Maternal Mortality and Women's Political Participation*

Sonia Bhalotra
University of Essex

Damian Clarke
Universidad de Santiago de Chile

Joseph Gomes
University of Navarra

Atheendar Venkataramani
University of Pennsylvania

December 24, 2018

Abstract

We show that large declines in maternal mortality can be achieved by raising women's political participation. We estimate that the recent wave of quotas for women in parliament in low income countries has resulted in a 9 to 12% decline in maternal mortality. Among mechanisms are that gender quotas lead to an 8 to 11% increase in skilled birth attendance and a 6 to 11% increase in prenatal care utilization. We find reinforcing evidence from the period in which the United States experienced rapid declines in maternal mortality. The historical decline was significantly greater in states that had longer exposure to women's suffrage.

JEL codes: I14, I15, O15.

Keywords codes: Maternal mortality, women's political representation, gender, quotas, suffrage, reproductive health services.

*Bhalotra: ISER & Department of Economics, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, United Kingdom, srbhal@essex.ac.uk; Clarke: Universidad de Santiago de Chile damian.clarke@usach.cl; Gomes: University of Navarra, ICS, Navarra Center for International Development, Pamplona, Spain, jgomes@unav.es; Venkataramani: University of Pennsylvania, USA, atheenv@pennmedicine.upenn.edu. This paper carries acknowledgement of UNU-WIDER in Helsinki, who originally commissioned the study in connection with the 17th Nordic Conference on Development Economics. We are grateful to James Fenske, Alessandro Tarozzi, Dean Yang, and conference/seminar audiences at the British Academy panel debate on reducing global inequality, the EPCS Rome (where this was a keynote lecture); IZA gender conference NY; UPF Barcelona; Essex; NEUDC Boston; ACEGD Conference at ISI Delhi; RES Manchester; UNAV; UB; DSE Winter School; SMU Dallas; and the World Bank Conference on "Equity and Development: Ten Years On" for their comments and feedback. Bhalotra acknowledges partial support from ESRC Grant ES/L009153/1 awarded to the Research Centre for Micro-Social Change at ISER, University of Essex.

1 Introduction

Maternal mortality, defined as the death of women within 42 days of childbirth, remains a looming global health problem well into the 21st century. It is estimated to account for 830 deaths per day, and more than 216 deaths per 100,000 live births globally (Ceschia and Horton, 2016). In sub-Saharan Africa, the maternal mortality ratio (MMR) exceeds the rate in developed countries a century ago (Alkema et al., 2016; Loudon, 1992).[1] Moreover, maternal mortality is only the tip of an iceberg, the mass of which is maternal morbidity.

Persistence of high rates of maternal mortality is striking given that the knowledge and technology needed to dramatically reduce it have been available for nearly a century, and the costs of intervention are relatively small (Cutler, Deaton and Lleras-Muney, 2006; Loudon, 1992). There remains far from universal coverage of reproductive health services in low income countries. Since 99% of maternal mortality occurs in developing countries, a natural explanation may be that low income has constrained progress. However, while income displays a positive association with each of female and male life expectancy, it exhibits only a weak relationship with the ratio of female to male life expectancy, a proxy for excess deaths of women associated with reproduction (Appendix Figure A1).[2] This suggests other factors at play.[3] We investigate the hypothesis that, among other factors, are gendered policy preferences. In particular, that addressing maternal mortality has been a low priority in male-dominated parliaments.

Maternal mortality has declined rapidly in the last two decades, but there was massive variation in rates of decline.[4] We leverage this variation to investigate the hypothesis that political will plays

[1] MMR is defined as deaths per 100,000 live births. In sub-Saharan Africa in 2015 it was 547; in the US in 1936 it was 555.

[2] Duflo (2012) notes: "other than pre-birth and in early childhood, women are most likely to be missing relative to men in childbearing years." Of the 6 million missing women each year, 21% are in their reproductive years (Wong, 2012).

[3] Our estimates show that GDP growth is MMR-reducing, albeit less effective than implementation of gender quotas. Our purpose is to highlight that there remains considerable variation in MMR conditional upon income.

[4] In this period, MMR increased in a few countries, including the United States (MacDorman et al., 2016), which has the highest MMR among developed countries (Kassebaum et al., 2016). In 2015, MMR was 26.4 in the USA compared with 9.2 in the UK and 4.4 in Sweden per 100,000 live births. Research investigating the potential for women in politics to reverse this trend is merited. In a recent tweet based on Mann et al. (2018), Amitabh Chandra makes a point similar to ours concerning allocative inefficiency related to interventions around women's health, see Twitter: Amitabh Chandra (stored for posterity here).

a significant role, and that women have greater political will (and/or efficacy) than men for maternal mortality reduction. The broad stylized facts line up with our hypothesis: since 1990 MMR has shown an unprecedented fall of 44%, a period in which the share of women in parliament has risen unusually rapidly, from under 10% to more than 20% (Figure 1a). We study whether these trends are causally related.

The share of women in parliament has been increasing at an increasing rate but smoothly, making it hard to isolate its effects from those of other gradually evolving trends. We address this problem by exploiting the abrupt legislation of parliamentary gender quotas sweeping through developing countries since the early to mid 1990s.[5] Figure 1b shows that trends in women's share in parliament track trends in quota coverage. We combine country-specific dates of quota implementation with the first annualized estimates of MMR across countries, released in 2015 to generate a global country-year panel for 1990–2015. Our strategy is to estimate event study style regressions that show trends in MMR pre- and post-quota adoption (Jacobson, LaLonde and Sullivan, 1993; Goodman-Bacon, 2018). We scrutinize our identifying assumption that quota implementation is quasi-random.

Our estimates show that passage of parliamentary gender quotas leads to an immediate 5 to 6 percentage point (55 to 66%) increase in the share of parliamentary seats held by women, and a 9 to 12% decrease in the maternal mortality ratio. We check that these estimates are not significantly modified by controlling for (potentially endogenous) income and for indicators of the quality of democracy. The effects of quotas are increasing in time since implementation, the share of seats reserved, and in pre-intervention maternal mortality rates. There is no evidence of differential pre-trends in the outcomes. Nevertheless, we show that the estimates are robust to controlling for potential predictors of quota implementation, including an index of women's rights that will capture any simultaneous progressive policy changes. We further investigate this by instrumenting the share of women in parliament with the legislation of gender quotas and producing 2SLS esti-

[5] In response to an active civil society movement and rising awareness of women's rights, in 1990 the UN Economic and Social Council set a target of 30% female representation in decision making bodies by 1995 (Pande and Ford, 2012), and this accelerated after the Beijing Declaration of 1995, see section 2.

mates for maternal mortality. Following Conley, Hansen and Rossi (2012), we estimate bounds on the IV estimates that assess sensitivity of our estimates to a degree of violation of the exclusion restriction. Since the best available country-year panel data on MMR are estimated (due to gaps in vital statistics) and are published with uncertainty bounds (Alkema et al., 2016), we show estimates using a double-bootstrap procedure resampling over the uncertainty intervals to calculate the standard errors. We also show results for a restricted sample of countries for which systematic and comparable survey data on MMR are available.

Although the analysis focuses upon reserved seat quotas for women, we also investigate candidate list quotas. We find that these quotas have a smaller effect on the share of women in parliament than reserved seat quotas, a result with some antecedents (Pande and Ford, 2012; Bagues and Campa, 2017). We find no significant impacts on MMR. This is probably a result of both the smaller impact on political representation, and the fact that countries implementing candidate list quotas during the study period were predominantly in Latin America. These countries had achieved dramatic declines in MMR prior to quota implementation, and our estimates for reserved seat quotas show that impacts are smaller where baseline rates of MMR were lower.

Investigating mechanisms that may link an increasing share of women in parliament to lower maternal mortality, we find evidence in favor of investments in key low-cost medical inputs. Gender quotas result in a 6.4 to 8.8 percentage point (7.7–10.6%) increase in skilled birth attendance and a 4.7 to 9.2 percentage point (5.7–11.1%) increase in antenatal care utilization. The WHO recommends universal access to these inputs, and they are widely promoted as tools for maternal mortality reduction (WHO, 2014; Jamison et al., 2013).[6] We also find some evidence of a decline in fertility, and an increase in girls' education following gender quotas, both of which previous research has shown to be associated with lower maternal mortality.

We find no discernible impact of gender quotas on GDP, or on health expenditure as a share of GDP. Importantly, the relationship between MMR and gender quotas is not sensitive to conditioning upon these variables. We also tested whether quotas lead to increases in development assistance

[6] In the only causal study available, Pettersson-Lidbom (2014) estimates that a 1% increase in the share of midwife-assisted home-births decreased MMR by 2% in 19th century Sweden.

for maternal health from international donors, as this is thought to have played a critical role in the world's response to the Millennium Development Goals (one of which was MMR reduction) since 2000 (Dieleman et al., 2016), but we find no evidence of this.

These results suggest that the operative mechanism linking parliamentary gender quotas to MMR reduction may have been a more efficient allocation of existing resources to reflect refreshed priorities, and improved allocative efficiency. We probe this by examining whether gender quotas were associated with detrimental effects on other health outcomes. We find no significant impact of quotas on adult male mortality, a crude analogue of maternal mortality. We also find no impact on tuberculosis mortality, a highly prevalent disease in low income countries that mostly affects adults in their (re)productive years and that has been equally burdensome for men and women. We find some evidence that gender quotas result in a fall in infant mortality for girls, but not boys. Overall, this evidence indicates that women parliamentarians are more effective in targeting women's health than at targeting health in general and, further, that they appear to improve allocative efficiency.

Our analysis of gender quotas uses global data but the identifying variation comes entirely from lower income countries, as these were the countries implementing quotas in the sample period. We investigated whether our findings generalize to other contexts by looking for a potential role for women's political voice at the time when today's richer countries experienced sharp declines in maternal mortality. We acquired data for the United States where a sharp drop in MMR has been documented to have followed the introduction of antibiotics in 1937 that were effective in treating peripartum bacterial infections (Jayachandran, Lleras-Muney and Smith, 2010). In the early 20th century, variation in women's influence on policy stemmed from suffrage (Miller, 2008; Kose, Kuka and Shenhav, 2016).

We exploit variation in dates of suffrage adoption across the states, prior to the 19th Constitutional Amendment of 1920, a federal mandate that extended the franchise to all women (Miller, 2008). We find that MMR fell more quickly in early suffrage states after 1937: 6 years after, it was 15% lower than the baseline difference. This bolsters our analysis of mechanisms, showing that uptake of medical innovation is greater when women are involved in policy-making. It seems plausible that states in which women have voted for longer are more sensitive to policies that favor women. However, to draw a clearer analogue to the contemporary low income country results and to be able to tie down the direct involvement of women (as policy makers rather than voters), we also show that early suffrage states had a 1.8 percentage point larger share of women in Senate in the antibiotic era, relative to a mean of 1.4%.

To summarize, using contemporary cross-country data across 25 years and historical cross-state data for the US, both encompassing periods of dramatic decline in maternal mortality, we provide compelling new evidence that raising women's political participation can have substantial impacts on maternal mortality. Overall, quotas led to a 13% decline in maternal mortality within 10 years of implementation, comparing favorably to the 44% decline in MMR globally that occurred over a 25 year period.[7] The importance of women's political participation is underscored by a dose-response relationship: countries that reserved 20-30% of parliamentary seats, close to the internationally recommended target, experienced an immediate 18% decline in MMR. We also find that the impact of gender quotas on MMR is increasing in the baseline rate of MMR, consistent with the "low-hanging fruit" argument, or diminishing returns.

