina
Czech Republic	Botswana
Denmark	Brazil
Dominican Republic	Brunei Darussalam
Ecuador	Bulgaria
Egypt	Burkina Faso
Finland	Burundi
France	Cambodia
Greece	Cameroon
Guyana	Cape Verde
Haiti	Chad
Hungary	Chile
Iceland	China
India	Colombia
Indonesia	Congo
Iran (Islamic Republic of)	Costa Rica
Iraq	Croatia
Ireland	Cuba
Israel	Cyprus
Italy	Democratic People's Republic of of Korea
Jamaica	Democratic Republic of the Congo
Japan	Dominican Republic
Kazakhstan	Ecuador
Kenya	Egypt
Kuwait	El Salvador
Kyrgyzstan	Estonia
Luxembourg	Ethiopia
Malaysia	Gabon
Maldives	Georgia
Mali	Ghana
Malta	Greece
Mauritania	Guinea
Mauritius	Guyana
Mexico	Haiti
Morocco	Honduras
Mozambique	Hungary
Myanmar	India
Nepal	Indonesia
Netherlands	Iran (Islamic Republic of)
New Zealand	Iraq
Niger	Israel
Norway	Italy
	Jamaica
	Jordan
	Kazakhstan
	Kenya
	Kuwait
	Kyrgyzstan
	Lao People's Democratic Republic
	Latvia
	Lebanon
	Lesotho
	Liberia
	Libya
	Lithuania

Table 15 continued: Overview of countries per time period with data on marriage age

Panel 1980-2010 (tables 2-5)	Cross-section 2000s (table 6)
Pakistan	Madagascar
Panama	Malawi
Paraguay	Malaysia
Peru	Maldives
Philippines	Mali
Poland	Malta
Portugal	Mauritania
Qatar	Mauritius
Republic of Korea	Mexico
Saudi Arabia	Mongolia
Singapore	Morocco
Slovakia	Mozambique
South Africa	Myanmar
Spain	Namibia
Sudan	Nepal
Sweden	New Caledonia
Switzerland	Nicaragua
Thailand	Niger
Tonga	Nigeria
Trinidad and Tobago	Oman
Tunisia	Pakistan
Turkey	Palau
United Arab Emirates	Panama
United Kingdom	Papua New Guinea
United Republic of Tanzania	Paraguay
United States of America	Peru
Venezuela (Bolivarian Republic of)	Philippines
Vietnam	Poland
Zambia	Portugal
Zimbabwe	Puerto Rico
	Qatar
	Republic of Moldova
	Romania
	Russian Federation
	Rwanda
	Samoa
	Sao Tome and Principe
	Saudi Arabia
	Senegal
	Seychelles
	Sierra Leone
	Singapore
	Slovenia
	Solomon Islands
	South Africa
	Spain
	Sri Lanka
	Sudan
	Suriname
	Swaziland
	Syrian Arab Republic
	Tajikistan
	Thailand
	Tonga
	Trinidad and Tobago
	Tunisia
	Turkey
	Uganda
	Ukraine
	United Arab Emirates
	United Republic of Tanzania
	Venezuela (Bolivarian Republic of)
	Vietnam
	Yemen
	Zambia
	Zimbabwe