Efforts to reduce maternal mortality over our study period have focused on raising access to trained birth assistance, prenatal and antenatal care, contraception and women's education (Grépin and Klugman, 2013; Kruk et al., 2016). There has been no recognition among policy makers of the potential relevance of the political economy of resource allocation influencing these inputs. However, the 6 to 9 percentage point increase in birth attendance and the 5 to 9 percentage point increase in prenatal care that we demonstrate flow from quota passage compare well with the 12 and 13 percentage point increases achieved through the recent 25 years.

Our study makes two key contributions. We are the first to propose that gender quotas can be an effective policy tool for maternal mortality reduction. This is important because (i) the broader evidence on the success of quotas is mixed (Coate and Loury, 1993; Besley et al., 2017; Pande and Ford, 2012; Niederle, 2016), and (ii) MMR has been difficult to bring down. Regarding the latter,

[7] Our analysis period is the same, 1990–2015. However, the estimated declines in this paper emerge from the 22 countries mandating quotas.

the decline in MMR of 44% since 1990 fell well short of the Millennium Development Goal (MDG) target decline of 75% (Hogan et al., 2010; Kassebaum et al., 2014), and yet the new Sustainable Development Goals (SDGs) have set a higher target. This is a clear flag that some policy innovation is needed. Our results suggest that women leaders are more effective than men in implementing the known recipes for success in this domain.

Second, we provide possibly the first systematic analysis of the impacts of the recent wave of implementation of gender quotas across countries.[8] Previous evidence on women's sway in policy making has mostly emerged from democratic regimes, in line with theoretical models of politician behavior that admit a role for politician identity (Besley and Coate, 1997). Our findings cohere with previous evidence that increasing the share of women politicians influences policy choices in favor of public goods or policies that align with the preferences of women (Chattopadhyay and Duflo, 2004; Taylor-Robinson and Heath, 2003; Swers, 2005; Clots-Figueras, 2012; Kose, Kuka and Shenhav, 2016). However, a number of the quota implementing countries in our sample were non-democratic.[9] Our results are consistent with women acting upon their innate preferences, potentially motivated by the mission of public service rather than by electoral motives.[10]

Reducing maternal mortality is of both intrinsic and functional value, as it favorably influences women's human capital attainment, employment, and growth (Albanesi and Olivetti, 2016, 2014; Jayachandran and Lleras-Muney, 2009; Bloom, Kuhn and Prettner, 2015).[11] A broad stream of research has documented the importance of population health for economic growth, via life

[8] See, for instance, the review by Pande and Ford (2012), who discuss the cross-country implementation of quotas but provides evidence emerging only from implementation of local government quotas in India.

[9] There is no clear agreement on the precise definition of democracy. Besley and Kudamatsu (2008) discuss two particular cut-offs based on democracy scores issued in Polity IV. According to the often used definition where any non-zero Polity-IV score is classified as democratic, 7 of 22 quota adopting countries were non-democratic in the 5 years pre- and post-quota adoption (China, Eritrea, Morocco, Rwanda, Saudi Arabia, Swaziland and Uganda). If the more demanding cut-off of a polity-IV score greater than 5 is used, 14 of 22 quota adopting countries would be classified as non-democratic for this period.

[10] Women tend to show more intrinsic motivation than men (Folbre, 2012). In the political domain, Baskaran et al. (2018) argue that women legislators in India exhibit more intrinsic rather than extrinsic motivation based upon comparing male and female legislator performance in swing vs non-swing constituencies in a sample of close elections between men and women. Experimental research showing that women have different preferences from men provides a behavioural underpinning to these results (Niederle, 2016).

[11] Although see Bhalotra, Venkataramani and Walther (2018) for contrasting evidence showing increases in fertility and reductions in labor force participation.

expectancy and human capital accumulation (Soares, 2005; Weil, 2007; Ashraf, Lester and Weil, 2009; Shastry and Weil, 2003; Bloom, Canning and Sevilla, 2004; Lorentzen, McMillan and Wacziarg, 2008; Aghion, Howitt and Murtin, 2010).

The rest of this paper is organized as follows. Section 2 presents estimates for gender quotas and Section 3 for extension of the franchise to women in the United States. Section 4 concludes.

2 Gender Quotas

2.1 Legislation

Since 1990, 22 countries in sub-Saharan Africa, the Middle East, and South and East Asia have implemented constitutionally protected quotas reserving seats in parliament for women. The geographic spread and trend in gender quotas is described in Figures A2 and A3.[12] The impetus to adopt these policies was the unanimous signing of the Beijing Platform for Action by all UN delegates at the Fourth World Conference on Women in 1995, after which quota adoption accelerated (Inter-Parliamentary Union, 2015; Chen, 2010; Krook, 2010). The Beijing Platform set a 30% target for participation of women in decision-making in its agenda of women's empowerment (UN Women, 1995) but many countries mandated smaller shares (see Figure A4). Later we identify country-specific predictors of quota implementation.

While the main focus of our study is reserved seat quotas, since 1990 the number of countries with candidate list quotas for women has also risen sharply (from 1 to 46). As discussed in the preceding section, candidate list quotas tend to have smaller impacts on the share of elected women representatives than reserved seat quotas. This is consistent with the fact that candidate list quotas do not guarantee seats in parliament but instead require that a specified proportion of female candidates appear on the ballot. During our study period, these quotas were implemented in areas where MMR had already declined prior to policy implementation. Consequently, we anticipate small, if

[12] The countries implementing quotas are: Afghanistan, Algeria, Bangladesh, Burundi, China, Djibouti, Eritrea, Haiti, Iraq, Jordan, Kenya, Morocco, Niger, Pakistan, Rwanda, Saudi Arabia, South Sudan, Sudan, Swaziland, Tanzania, Uganda and Zimbabwe. Samoa implemented quotas in 2016 after the MMR data became available, and we do not have data for Kosovo, Somalia and Taiwan, which have implemented quotas. Uganda is the only country which reserved seats before 1990, in 1989.

any, impact of candidate list quotas on MMR.

Casual inspection suggests support for our hypothesis that reserved seat quotas are associated with MMR decline. Comparing country pairs with similar GDP per capita in 1990, selecting one which implemented reserved seat quotas before 2010 and one which did not, we found that the quota-implementing country typically witnessed a larger decline in maternal mortality in 1990–2010. Thus, Rwanda did better than Malawi, Kenya did better than Zimbabwe and Niger did better than the DRC.

2.2 Data

We merge quota dates with MMR data and the estimation sample contains (at most) 174 countries, through 1990–2015. Summary statistics are in Table A1. The data on country-specific adoption of parliamentary gender quotas up until 2005 are from Dahlerup (2005). We updated these using the Global Database of Quotas for Women. The data include information on the date of passage and the share of seats reserved for women. We merge these data to a comprehensive country-year panel on the share of women in parliament aggregating information from multiple sources, namely the World Development Indicators (WDI), the UN Millennium Development Goals (MDG) Indicators and the ICPSR dataset compiled by Paxton, Green and Hughes (2008).

For maternal mortality, we use estimates recently made available from the United Nations Mortality Estimation Inter-Agency Group (MMEIG) containing data for 1990–2015 for as many as 183 countries. These are widely considered the best MMR estimates to date, as they address known measurement difficulties in survey and vital statistics data on maternal mortality using Bayesian methods applied to multiple, complementary data sources including vital statistics, special inquiries, surveillance sites, population-based household surveys and census files (Alkema et al., 2016, 2017). The world distribution of average MMR for the period of 1990–2015 from these data is represented in Appendix Figure A5. Prior to the release in 2015 of these MMR data, there were no annual time series for a comprehensive set of countries. This has no doubt contributed to maternal mortality being vastly understudied relative to, say, infant mortality. As these data include measures of MMR that are estimated, we conduct a sensitivity check that allows for this in inference. We also show that our results hold when using survey data for a restricted sample of countries for which such data are consistently available.

We also use data on a range of time-varying controls, intermediate outcomes and placebo outcomes. Most of these data are compiled from large cross-country databases including the World Bank's World Development Indicators (WDI) database. For some of these variables we have observations for only a subset of years. Appendix A provides details of all the variables used, and Appendix Table A1 provides the summary statistics.

2.3 Empirical Strategy

We exploit the staggered timing of the implementation of quotas across countries, looking to identify causal effects from significant breaks in the outcome series following implementation. Research designs working in such a setting often employ the single coefficient difference-in-differences (DD) estimator. As shown in Goodman-Bacon (2018), this is only strictly valid when treatment occurs once, between the pre- and the post-period, generating fixed treated and control units. When treatment varies over time, arriving in some regions after others, there are in fact multiple experiments. Already treated units can act as controls for later treated units because their treatment status does not change. However, if there are changes in treatment effects over time, these get subtracted from the DD estimate, biasing the single coefficient estimator away from the true treatment effect. This is not a problem with the underlying design but, rather, with the restriction to a single coefficient. For this reason, we consistently present flexible coefficient estimates using an event study style specification (Jacobson, LaLonde and Sullivan, 1993).

Specifically, we estimate:

$$\begin{aligned} Y_{ct} &= \alpha + \sum_{l=2}^{10+} \beta_l^{lead} Quota_c \times 1\{lead_t = l\} + \sum_{k=0}^{10+} \beta_k^{lag} Quota_c \times 1\{lag_t = k\} \\ &\quad + \boldsymbol{X_{ct}} \boldsymbol{\gamma} + \mu_t + \phi_c + \varepsilon_{ct}. \end{aligned} \tag{1}$$

The variation is across country c and year t. The outcome Y_{ct} is, first, the proportion of women in parliament, allowing us to estimate how effective gender quotas are at increasing representation. What we may think of as second-stage outcomes but in fact are estimated as reduced form outcomes are the natural logarithm of the maternal mortality ratio and, later, a series of outcomes that are inputs to maternal mortality, such as assisted delivery. $Quota_c$ is 1 if a country ever adopted a quota, and this is interacted with a full set of leads and lags with respect to the year the quota was adopted. We include 10 lags and leads, the tenth term including all years greater than 10, and the first lead is omitted as the base category. We include country and year fixed effects (ϕ_c and μ_t respectively), and cluster standard errors at country level (Bertrand, Duflo and Mullainathan, 2004).

The β^{lag} coefficients capture the impacts of interest and the β^{lead} coefficients partially test the identifying assumption of no differential pre-trends. The β^{lead} coefficients provide only a partial test of the identifying assumptions, as to estimate unbiased parameters we require parallel trends between treated and non-treated units *in the absence of treatment*. Parallel pre-trends provide support for this assumption, but cannot be used to test what would have happened at the time of the reform had the reform not been implemented (Kahn-Lang and Lang, 2018).

In the appendix, we present estimates from a parametric DD specification where the independent variable is defined as one for all years following the implementation of a quota for implementing countries, and zero before. It is set to zero for all countries that do not implement quotas in the sample period. As income and democracy are potentially correlated with both quotas and MMR, we include log GDP per capita and democracy score as time-varying covariates $\boldsymbol{X_{ct}}$. However as these controls are potentially endogenous, we show results with and without them. In a specification check, we drop the 47 high income countries from the sample so that the control group is more homogeneous. We implement further checks, testing robustness to including potential predictors of quota legislation as controls in both estimating equations and showing bounds on IV estimates that allow for failure of the exclusion restriction (Conley, Hansen and Rossi, 2012).

As the countries in the sample vary considerably in population size, we re-estimated the equation weighting by this. Solon, Haider and Wooldridge (2015) argue that this affords a test of model mis-specification. Since MMR varies considerably across countries, proportional changes implied by using logarithms will exaggerate achievements in countries with lower baseline rates (Deaton, 2006). We therefore replaced the logarithm with the level of MMR as a robustness exercise. We also investigate intensive margin effects, exploiting variation in quota size, and we investigate effects by duration and by baseline rates of MMR. As discussed in the introduction, we test sensitivity of our conclusions to allowing for the uncertainty with which maternal mortality data are estimated.

To understand the scope of women's influence on health outcomes, we replace MMR with mortality for adult males (age 15–60), roughly mirroring the age profile of MMR.[13] We also produce estimates for tuberculosis mortality and infant mortality as these affect both genders.[14] Since the TB data had the occasional zero, we use the inverse hyperbolic sine transformation rather than the log transformation for this outcome. After presenting the main results we investigate the impact of quotas on intermediate outcomes with a view to identifying mechanisms.

2.4 Results

Estimates of Equation 1 are in Figure 2. Panel A shows a discrete jump in women's parliamentary representation in the year after quotas are implemented. Panel B shows a concomitant break in the coefficient series, with maternal mortality falling more rapidly in quota implementing countries. The drop is apparent in the year after implementation and becomes significant two years after quotas are introduced and is then sustained at an increasing rate. The lead coefficients allay concerns about endogeneity of policy adoption – in both figures, outcome trends prior to the date of quota implementation in countries that implemented quotas are not significantly different from outcome trends for those same years in countries that did not go on to implement quotas.

For the main outcomes, so as to be able to report an effect size, we additionally estimate single

[13] Mean MMR in the global sample is 233 per 100,000 births, with range, 3 to 2890. The width of the range demonstrates the potential for reduction. Notice that mean adult male mortality is 238 per 1,000 male population, with range 58.8 to 689 (Table A1).

[14] If anything, the incidence and death rates from TB are higher among men than women: "In 2017 close to 6 million adult men contracted TB and around 840,000 died from it. This compares with an estimated 3.2 million adult women who fell ill and almost half a million who died from TB" (WHO, September 2018).

coefficient difference-in-differences models. These estimates are provided in Table A2. Following Figure 2, we allow a one year lag for the share of women in parliament, and an additional year for impacts on maternal mortality. As the share of women can only change at the next election, we identified for every country, the years between quota legislation and election. The mode and median are zero years, the mean is 1.3. Once women are in parliament, it is plausible that it takes (at least) one year for any changes they induce to have discernible population-level impacts on maternal mortality.[15] The point estimates indicate statistically significant effects of gender quotas on the proportion of women in parliament of 5–6 percentage points which, relative to the average in 1985–1990 of 9%, represents a 55 to 66% increase.[16] We also identify a substantial reduction in MMR of 9–12%.

2.5 Robustness Checks and Extensions

Sample, functional form, weights, endogenous surveillance, clustering. Dropping high income countries and re-estimating produces essentially identical estimates (Figure A9). Table A2 also shows that the estimates are robust to using level rather than log MMR. It also displays point estimates with and without population weights. Since China and India are outliers in population size, the weighted estimates exclude them (China implemented quotas, India did not). So as to isolate changes ensuing from weighting from changes associated with removing these countries, we also show unweighted estimates on the reduced sample. The point estimates are larger with China and India excluded, and again larger when weighted. However, all changes in the sequence are not statistically meaningful. A potential concern is that the availability and quality of MMR data may be endogenous if surveillance and tracking are correlated with preferences in favor of addressing MMR decline. However, any bias this creates in the coefficient of interest will render

[15]The estimates are not sensitive to shrinking the lags since impacts endure.

[16]The median (mean) gender quota is 21% (20%). The estimated impacts of quotas on the proportion of women in parliament are smaller than the entire size of quotas. In quota implementing countries the pre-quota share of women in parliament was not always zero, the average was 7.9%, rising to 20.9% post-quota (median: 6.2 and 21.0%). Taking all countries, the mean was 14.1%, median 11.5% (see Figures A6–A7 for full distributions). See Figure A8 for temporal variation by country. In Rwanda we see a jump in line with quota legislation but from a high baseline, while Djibouti shows a sharp jump from zero to quota attainment. In some countries, it took time from quota passage until fulfillment. In Niger, for instance, the quota was in 2000 but the next election in 2004.

our estimates conservative. Another possible concern is that inference in our specification treats the data as independent across countries, but not within countries. To address potential concerns that quota implementation was temporally correlated, we additionally estimate event studies with two-way clustering (Cameron, Gelbach and Miller, 2011) of standard errors by both country and by year, see Figure A10. While the confidence intervals are now wider, we still observe statistically significant effects.

Income and democracy controls. All estimates discussed so far are conditional upon income and democracy. However, because they are potentially endogenous, it is important to show that our estimates are not sensitive to inclusion of these controls (see Figure A11). We find that democracy has direct impacts on both outcomes, increasing women in parliament and decreasing maternal mortality, but only when the democracy score is above the mean.[17] It is notable that income has no impact on the share of women in parliament, but it has a significant impact on MMR. A 1% increase in GDP results in a 0.5% reduction in MMR. A crude back-of-the-envelope calculation assuming log-linearity, and holding democracy and quotas constant suggests that to achieve the estimated 9–12% reduction in MMR due to quota adoption (on the same sample), GDP would have to increase by about 18–24%. Income is potentially endogenous so this is only a crude calculation but note that we test whether GDP changes in response to quotas and we find it does not.

Duration and dose effects, heterogeneity by baseline MMR. We observe increasing impacts over time as displayed in Figure 2b. By 10 years out, MMR was 13% lower in countries that passed quotas. Intensive margin impacts of reserved seats that leverage variation in quota size across countries (Figure A4) are in Table A3. The estimates are rising in quota size, consistent with a "dose-response." The unweighted estimates indicate that quotas of less than 15% have no significant impact, quotas of 15 to 20% raise the share of women in parliament by 5.5 percentage points and reduce MMR by 8.6% and the corresponding figures for quotas of 20–30% are 7.7 percentage points and 17.5% respectively. We also investigated heterogeneity in the impact of quotas by baseline MMR, dividing the sample so as to allocate roughly a third of all quota countries

[17] Democracy raises women's share when the score is at least 6 on a scale 0–10, and directly impacts MMR when the score is 9 or 10.

to each of three samples, indicated as low, medium and high rates of baseline MMR. We find a clear tendency for the impact of quotas to be higher where baseline rates are higher. The coefficient is 0.020 in low baseline countries and -0.112 in high baseline countries (see Figure A12 for full event studies).

Omitted trends: IV and bounds. Although the event study plots mitigate potential concerns about omitted trends, we directly assess and address any bias in the regression coefficients associated with the possibility that when quotas were adopted, the country was already adopting other measures favorable to maternal mortality decline. To do this we estimate 2SLS regressions of MMR on the share of women in parliament, instrumented with quota implementation. Now the concern about omitted trends translates to a concern that the instrument is invalid. In particular, if quota implementation proxies a change in an omitted variable then it does not satisfy the IV exclusion restriction. However, as quota implementation is likely to be "plausibly exogenous" if not strictly so, we follow Conley, Hansen and Rossi (2012) and provide bounds on the IV estimates. The first stage is in columns 1–3 of Table A2.[18] The second stage estimates are in Table A4. These provide the scaled impact of women's parliamentary representation among compliers. They indicate that a 1 percentage point increase in women's share in parliament is associated with a 1.8% decrease in MMR. In estimating bounds on the 2SLS estimates, we allow the adoption of quotas to have a direct impact on maternal mortality of up to -1% over and above its impact on MMR via increasing women in parliament. The estimated bounds are informative, indicating a 0.1% to 3.2% reduction in maternal mortality for a 1 percentage point increase in the share of women in parliament (Table A4). The unweighted estimates produce estimates in an entirely negative range, whether or not India and China are in the sample, although once we weight the bounds include zero.

Omitted trends: Predictors of quota legislation. As the determinants of quota legislation are of substantive interest and previous work does not provide any clear quantitative analysis, we investigated them directly by acquiring country-year panel data on predictors that have been discussed in the political science literature, typically with reference to case studies (Krook, 2010; Baines

[18] We note that the instrument does not always pass a weak instrument test, but present these as ancillary estimates.

and Rubio-Marin, 2005); see Table A5. The predictors include evolving norms of equality and representation and accelerating movements for women's rights, pressure from international organizations (which can be proxied with overseas development assistance), and occasions of broader constitutional reform including transitions into democracy and post-conflict reconstruction (including peace-keeping forces). Using cross-country panel data methods, we find some evidence that transitions from autocratic rulers to democracy, recent changes in women's economic rights, and exposure to international organizations predict quota legislation. We include all of the potential predictors, including changes in women's rights, as controls in the estimated equations. If the predictors of quota legislation rather than the passage of the legislation drive impacts on MMR then this would be revealed in the coefficient on quota legislation becoming insignificantly different from zero. Our estimates are, however, robust to these controls (Table A6).[19]

Candidate list quotas We obtained estimates of candidate list quotas on women's representation and found small but significant impacts. We found no impact on MMR (see Appendix Figure A13). Notice that, if we are willing to assume that the omitted variables that predict quota implementation are the same for the two sorts of quotas then this result further undermines the possibility that those omitted variables are driving our finding that reserved seat quotas lead to MMR decline.

Accounting for uncertainty in measurement of maternal mortality. As discussed in the Data section, the global country panel of maternal mortality data that we use were generated using a range of vital and demographic data sources (Alkema et al., 2017, 2016; World Health Organization, 2015; Wilmoth et al., 2012). However, given the multiplicity of data sources for some countries and the paucity in others, the estimates are modeled, and thus come with their own uncertainty intervals. We assessed if our conclusions were sensitive to directly accounting for this uncertainty. We follow a double-bootstrap procedure to calculate standard errors when undertaking inference.

[19]Since progress on women's rights is of particular interest, we investigated this further. Using recently collated data on women's political, social and economic rights (Cingranelli, Richards and Clay, 2013), we estimate a different event study, regressing the rights index on a series of year dummies, defined for a small window around the (country-specific) date of quota legislation. Consistent with quotas being part of the index of political rights, we observe a trend break in this index. However, we see no evidence of trend breaks in women's economic and social rights coincident with the date of quota legislation. Thus it does not seem that the passage of gender quotas is capturing secular generic progress in women's rights.

The first stage of the two stage procedure bootstraps over the full sample, clustering at the country level, and thus accounting for the (usual) sampling uncertainty. The second stage re-samples from the uncertainty intervals attached to the point estimates of maternal mortality to directly account for uncertainty in the data series.[20]

Table A7 replicates the difference-in-differences estimates from Table A2, showing p-values for the impact of quotas on maternal mortality associated with a range of re-sampling procedures. The different re-sampling procedures reflect different assumptions relating to the distribution of maternal mortality in the uncertainty intervals presented by the MMEIG. Appendix B describes the re-sampling algorithms and assumptions. We first provide p-values associated with a standard clustered bootstrap prior to taking into account uncertainty in MMR measurements. Next we provide two sets of bootstrapped p-values computed assuming either a triangular distribution or a normal distribution for MMR uncertainty intervals. While the end points of the triangular distribution are at the ends of the uncertainty interval, the normal distribution provides coverage outside of the 80% UI.[21]

Table A7 shows that the triangular correction is (generally) less demanding than the normal correction, and that allowing for correlation within country reduces the estimate uncertainty. When the dependent variable is log(MMR), p-values based on the two distributional assumptions are larger than the standard bootstrapped p-values and depending on the specification fall between 0.091 and 0.226. When the dependent variable is MMR, p-values based on the two distributional assumption are larger than the standard bootstrapped p-values and fall between 0.002 and 0.069.