Table 16: Data and Sources

Variable Name	Description	Source	Data restrictions and remarks
Country	Name of country	Feenstra, Robert C., Inklaar, R. & Timmer, M. P. (2015). The Next Generation of the Penn World Table. American Economic Review, forthcoming, available for download at www.ggdc.net/pwt	
CCode	ISO 3166-1 alpha-3 country codes	Defined in ISO 3166-1, part of the ISO 3166 standard published by the International Organization for Standardization (ISO)	
Male Marriage Age (SMAM)	Singulate mean age at marriage (SMAM) for men, measured as the average length of single life expressed in years among those who marry before age 50.	United Nations, Department of Economic and Social Affairs, Population Division (2013). World Marriage Data 2012 (POP/DB/Marr/Rev2012).	for each decade (1980s, 1990s, 2000s), simple averages are taken from all available values per country on male and female SMAM
Female Marriage Age (SMAM)	Singulate mean age at marriage (SMAM) for women, measured as the average length of single life expressed in years among those who marry before age 50.		
First Difference Female Marriage Age	smam_female in the 2000s (average 2000-2009) minus smam_female in the 1980s (average 1980-1989)		
Spousal Age Gap (SAG)	Male Marriage Age minus Female Marriage Age		
Spousal Age Gap Ratio	Male Marriage Age over Female Marriage Age		
plow_negative_environment	The average fraction of ancestral land that was suitable for growing barley, rye, and wheat divided by the fraction that was suitable for any crops.	Alesina, A., Giuliano, P., & Nunn, N. (2013). On the Origin of Gender Roles: Women and the Plough. *Quarterly Journal of Economics, 128* (2): 469-530. Data taken from http://scholar.harvard.edu/nunn/pages/data-0	
plow_positive_environment	The average fraction of ancestral land that was suitable for growing foxtail millet, pearl millet, and sorghum divided by the fraction that was suitable for any crops.		
LOG GDP per Capita	The log of GDP per capita per time period (Output-side real GDP at current PPPs)	Feenstra, Robert C., Inklaar, R. & Timmer, M. P. (2015). The Next Generation of the Penn World Table. *American Economic Review*, forthcoming, available for download at www.ggdc.net/pwt	for each decade (1980s, 1990s, 2000s), simple averages are taken from all available values on income per country
Secondary Schooling Completion (Diff)	Secondary Schooling Completion rate of males minus the rate of females	Own construction based on dataset by Barro and Lee (Barro, R., & Lee, J.-L. (2010). A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics, 104* , 184-198.) www.barrolee.com	for each decade (1980s, 1990s, 2000s), simple averages are taken from all available values for the respective education variable per country
Secondary Schooling Completion (Ratio)	Secondary Schooling Completion rate of males over the rate of females		
Average Years Tertiary Education (Diff)	Average years of tertiary education of males minus the years of females		
Average Years Tertiary Education (Ratio)	Average years of tertiary education of males over the years of females		
Female Secondary Schooling Completion	Secondary Schooling Completion rate of females		
First Difference Female Secondary Schooling Completion	Female secondary schooling in the 2000s (average 2000-2009) minus female secondary schooling in the 1980s (average 1980-1989)		
Female Average Years Tertiary Education	Average years of tertiary education of females		
Primary Schooling Completion (Ratio)	Primary Schooling Completion rate of males over the rate of females		
Gender Parity Index (GPI) for Adult Literacy	Ratio of female to male aduty literacy rates	UNESCO Institute for Statistics (UIS) Data Centre (http://data.uis.unesco.org).	
Fertility	Total fertility (children by women)	United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision, DVD Edition.	for each decade (1980s, 1990s, 2000s), simple averages are taken from all available values
Female Labor Force Participation	Female labour force as a percent of the female working age population.	International Labour Organization (ILO); data online available.	
Urbanization	Urban population (as % of total population)	Own construction based on "Rural population" indicator from UNESCO Institute for Statistics (UIS) Data Centre (http://data.uis.unesco.org).	
Muslim	Muslim population (as % of total population)	Religion adherence data from Barro, R. (2003). http://scholar.harvard.edu/barro/publications/religion-adherence-data	No data for 1980s and 1990s available. Took religion adherence from the 1970 as proxy for 1980s, and adherence from the 2000 as proxy for 1990s
French Legal Origin	Dummy for country with French legal origin / tradition	Rodrik et al., (2004)	
Cum. pop. married at 40	Cumulative percentage of married men at the age of 40 (out of total male population) divided by cumulative percentage of married women at the age of 40 (out of total female population)	Own construction based on United Nations, Department of Economic and Social Affairs, Population Division (2013). World Marriage Data 2012 (POP/DB/Marr/Rev2012).	For each decade (1980s, 1990s, 2000s), simple averages are taken from all available values per country
Asia	Dummy variable taking value 1 if country is located on given continent, 0 otherwise	Own construction based on World Bank definition of World regions	
Europe			
Africa			
North America			
South America			
Oceania			
Women's economic rights (wecon)	Women's Economic Rights index ranging from 0 (no economic rights) to 3 (all or nearly all of women's economic rights were guaranteed by law and the government fully and vigorously enforces these laws in practice)	Cingranelli, D. L., Richards, D. L., & Clay, K. C. (2014). The CIRI Human Rights Dataset. http://www.humanrightsdata.com. Version 2014.04.14.	For each decade (1980s, 1990s, 2000s), simple averages are taken from all available values per country
Women's political rights (wopol)	Women's Political Rights index ranging from 0 (no political rights) to 3 (political rights are guaranteed in both law and practice)		
Women's social rights (wosoc)	Women's Social Rights index ranging from 0 (no social rights for women) to 3 (all or nearly all of women's social rights were guaranteed by law and the government fully and vigorously enforced these laws in practice)		
Sex ratio at birth	Sex ratio at birth by decade and country (males over females)	United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Prospects: The 2012 Revision, DVD Edition.	
Sex ratio under 5 mortality	Deaths of boys with age 0-4 (as % of all boys in that age) divided by the deaths of girls with age 0-4 (as % of all girls in that age)		
Sex ratio under 15 mortality	Deaths of boys with age 0-14 (as % of all boys in that age) divided by the deaths of girls with age 0-14 (as % of all girls in that age)		