[20] The maternal mortality data are published by the MMEIG along with 80% uncertainty intervals associated with each point estimate. In describing the modeling procedure, the authors note “We computed 80% uncertainty intervals (UIs) for the MMR and all related outcomes using the 10th and 90th percentiles of the posterior distributions. …We report 80% UIs rather than 95% UIs because of the substantial uncertainty inherent in maternal mortality outcomes: intervals based on higher uncertainty levels quickly lose their ability to present meaningful summaries of a range of likely outcomes.” (Alkema et al., 2016, p. 1250)

[21] In each of the two types of distributions we allow for the possibility of either assuming full correlation in uncertainty by country or not. The corrections by country assume full correlation in uncertainty within a country over time. Where not by country, the estimator assumes no correlation within a country over time. The triangular corrections re-sample from MMR so that coverage respects the full 80% uncertainty interval suggested by the MMEIG. The normal corrections re-sample so that 80% of re-samples fall within the 80% uncertainty interval reported by the MMEIG. Both of these inference procedures are implemented assuming no correlation by country, and then assuming full correlation in uncertainty by country.

Thus our results are robust to allowing for uncertainty in MMR estimates when the dependent variable is in levels. When it is in logarithms, robustness is more sensitive to specification.

As an additional check, we re-estimate the event study specification using actual (rather than estimated) maternal mortality ratios calculated from Demographic and Health Survey (DHS) reports of maternal deaths for the 44 countries in which the DHS maternal mortality module has been implemented. We observe similar results, indicating a reduction in rates of maternal death after the implementation of quotas; see Figure A14.

Other health outcomes. In focusing on maternal mortality, we engaged the tendency for women leaders to serve the preferences of women citizens.[22] In fact our findings are also in line with women attaching greater weight to health outcomes than men. This is plausible because women disproportionately bear the costs of bad health: women risk dying in childbirth, they bear the burden of giving birth again when children die, and they are the main caregivers for sick adults and children. Although high fertility and high morbidity characterize poor countries, the tendency for women to attach more weight to health is also evident in the British Election Survey of 2001: women expressed most concern over the quality of the National Health Service, while the single most important concern for men was low taxes (Campbell, 2004).[23] In line with this, Miller (2008) and Bhalotra and Clots-Figueras (2014) show that women's political participation improved infant mortality in early 19$^{\text{th}}$ century America and contemporary India respectively.[24]

We therefore investigated whether the introduction of gender quotas led to improvements in health in other domains. For reasons discussed in section 2.3, we looked at adult male mortality, TB and infant mortality. See Figure A15. The event study plot for mortality among adult men

[22] The political identity literature tends to refer to leader preferences and there is some evidence that leaders influence not only citizens of their identity but the wider population in accordance with their preferences (see Bhalotra, Clots-Figueras and Iyer (2018); Bassi and Rasul (2017)). However, in democratic regimes, an alternative possibility is that women leaders implement women-friendly policies for strategic reasons, namely, to incentivize women voters to re-elect them.

[23] In addition to having stronger preferences over health, women may be more effective at delivering health if, because of their greater involvement in child-bearing and caring for the sick, health is more salient in their minds or they have more information on how it can be addressed.

[24] Infant mortality is a widely used proxy for public health in the earlier stages of development. These results may be further influenced by the tendency for women to dedicate more resources toward children than men, possible evolutionary roots of which lie in paternity uncertainty (Cox, 2007).

suggests no significant impacts following the reform, with quite tightly estimated zeros until at least 5 years post-quota implementation, and imprecisely estimated reductions from 7 years post reform. The DD coefficient is positive but even then it is about a third of the size of the coefficient for MMR, and it collapses once we introduce population weights. For tuberculosis and infant mortality we similarly observe no statistically significant impact of quotas in event study specifications. Inference is somewhat compromised by an indication of pre-reform trends, but these are not statistically significant. The corresponding DD model yields statistically insignificant coefficients (Table A8).[25]

However if instead of using infant mortality from the World Development Indicators, we draw this variable from the microdata in the Demographic and Health Surveys (DHS) for the sub-sample of DHS countries, and separate girls and boys, we find some evidence that gender quotas lead to lower infant mortality for girls of, on average, 12 percent (Figure A16). This is despite the fact that policies typically used to address infant mortality (e.g. provision of clean water or access to medical professionals and drugs) cannot readily discriminate between boys and girls. The reason that MMR is a conceptually clean outcome to study is that reproductive health services that address maternal mortality are by definition targeted at women.

Overall, there are two takeaways from these results. First, women leaders appear to prioritize the health of women and girls over and above their concerns for health in general.[26] Second, although there was no perceptible decline in male mortality or in TB mortality following gender quotas, it is notable that there was no increase as this undermines the possibility that women

[25] The evidence is suggestive rather than conclusive. First, mortality rates by cause of death and age for many developing countries are inadequate, for instance, see Klasen and Vollmer (2013). The MMR data we use were generated by a major multi-UN task force, no analogue of which has been appointed to create estimates for other categories of mortality. If there were more measurement error in measuring TB or male mortality than in measuring MMR and if that measurement error were classical, then the coefficients for TB and male mortality would be noisier. This said, as we also find that they are smaller, or less negative, this alone is unlikely to explain away our finding of differentially large effects on MMR. Second, one needs to be careful comparing changes delivered by gender quotas for conditions with different treatability. For instance, the injuries and accidents that contribute to adult male mortality may be harder for policy to address than the reproductive health services that contribute to maternal mortality.

[26] We do not measure outcomes for every domain of health spending, so in principle some unmeasured outcome may have suffered. However, as discussed in the section 2.3, adult male mortality is a natural analogue to MMR, infant mortality is a marker of population health, and TB remains an important cause of illness and death for men and women in poor countries.

leaders achieved MMR decline by reallocating resources away from other areas of public health investment. Since we have documented that gender quotas were not associated with increases in GDP, the share of GDP spent on public health, or international development assistance for maternal health, it seems that women effected maternal mortality decline by using available resources more effectively.

2.6 Mechanisms

Having shown that increasing the share of women in parliament leads to more rapid declines in maternal mortality, we now seek to identify underlying mechanisms. To do this, we estimated reduced form equations for endogenous mediators of the relationship between gender quotas and MMR. We first consider impacts on health services interventions recommended by the WHO: antenatal care, which can help identify life threatening conditions such as pre-eclampsia and eclampsia early on; and deliveries attended by a skilled professional, which can address causes of mortality specific to the birthing process, such as uterine bleeding and post-partum infection (WHO, 2014). Simple OLS regressions of MMR on these inputs using our analysis sample and conditioning on GDP and democracy show that a 1 percentage point increase in the share of attended births or women receiving prenatal care is associated with a 3.4 and 2.3% decline in MMR respectively.

We find that passage of gender quotas led to an immediate rise in the share of women attending antenatal care, and a lagged rise in the share of attended births (Figure 3).[27] The DD estimates in Table A9 use a lag of 2 years on the quota variable (similar to the lag allowed for MMR), and demonstrate robustness to controls, to exclusion of India and China, and to population weights. We observe a statistically significant increase of 6.4 to 8.8 percentage point in skilled birth attendance and a 4.7 to 9.2 percentage point increase in the share of women using prenatal care.

There is no robust evidence that gender quotas lead to increases in health expenditure (Table A9), and the impact of quotas on maternal mortality is robust to including health expenditure as an

[27] While movements in maternal mortality were observed prior to the lagged increase in birth attendance, it is important to note that some decline in maternal mortality may be achieved without these inputs, and that these inputs simply capture extensive margin changes in care (quantity covered), but not any intensive margin response (e.g., better medical equipment for existing staffed clinics).

additional control (Figure A17).[28] We also find that the introduction of quotas had no significant effects on international development assistance for health (DAH) that goes towards maternal health (see Figure A18). This was of particular interest as DAH has played a critical role in the world's response to the MDGs (one of which was MMR reduction) since 2000, although less so since 2010. In 2015, US$36.4 billion was disbursed in DAH, and 9.8% was for maternal health (Dieleman et al., 2016).

We further investigated fertility and women's education, given evidence that these variables are associated with maternal mortality (Bhalotra and Clarke, 2013). We find a tendency for fertility to decline after the passage of gender quotas (Figure A19). We also see an increase in the education of girls aged 15–19 at the time of the reform, although the education plot suggests a pre-trend, creating uncertainty about whether the increase in girls' education was a causal effect of the quota (Figure A20). We also tested for the possibility that gender quotas lead to higher income and that this, in turn, contributes to MMR decline. We see no evidence of any trend break in GDP following the passage of quotas (Figure A21). Women leaders could have effected declines in MMR at low cost by disseminating information, campaigning, monitoring, or inspiring action (Miller, 2008; Baskaran et al., 2018; Beaman et al., 2009; Bhalotra and Clots-Figueras, 2014).[29] We shall investigate mechanisms further below, using historical data for the United States.

3 Women's Suffrage- Early Twentieth Century

While changes in women's political participation in developing countries today are closely linked to gender quotas, in the era in which today's richer countries achieved steep declines in

[28] As health expenditure is only available for a subset of the sample (years 1995–2013), introducing it as a control creates compositional effects. This is why it is not included in the main estimates.

[29] Miller (2008) cites evidence from historical studies that women conducted door to door information campaigns in early 20th century America, to encourage families to boil drinking water, and this contributed to sharp reductions in infant mortality. Baskaran et al. (2018) show that women legislators in India are more likely to complete an allocated village road building project in their constituency than are male legislators. They also show that women are less corrupt than men and that, in contrast to men, they act to raise economic activity in their constituencies even when they have won in a non-swing constituency. They argue that, if economic growth is the common currency in which costs are evaluated, then having women instead of men in government imposes no economic cost. Beaman et al. (2009) show that quotas for women in village council leadership in India led to raised aspirations and higher educational investments in girls. Bhalotra and Clots-Figueras (2014) show that breastfeeding rates in Indian districts increase when women legislators are elected from the district.

maternal mortality, much of the variation in women's voice in policy-making stemmed from differential timing in the adoption of women's suffrage. Thus, to complement the preceding analysis, we examined precipitous declines in maternal mortality driven by new medical technology in the United States, and analyzed whether the size of these declines varied on the basis of when individual states adopted women's suffrage. To aid interpretation of our findings, we investigate whether early adoption of suffrage predicts the share of women in government in the period of rapid MMR decline.

3.1 Background

Adoption of Women's Suffrage. While the 19th amendment to the US Constitution, ratified in 1920, established women's suffrage nationwide, a number of states implemented women's suffrage prior to this mandate (Figure A22). The drivers of differential timing of women's suffrage across states are reviewed in Miller (2008) and Kose, Kuka and Shenhav (2016). We summarize the relevant points here. States in the "*wild west*" were the first to extend suffrage, all during the late 19th century. Some historians attribute this to harsh frontier conditions making it more difficult to sustain traditional gender roles (Brown, 1958; Grimes, 1967) but the quantitative literature has found no robust correlates of adoption dates (Cornwall et al., 2007). Importantly, there is no evidence that implementation of other gender-progressive policies that may have had direct impacts on maternal mortality decline was correlated with suffrage adoption. This includes regulation governing alimony and divorce, mother's pension, women's maximum work hours, women's minimum wages, prohibition, worker's compensation, child labor, compulsory schooling, and state attributes such as literacy rates and prevailing wages (Miller, 2008).

Previous work has shown that state-level implementation of women's suffrage was associated with a sharp 25 to 37% (or 12 percentage point) rise in voter turnout in both the gubernatorial (Lott Jr. and Kenny, 1999) and presidential elections (Kose, Kuka and Shenhav, 2016), and an increase in the weight of women in policy making (Miller, 2008).

Maternal Mortality Decline. Sulfonamides, the first antibiotics, were effective in treating peripartum infections that accounted for about 40% of maternal deaths (Albanesi and Olivetti, 2016). Prior to their arrival, MMR in the U.S. was as high as in sub-Saharan Africa today, and penicillin did not arrive until 1942. There was an unprecedented and sharp drop in maternal mortality upon the introduction of sulfa in 1937. Importantly, the trend break in maternal mortality occurred at more or less the same time (in 1937 or 1938) in all states (Jayachandran, Lleras-Muney and Smith, 2010). However, we estimate that the post-1937 decline varied considerably across the states and investigate whether this was associated with variation in women's influence on policy making. Browsing cases suggests it might have been.[30]

3.2 Data

Data on the timing of women's suffrage was compiled by Miller (2008). We have data for 48 states and Washington D.C., Hawaii and Alaska had not been granted statehood during the study period. We obtained state-year maternal mortality rates from Jayachandran, Lleras-Muney and Smith (2010), who collated these from US vital statistics data. These data are available for all states but Alaska, Hawaii and Washington D.C. Details of all variables used are in Appendix A.

3.3 Empirical Strategy

The hypothesis of interest is that, once a technology that could bring about large declines in maternal mortality became available, it was deployed more effectively in states that adopted women's suffrage earlier. The analysis sample is 1925–1943, a short window around 1937, in which there were few large-scale public health interventions. We estimate an event study style regression in which we interact an indicator for early suffrage adoption states with a set of leads and lags sur-

[30] For instance, Colorado extended the franchise to women in 1893, 27 years before neighboring New Mexico or Alabama did in 1920. In 1936, MMR in Colorado, New Mexico and Alabama was similar, at 710, 740 and 740 respectively. By 1950, MMR in Colorado had fallen to 80, just below the US average of 86, while in New Mexico and Alabama it was still about double the US average at 150 and 170 respectively (national-level summary statistics are in Table A10). In contemporary America, Colorado ranks 4th in women's political representation, while Alabama ranks 46 and these differences are persistent. While New Mexico ranks 14 now, it ranked 34 in 1975 (see Rutgers: CAWP).

rounding the arrival of sulfonamide drugs in 1937:

$$\begin{aligned} ln(MMR)_{st} \quad = \quad & \gamma_0 + \sum_{j=2}^{12} \gamma_j^{lead} EarlySuf_s \times \mathbb{1}(\text{Year} = 1937 - j)_t \\ & + \sum_{k=0}^{6} \gamma_k^{lag} EarlySuf_s \times \mathbb{1}(\text{Year} = 1937 + j)_t + \phi_t + \theta_s + \upsilon_{st} \end{aligned} \tag{2}$$

where s indexes states, t indexes years, $EarlySuf_s$ indicates states that legislated women's suffrage prior to the 19[th] amendment, and θ_s and ϕ_t represent state and year fixed effects. Standard errors are clustered at the state level.

We also show the corresponding DD style regression in which we interact an indicator for early adoption states with an indicator for the post-antibiotic years, allowing for trend as well as level differences by including a further interaction with year. As tracking maternal mortality is potentially a political choice, we re-estimate the model restricting the sample to a balanced panel so as to account for any correlation between data on maternal mortality and women's suffrage. As in the cross-country study, we investigate sensitivity of the results to weighting the regressions with state population. We also estimate results for a placebo outcome, pneumonia mortality. We chose this as it was (a) treatable with sulfa drugs (Jayachandran, Lleras-Muney and Smith, 2010), and (b) affected both genders. Among children (the age group with the highest infection rates) it affected boys more than girls (Bhalotra and Venkataramani, 2014). This allows us to differentiate between women's political participation favoring health outcomes in general, and maternal mortality in particular.

We interpret early suffrage as a proxy for the strength of women's voice in policy making as it is plausible that this increases with years of exposure to women being able to vote. An alternative interpretation may be that early adopters of suffrage had an underlying tendency to be gender progressive, and that they would have had faster declines in MMR irrespective of any influence of women in policy making. Any time-invariant level difference in progressiveness between the early adopting (Western) states and the rest will be absorbed by state fixed effects. To allow for time-varying differences between the western and other states, we test sensitivity to inclusion of census-region and year-specific fixed effects. Also, we focus not upon the coefficient on suffrage but rather on the coefficient on suffrage interacted with an indicator of access to sulfa drugs. If the general progressiveness of early adopters was such as to favor addressing MMR then, even before the introduction of antibiotics, we should expect to have seen steeper declines in MMR in early adopting states. However, we see no differentially steeper pre-trend in MMR in early vs late suffrage states, a test of which is provided by the significance of the γ^{lead} terms. Following Miller (2008), cited above, we will, in a robustness check, control for women's labor force participation, interacting it with the post-antibiotic dummy. In an attempt to identify a mechanism that is more clearly linked to our hypothesis than to general progressiveness, we investigate whether early suffrage states had more women in government when the antibiotics arrived and made rapid MMR decline feasible.

3.4 Results

We collected data by state and year on the proportion of women in the House of Representatives (HoR) and the National Senate (Figure A23 and Table A11). In early adoption states relative to late adoption states (late being 1920), the share of women in Senate is a statistically significant 1 percentage point (110%) higher in 1920–1960 and 1.8 percentage points (125%) higher in 1937–1943, the latter being the period of rapid maternal mortality decline within the analysis sample. The share of women in the HoR is 47% higher in 1937–43, but this estimate is not precisely determined.

The event study plot for MMR is in Figure 4a. Maternal mortality fell sharply in 1937 and five years later the average decline was 50%, with state-specific declines varying between 6 and 80%. We show that some of this variation is explained by duration of exposure to women's suffrage. We find that MMR declined more rapidly in states that adopted suffrage early. The early adopters had lower levels of MMR in the pre-antibiotic era and, after 1937, the gap between early and late adopters widened. Pre-1937, the level of MMR in early adopting states was lower than in late adoption states by 11%. Six years later, this gap had widened to 26%, resulting in an estimated 15% reduction.

There was no statistically significant difference in the trend in MMR in the pre-antibiotic era between the two groups of states. Our findings are robust to including interactions of baseline women's labor force participation with the post-sulfa dummy, year, and the interaction of post and year. They are also robust to to restricting the sample to a balanced panel to account for endogenous tracking of maternal mortality, and to weighting by state population (see Figure A24). We also estimated a specification controlling for census division by year fixed effects to capture time-varying differences between early adopters in the west and the other states. We still see a trend break and although the event study coefficients are now less precisely estimated (Figure A25), the DD models with the census division by year fixed effects produce largely similar estimates.[31] We considered measures of the state-specific quality of vital statistics registers in the 1930s (discussed in in Bhalotra and Venkataramani (2014)) but as the quality of registration did not change discretely at the time of arrival of sulfa drugs, this is unlikely to bias the estimated parameters.

The DD style regression is in Table A12. We see a similar pattern of results with and without state population weights, but the estimates are larger and more precise with weights. They indicate that the level drop in MMR was 8.5% larger in early adopting states (coefficient on early adoption $\times$ post-antibiotic), and that the trend decline was 1.5% faster (coefficient on early adoption $\times$ post-antibiotic $\times$ year). The event study for pneumonia mortality (Figure 4b) shows that although there were large declines in pneumonia following the introduction of antibiotics (Jayachandran, Lleras-Muney and Smith, 2010; Bhalotra and Venkataramani, 2014), there was no significant difference in the post-sulfa rates of decline in early vs late suffrage adopting states.

4 Conclusion

Our findings suggest that neither increases in country income nor advances in medical technology are sufficient for the realization of potential improvements in maternal mortality. We show that women's involvement in policy-making can effect rapid maternal mortality decline and, as far as the evidence goes, at low cost. Thus gender quotas may be a powerful at-scale means of modifying public health priorities in favour of maternal health. Despite significant progress, especially

[31] In the weighted specification, the coefficient on Early Suffrage $\times$ Post Sulfa is -0.075^{*}, and the coefficient on Early Suffrage $\times$ Post Sulfa $\times$ Time is -0.015^{**}. Analogous values for the specification without census division by year FEs are -0.085^{**} and -0.015^{**}.

since 2000, preventable maternal mortality remains high. The lifetime risk of maternal mortality is 1 in 41 women in low income countries. Despite a wave of gender quota implementation, 130 countries in the world have none. There is thus substantial room for manoeuvre. Our findings have implications for the recently launched Global Health 2035 report, and the ambitious Sustainable Development Goals. The MDG target was not met and the SDG target is more ambitious, so we clearly need some policy innovation. In fact this paper shows that SDG 3.1 for reducing maternal mortality is complementary to SDG 5.5 for raising the share of women in parliament.

References

Aghion, Philippe, Peter Howitt, and Fabrice Murtin. 2010. "The Relationship Between Health and Growth: When Lucas Meets Nelson-Phelps." National Bureau of Economic Research, Inc NBER Working Papers 15813.

Albanesi, Stefania, and Claudia Olivetti. 2014. "Maternal health and the baby boom." *Quantitative Economics*, 5(2): 225–269.

Albanesi, Stefania, and Claudia Olivetti. 2016. "Gender Roles and Medical Progress." *Journal of Political Economy*, 124(3): 650–695.

Alkema, Leontine, Doris Chou, Daniel Hogan, Sanqian Zhang, Ann-Beth Moller, Alison Gemmill, Doris Ma Fat, Ties Boerma, Marleen Temmerman, Colin Mathers, and Lale Say. 2016. "Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group." *The Lancet*, 387(10017): 462–474.

Alkema, Leontine, Sanqian Zhang, Doris Chou, Alison Gemmill, Ann-Beth Moller, Doris Ma Fat, Lale Say, Colin Mathers, and Daniel Hogan. 2017. "A Bayesian approach to the global estimation of maternal mortality." *The Annals of Applied Statistics*, 11(5): 1245–1274.

Ashraf, Quamrul H., Ashley Lester, and David N. Weil. 2009. "When Does Improving Health Raise GDP?" In *NBER Macroeconomics Annual 2008, Volume 23*. *NBER Chapters*, 157–204. National Bureau of Economic Research, Inc.

Bagues, Manuel F., and Pamela Campa. 2017. "Can Gender Quotas in Candidate Lists Empower Women? Evidence from a Regression Discontinuity Design." Institute for the Study of Labor (IZA) IZA Discussion Papers 10888.

Baines, Beverley, and Ruth Rubio-Marin. 2005. *The Gender of Constitutional Jurisprudence.* Cambridge:Cambridge University Press.

Baskaran, Thushyanthan, Sonia R. Bhalotra, Brian Min, and Yogesh Uppal. 2018. "Women Legislators and Economic Performance." Institute for the Study of Labor (IZA) IZA Discussion Papers 11596.

Bassi, Vittorio, and Imran Rasul. 2017. "Persuasion: A Case Study of Papal Influences on Fertility-Related Beliefs and Behavior." *American Economic Journal: Applied Economics*, 9(4): 250–302.

Beaman, Lori, Raghabendra Chattopadhyay, Esther Duflo, Rohini Pande, and Petia Topalova. 2009. "Powerful women: does exposure reduce bias?" *The Quarterly Journal of Economics*, 124(4): 1497–1540.

Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh. 2001. "New tools in comparative political economy: The Database of Political Institutions." *World Bank Economic Review*, 15(1): 165–176.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. "How Much Should We Trust Differences-In-Differences Estimates?" *The Quarterly Journal of Economics*, 119(1): 249–275.