Table 16 continued: Data and Sources

Variable Name	Description	Source	
Female SMAM / SAG Border Neighbors	Weighted average of female SMAM / SAG of adjoining countries with a common border, where weights are according to relative length of shared border	Own construction based on United Nations, Department of Economic and Social Affairs, Population Division (2013). World Marriage Data 2012 (POP/DB/Marr/Rev2012), and for the weighting by border length from CEPII, following Jetter, M., Correa, E. A., & Agudelo, A. M. (2015). Corruption: Transcending borders (under review)	For each decade (1980s, 1990s, 2000s), simple averages are taken from all available values on the respective variable per country
Female SMAM / SAG 5 neighboring countries	Simple average of the female SMAM / SAG of five neighboring countries	Own construction based on United Nations, Department of Economic and Social Affairs, Population Division (2013). World Marriage Data 2012 (POP/DB/Marr/Rev2012), and own selection of 5 neighboring countries	
Gender Inequality Index (GII)	Index for measurement of gender disparity along three dimensions (reproductive health, gender empowerment, economic status) scaled from 0 (total equality) to 1 (total inequality)	United Nations Development Programme (UNDP) 2013, for download at http://hdr.undp.org/en/content/table-4-gender-inequality-index	Only available since 2010, which we take as proxy for the 2000s time interval
Women Treated With Respect	Percentage of female respondents answering yes to the question, "Do you believe that women in this country are treated with respect and dignity, or not?"	Data originally from Gallup World Poll; data here taken from respective category in Social Progress Index 2014 (www.socialprogressimperative.org)	Took 2014 values as proxy for the 2000s time interval
Minimum Legal Marriage Age for Women	Minimum legal age for marriage without parental consent as defined in terms of the laws of the individual country	United Nations Statistics Division (DYB 2011: http://unstats.un.org/unsd/ demographic/products/dyb/dyb2011/notes/notes24.pdf)	
Spousal Age Gap Ratio Parental Generation	Male Marriage Age over Female Marriage Age per country (average 1980-1989)	Own construction based on United Nations, Department of Economic and Social Affairs, Population Division (2013). World Marriage Data 2012 (POP/DB/Marr/Rev2012)	Due to lags only available for 2000s time period
Female Primary Schooling	Percentage of female population with a completed primary education	Barro, R., & Lee, J.-L. (2010). A New Data Set of Educational Attainment in the World, 1950-2010. Journal of Development Economics, 104, 184-198. www.barrolee.com	
Quality of Schooling male relative to female	Gender difference (male over female) in student performance on the science scale for the PISA test 2006	OECD 2007. PISA 2006: Science Competencies for Tomorrow's World. http://www.oecd.org/edu/school/programmeforinternationalstudentassessmentpisa/pisa2006results.htm	Took 2006 PISA test as proxy for the 2000s time period
Adolescent births	Number of births to women with age 15-19 per 1,000 women with age 15-19	Taken as sub-dimension from the Gender Inequality Index (GII); United Nations Development Programme (UNDP) 2013, for download at http://hdr.undp.org/en/content/table-4-gender-inequality-index	Took 2010 values as proxy for the 2000s time interval
Women in Politics	Proportion of seats in parliament held by women, measured in 2000	United Nations' Women's Indicators and Statistics Database.	