Besley, Timothy, and Masayuki Kudamatsu. 2008. "Making Autocracy Work." In *Institutions and Economic Performance*. , ed. Elhanan Helpman, 453–510. Harvard University Press.

Besley, Timothy, and Stephen Coate. 1997. "An economic model of representative democracy." *The Quarterly Journal of Economics*, 112(1): 85–114.

Besley, Timothy, Olle Folke, Torsten Persson, and Johanna Rickne. 2017. "Gender quotas and the crisis of the mediocre man: Theory and evidence from Sweden." *American Economic Review*, 107(8): 2204–42.

Bhalotra, Sonia, and Atheendar Venkataramani. 2014. "Shadows of the Captain of the Men of Death: Early Life Health Interventions, Human Capital Investments, and Institutions." University of Essex Mimeo 8671.

Bhalotra, Sonia, and Damian Clarke. 2013. "Educational Attainment and Maternal Mortality." UNESCO Background paper prepared for the Education for All Global Monitoring Report 2013/4 2014/ED/EFA/MRT/PI/14.

Bhalotra, Sonia, and Irma Clots-Figueras. 2014. "Health and the political agency of women." *American Economic Journal: Economic Policy*, 6(2): 164–197.

Bhalotra, Sonia, Atheendar Venkataramani, and Selma Walther. 2018. "Fertility Responses to Reductions in Mortality: Quasi-Experimental Evidence from 20th Century America." mimeo.

Bhalotra, Sonia R., Irma Clots-Figueras, and Lakshmi Iyer. 2018. "Religion and Abortion: The Role of Politician Identity." Institute for the Study of Labor (IZA) IZA Discussion Papers 11292.

Bloom, David E, David Canning, and Jaypee Sevilla. 2004. "The effect of health on economic growth: a production function approach." *World Development*, 32(1): 1–13.

Bloom, David E., Michael Kuhn, and Klaus Prettner. 2015. "The Contribution of Female Health to Economic Development." National Bureau of Economic Research Working Paper 21411.

Brown, Dee. 1958. *The Gentle Tamers: Women of the Old Wild West.* Lincoln, NE:University of Nebraska Press.

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller. 2011. "Robust Inference With Multiway Clustering." *Journal of Business & Economic Statistics*, 29(2): 238–249.

Campbell, Rosie. 2004. "Gender, Ideology and Issue Preference: Is There such a Thing as a Political Women's Interest in Britain?" *The British Journal of Politics and International Relations*, 6(1): 20–44.

Ceschia, Audrey, and Richard Horton. 2016. "Maternal Health: Time for a Radical Reappraisal." *The Lancet*, 388(10056): 2064–2066.

Chattopadhyay, Raghabendra, and Esther Duflo. 2004. "Women as policy makers: Evidence from a randomized policy experiment in India." *Econometrica*, 72(5): 1409–1443.

Chen, Li-Ju. 2010. "Do Gender Quotas Influence Women's Representation and Policies?" *The European Journal of Comparative Economics*, 7(1): 13–60.

Cingranelli, D. L., D. L. Richards, and K. C. Clay. 2013. "The ciri human rights dataset." *http://www.humanrightsdata.org*, Version 2013.12.05.

Clots-Figueras, Irma. 2012. "Are Female Leaders Good for Education? Evidence from India." *American Economic Journal: Applied Economics*, 4(1): 212–244.

Coate, Stephen, and Glenn C Loury. 1993. "Will affirmative-action policies eliminate negative stereotypes?" *American Economic Review*, 1220–1240.

Conley, Timothy G., Christian B. Hansen, and Peter E. Rossi. 2012. "Plausibly Exogenous." *The Review of Economics and Statistics*, 94(1): 260–272.

Cornwall, Marie, Brayden King, Elizabeth Legerski, Eric Dahlin, and Kendra Schiffman. 2007. "Signals or Mixed Signals: Why Opportunities for Mobilization are not Opportunities for Policy Reform." *Mobilization: An International Quarterly*, 12(3): 239–254.

Cox, Donald. 2007. "Biological Basics and the Economics of the Family." *Journal of Economic Perspectives*, 21(2): 91–108.

Cutler, David, Angus Deaton, and Adriana Lleras-Muney. 2006. "The determinants of mortality." *Journal of Economic Perspectives*, 20(3): 97–120.

Dahlerup, Drew. 2005. "Increasing Women's Political Representation: New Trends in Gender Quotas." In *Women in Parliament: Beyond Numbers*. , ed. J. Ballington and A. Karam, 140–153. International Institute for Democracy and Electoral Assistance.

Deaton, Angus. 2006. "Global patterns of income and health: facts, interpretations, and policies." National Bureau of Economic Research.

Dieleman, Joseph L, Matthew T Schneider, Annie Haakenstad, Lavanya Singh, Nafis Sadat, Maxwell Birger, Alex Reynolds, Tara Templin, Hannah Hamavid, Abigail Chapin, and Christopher J L Murray. 2016. "Development assistance for health: past trends, associations, and the future of international financial flows for health." *The Lancet*, 387(10037): 2536–2544.

Duflo, Esther. 2012. "Women Empowerment and Economic Development." *Journal of Economic Literature*, 50(4): 1051–1079.

Folbre, Nancy. 2012. "Should Women Care Less? Intrinsic Motivation and Gender Inequality." *British Journal of Industrial Relations*, 50(4): 597–619.

Goodman-Bacon, Andrew. 2018. "Difference-in-Differences with Variation in Treatment Timing." National Bureau of Economic Research Working Paper 25018.

Grépin, Karen A, and Jeni Klugman. 2013. "Maternal health: a missed opportunity for development." *The Lancet*, 381(9879): 1691–1693.

Grimes, Alan Pendleton. 1967. *The Puritan Ethic and Woman Suffrage.* New York:Oxford University Press.

Hogan, Margaret C, Kyle J Foreman, Mohsen Naghavi, Stephanie Y Ahn, Mengru Wang, Susanna M Makela, Alan D Lopez, Rafael Lozano, and Christopher JL Murray. 2010. "Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5." *The Lancet*, 375(9726): 1609–1623.

Inter-Parliamentary Union. 2015. "Women in Parliament: 20 years in review." IPU, Geneva.

Jacobson, Louis S, Robert J LaLonde, and Daniel G Sullivan. 1993. "Earnings Losses of Displaced Workers." *American Economic Review*, 83(4): 685–709.

Jamison, Dean T., Lawrence H. Summers, George Alleyne, Kenneth J. Arrow, Seth Berkley, Agnes Binagwaho, Flavia Bustreo, David Evans, Richard G. A. Feachem, Julio Frenk, Gargee Ghosh, Sue J. Goldie, Yan Guo, Sanjeev Gupta, Richard Horton, Margaret E. Kruk, Adel Mahmoud, Linah K. Mohohlo, Mthuli Ncube, Ariel Pablos-Mendez, K. Srinath Reddy, Helen Saxenian, Agnes Soucat, Karene H. Ulltveit-Moe, and Gavin Yamey. 2013. "Global health 2035: a world converging within a generation." *The Lancet*, 382(9908): 1898–1955.

Jayachandran, Seema, Adriana Lleras-Muney, and Kimberly V. Smith. 2010. "Modern Medicine and the Twentieth Century Decline in Mortality: Evidence on the Impact of Sulfa Drugs." *American Economic Journal: Applied Economics*, 2(2): 118–46.

Jayachandran, Seema, and Adriana Lleras-Muney. 2009. "Life Expectancy and Human Capital Investments: Evidence from Maternal Mortality Declines." *The Quarterly Journal of Economics*, 124(1): 349–397.

Kahn-Lang, Ariella, and Kevin Lang. 2018. "The Promise and Pitfalls of Differences-in-Differences: Reflections on '16 and Pregnant' and Other Applications." National Bureau of Economic Research Working Paper 24857.

Kassebaum, Nicholas J, Amelia Bertozzi-Villa, Megan S Coggeshall, Katya A Shackelford, Caitlyn Steiner, Kyle R Heuton, Diego Gonzalez-Medina, Ryan Barber, Chantal Huynh, Daniel Dicker, et al. 2014. "Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013." *The Lancet*.

Kassebaum, Nicholas J, Ryan M Barber, Zulfiqar A Bhutta, Lalit Dandona, Peter W Gething, Simon I Hay, Yohannes Kinfu, Heidi J Larson, Xiaofeng Liang, Stephen S Lim, et al. 2016. "Global, regional, and national levels of maternal mortality, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015." *The Lancet*, 388(10053): 1775–1812.

Klasen, Stephan, and Sebastian Vollmer. 2013. "Missing Women: Age and Disease: A Correction." Courant Research Centre PEG Courant Research Centre: Poverty, Equity and Growth - Discussion Papers 133.

Kose, Esra, Elira Kuka, and Na'ama Shenhav. 2016. "Women's Enfranchisement and Children's Education: The Long-Run Impact of the U.S. Suffrage Movement." Institute for the Study of Labor (IZA) IZA Discussion Papers 10148.

Krook, Mona Lena. 2010. *Quotas for Women in Politics: Gender and Candidate Selection Reform Worldwide.* Oxford:Oxford University Press.

Kruk, Margaret E, Stephanie Kujawski, Cheryl A Moyer, Richard M Adanu, Kaosar Afsana, Jessica Cohen, Amanda Glassman, Alain Labrique, K Srinath Reddy, and Gavin Yamey. 2016. "Next generation maternal health: external shocks and health-system innovations." *The Lancet*, 388(10057): 2296–2306.

Lorentzen, Peter, John McMillan, and Romain Wacziarg. 2008. "Death and development." *Journal of Economic Growth*, 13(2): 81–124.

Lott Jr., John R, and Lawrence W. Kenny. 1999. "Did Women's Suffrage Change the Size and Scope of Government?" *Journal of Political Economy*, 107(6): 1163–1198.

Loudon, Irvine. 1992. *Death in Childbirth: An International Study of Maternal Care and Maternal Mortality 1800–1950.* Oxford, UK:Clarendon Press.

MacDorman, Marian F, Eugene Declercq, Howard Cabral, and Christine Morton. 2016. "Is the United States' Maternal Mortality Rate Increasing? Disentangling trends from measurement issues." *Obstetrics & Gynecology*, 128(3): 447.

Manning, Jennifer E., and Ida A. Brudnick. 2018. "Women in Congress, 1917-2018: Service Dates and Committee Assignments by Member, and Lists by State and Congress." Congressional Research Service CRS Report.

Mann, Susan, Lisa M Hollier, Kimberlee McKay, and Haywood Brown. 2018. "What We Can Do about Maternal Mortality—And How to Do It Quickly." *New England Journal of Medicine*, 379(18): 1689–1691.

Miller, Grant. 2008. "Women's Suffrage, Political Responsiveness, and Child Survival in American History." *The Quarterly Journal of Economics*, 123(3): 1287–1327.

Niederle, Muriel. 2016. "Gender." In *The Handbook of Experimental Economics, Volume 2: The Handbook of Experimental Economics, second edition.* , ed. John H Kagel and Alvin E Roth, 481–553. Princeton:Princeton university press.

Pande, Rohini, and Deanna Ford. 2012. "Gender Quotas and Female Leadership." In *Gender Equality and Development, Background Paper.* , ed. World Development Report 2012. World Bank.

Paxton, P, J Green, and M Hughes. 2008. "Women in parliament, 1945-2003: Cross-national dataset." *ICPSR24340-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], http://doi.org/10.3886/ICPSR24340.v1.*

Pettersson-Lidbom, Per. 2014. "Midwives and maternal mortality: Evidence from a midwifery policy experiment in Sweden in the 19th century." mimeo.

Shastry, Gauri Kartini, and David N Weil. 2003. "HOW MUCH OF CROSS-COUNTRY INCOME VARIATION IS EXPLAINED BY HEALTH?" *Journal of the European Economic Association*, 1(2-3): 387–396.

Soares, Rodrigo R. 2005. "Mortality reductions, educational attainment, and fertility choice." *American Economic Review*, 95(3): 580–601.

Solon, Gary, Steven J Haider, and Jeffrey M Wooldridge. 2015. "What are we weighting for?" *Journal of Human resources*, 50(2): 301–316.

Swers, Michele, L. 2005. "Connecting Descriptive and Substantive Representation: An Analysis of Sex Differences in Cosponsorship Activity." *Legislative Studies Quarterly*, 30(3): 407–433.

Taylor-Robinson, Michelle M, and Roseanna Michelle Heath. 2003. "Do women legislators have different policy priorities than their male colleagues? A critical case test." *Women & Politics*, 24(4): 77–101.

UN Women. 1995. "Beijing Declaration and Platform for Action." *http://www.un.org/womenwatch/daw/beijing/pdf/BDPfA%20E.pdf. Accessed on 22 Feb, 2017.*

Weil, David N. 2007. "Accounting for the Effect Of Health on Economic Growth." *The Quarterly Journal of Economics*, 122(3): 1265–1306.

WHO. 2014. "Maternal mortality, Fact sheet Number 348, Updated May 2014, Accessed - July 2014."

Wilmoth, John R., Nobuko Mizoguchi, Mikkel Z. Oestergaard, Lale Say, Colin D. Mathers, Sarah Zureick-Brown, Mie Inoue, and Doris Chou. 2012. "A New Method for Deriving Global Estimates of Maternal Mortality." *Statistics, Politics and Policy*, 3(2): 2151–7509.

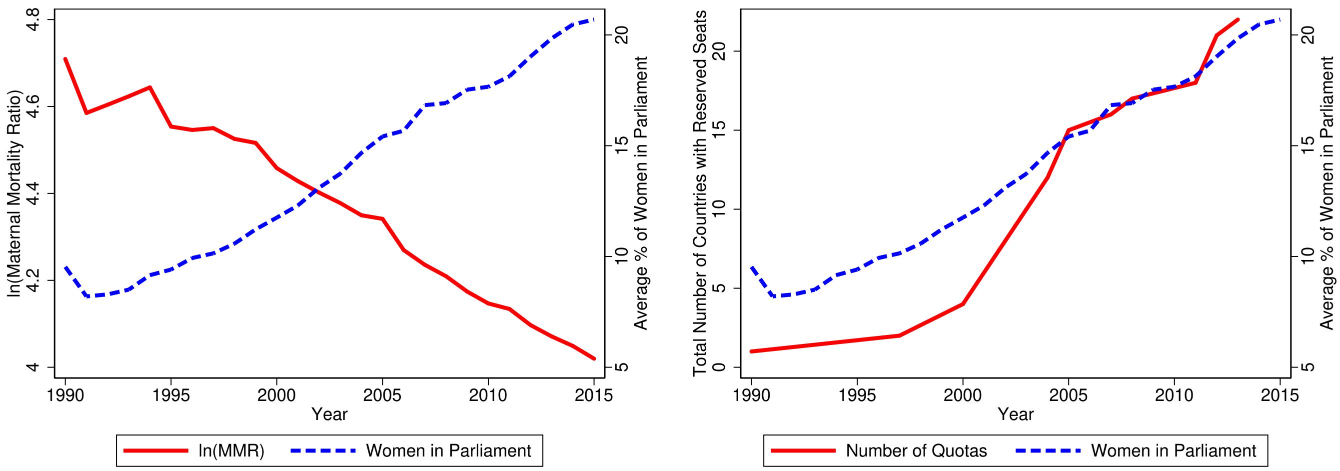
Wong, Yen Nee. 2012. "World Development Report 2012: Gender Equality and Development." In *Forum for Development Studies*. Vol. 39, 435–444.

World Health Organization. 2015. *Trends in Maternal Mortality: 1990 to 2015. Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.* Geneva:WHO.

Figures and Tables

Figure 1: Trends in gender quotas, women in parliament and maternal mortality

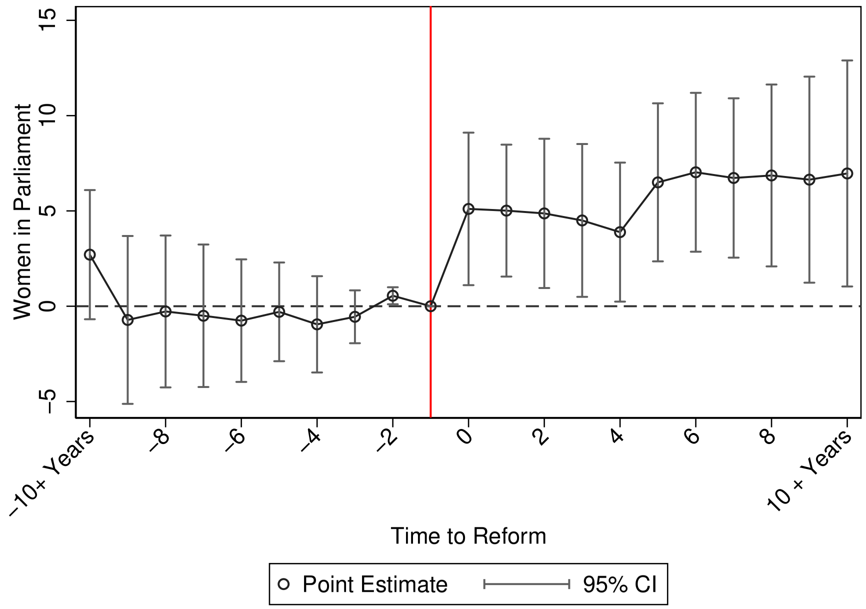
(a) Women in parliament and ln(maternal mortality ratio) (b) Reserved seats and women in parliament



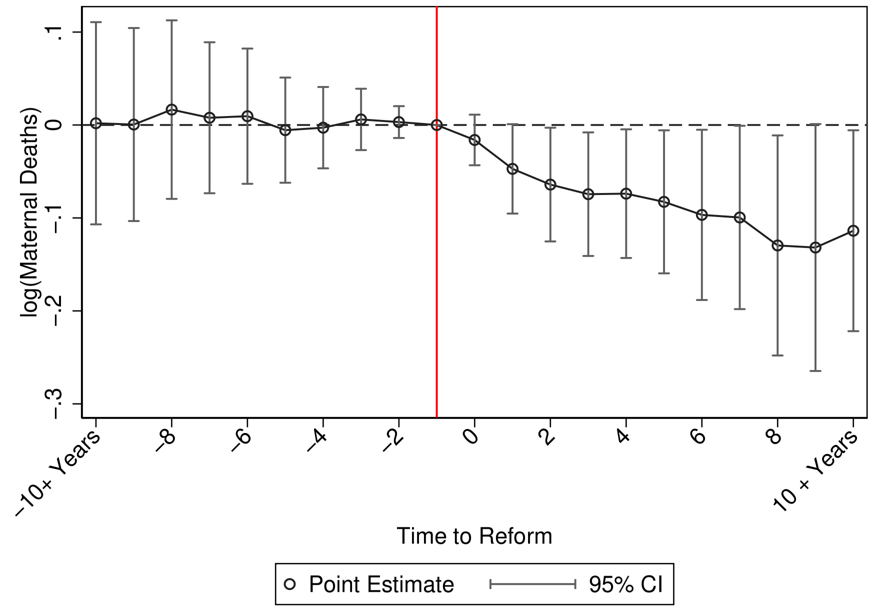
Notes: Raw trends in number of countries with parliamentary gender quotas, the percentage of women in parliamentary seats and the log of the maternal mortality ratio. Data sources are provided in the Data Appendix. The sample is a global sample of 174 countries for which we have annual data through 1990–2015.

Figure 2: Gender quotas: Event studies for women in parliament and maternal mortality

(a) Percent of women in parliament



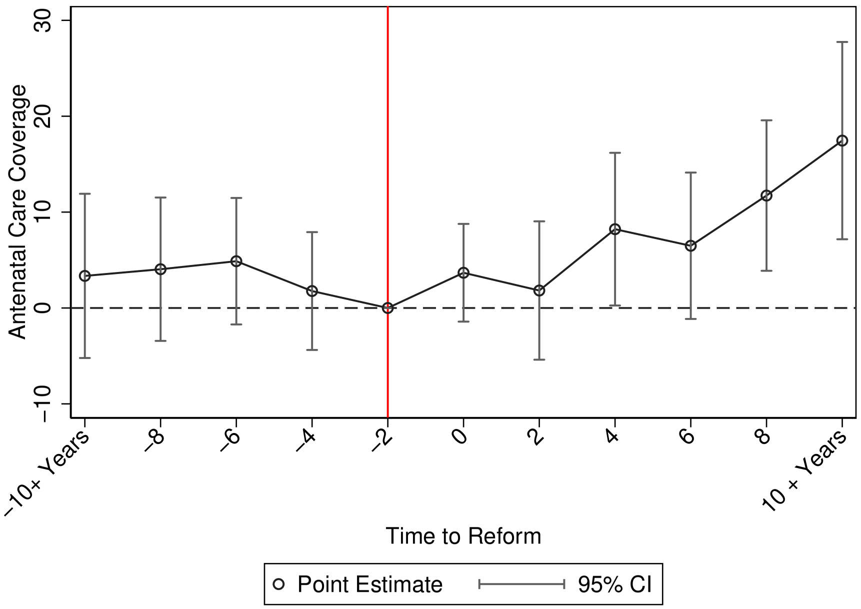
(b) ln(maternal mortality ratio)



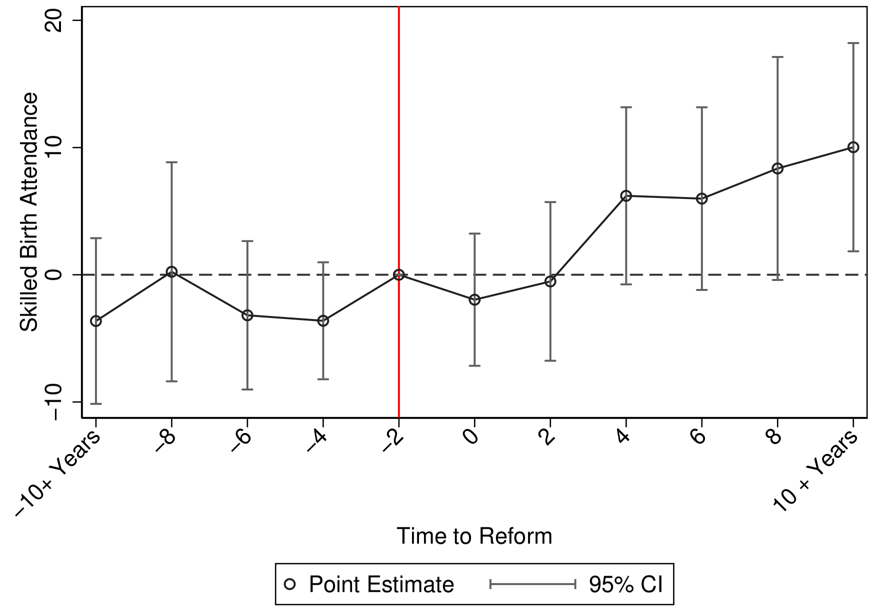
Notes: Point estimates of the lag and lead terms in the event study specification described in equation 1 are presented, along with their 95% confidence intervals. Estimates are conditional on country and year fixed effects, the natural logarithm of per capita GDP, and indicators for levels of the Polity IV democracy index. Time periods greater than 10 years from the reform date are displayed as a single "10 +" indicator. Standard errors are clustered by country. The omitted base category is taken as 1 year prior to the reform, indicated by the solid vertical line.

Figure 3: Mechanisms: Event studies for impacts of gender quotas on intermediate outcomes

(a) Antenatal Care



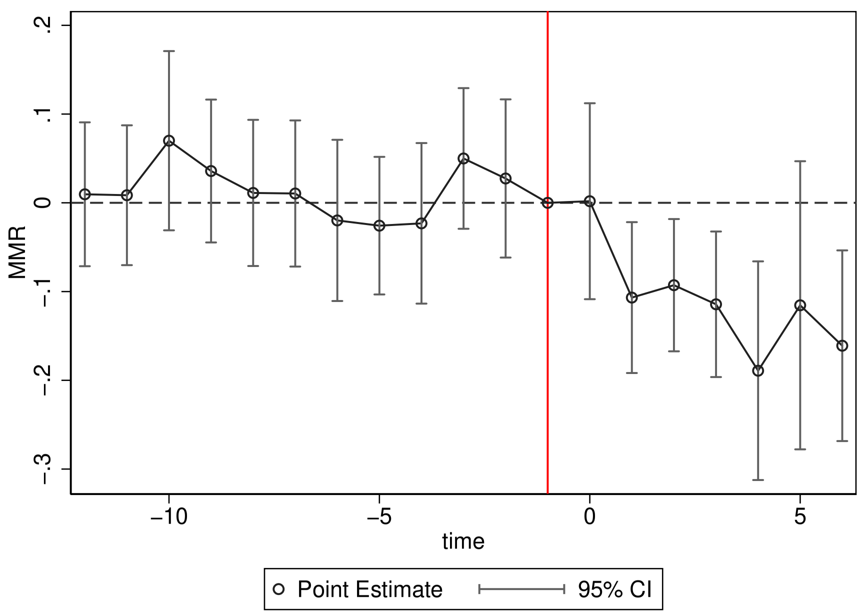
(b) Attended Births



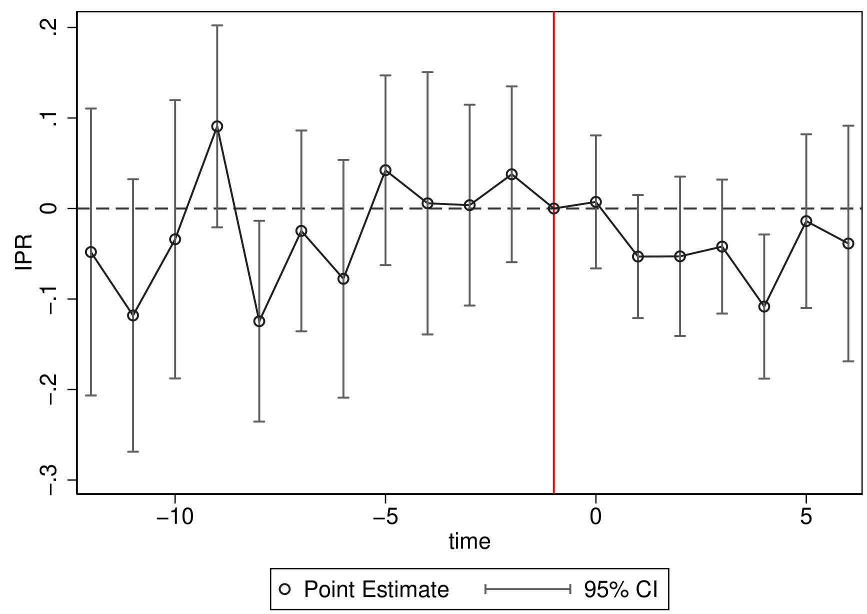
Notes: Event-study estimates of intermediate outcomes as a function of the passage of gender quotas, following specification 1. Antenatal coverage and birth attendance refer to the percentage of coverage, are accessed from the World Bank databank, and are only available for a sub-sample of years for each country (an unbalanced panel from 1990–2015). Given the unbalanced coverage of mechanism variables by countries and years, we present estimates pooling in 2 yearly bins, rather than yearly bins, to avoid unbalanced coverage in particular lag and lead terms where possible. Event studies are conditional on country and year fixed effects only. We present DD models with a single post-quota indicator in Table A9, showing robustness to controls, and to weighting by population. Additional data descriptions are available in the online Appendix.

Figure 4: Women's suffrage: Event studies for maternal mortality and pneumonia mortality

(a) ln(maternal mortality ratio)



(b) ln(rate of infant pneumonia mortality)



Notes: Event study plots differential rates of reduction of maternal mortality ratios (panel A) and infant pneumonia mortality rates (panel B) in early relative to late suffrage states, surrounding the arrival of Sulfa drugs (year 0). The omitted year is -1. All estimates are with respect to the prevailing differential one year prior to the reform. Standard errors associated with the 95% confidence intervals are clustered by state.

ONLINE APPENDIX

Maternal Mortality and Women's Political Participation

Sonia Bhalotra, Damian Clarke, Joseph Gomes, Atheendar Venkataramani

List of Figures

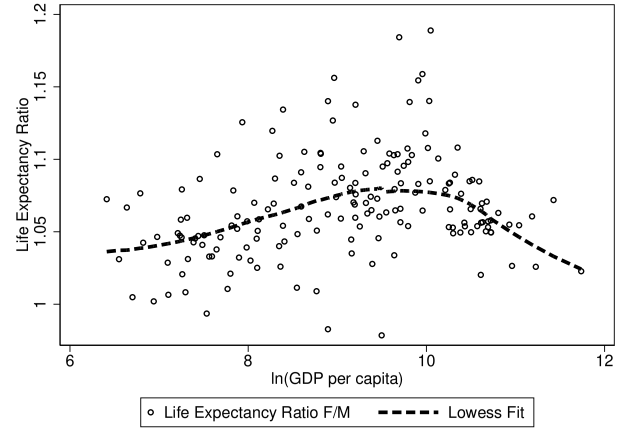
List of Tables

Figure A1: Life expectancy in 2010

(a) Female life expectancy

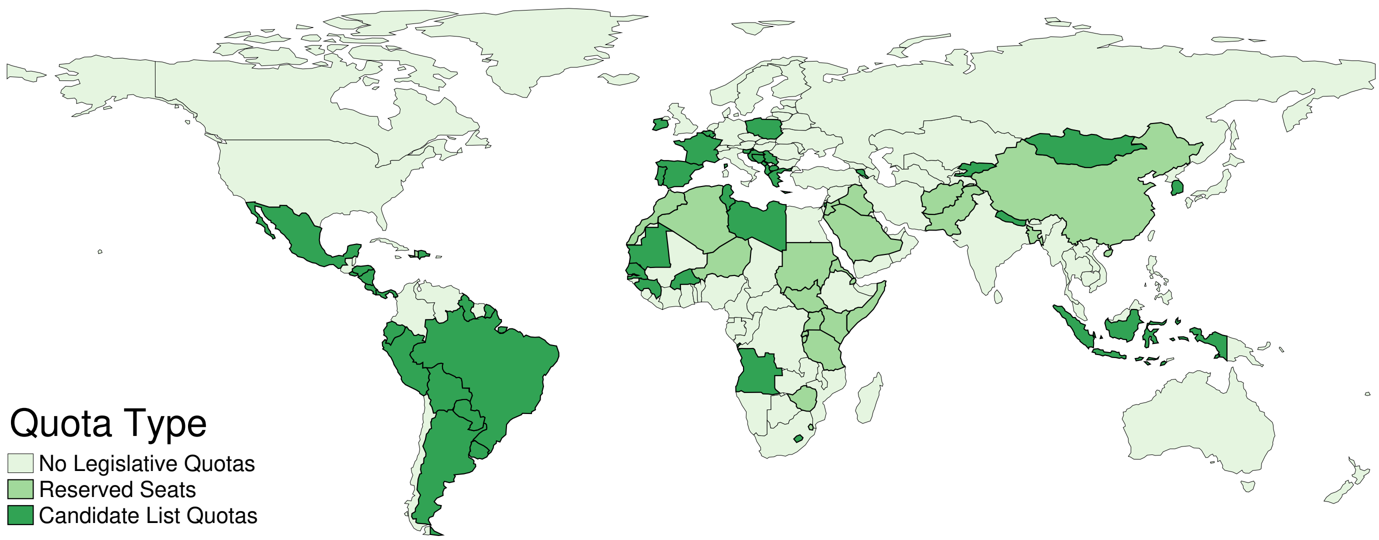
(b) Male life expectancy

(c) Female/male life expectancy ratio



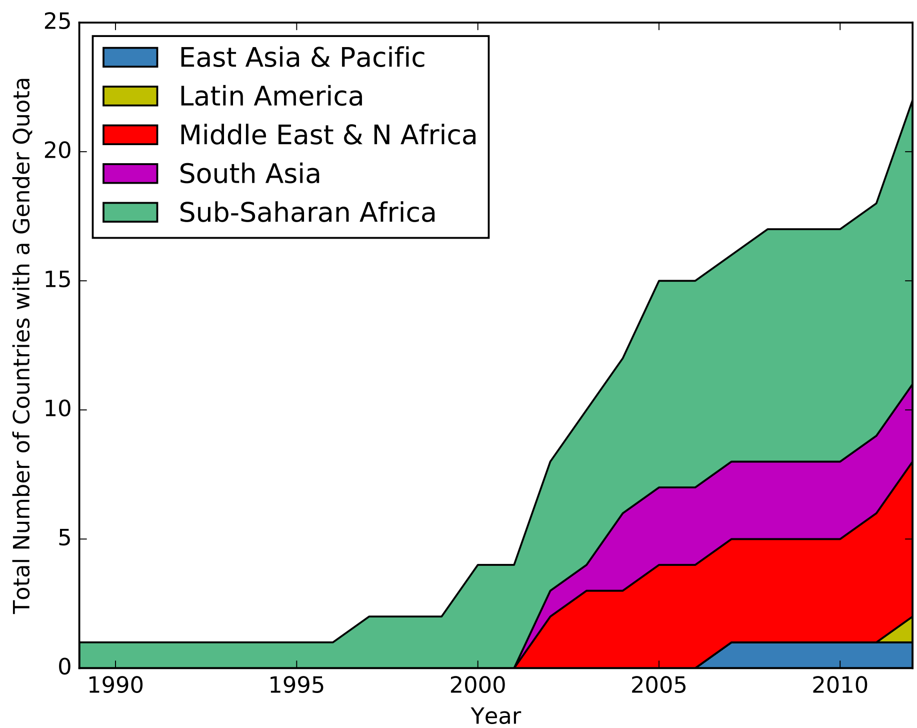
Notes: Life expectancy at birth and PPP-adjusted GDP per capita data are collated by the World Bank Data Bank. These indicators are SP.DYN.LE00.FE.IN (Female life expectancy) SP.DYN.LE00.MA.IN (Male life expectancy) and NY.GDP.PCAP.PP.KD (PPP adjusted GDP per capita). The life expectancy ratio is calculated as female life expectancy divided by male life expectancy for each country. Lowess fits are overlaid on scatter plots, using a bandwidth of 0.8 for local linear smoothing.

Figure A2: Quota coverage: 1990–2015



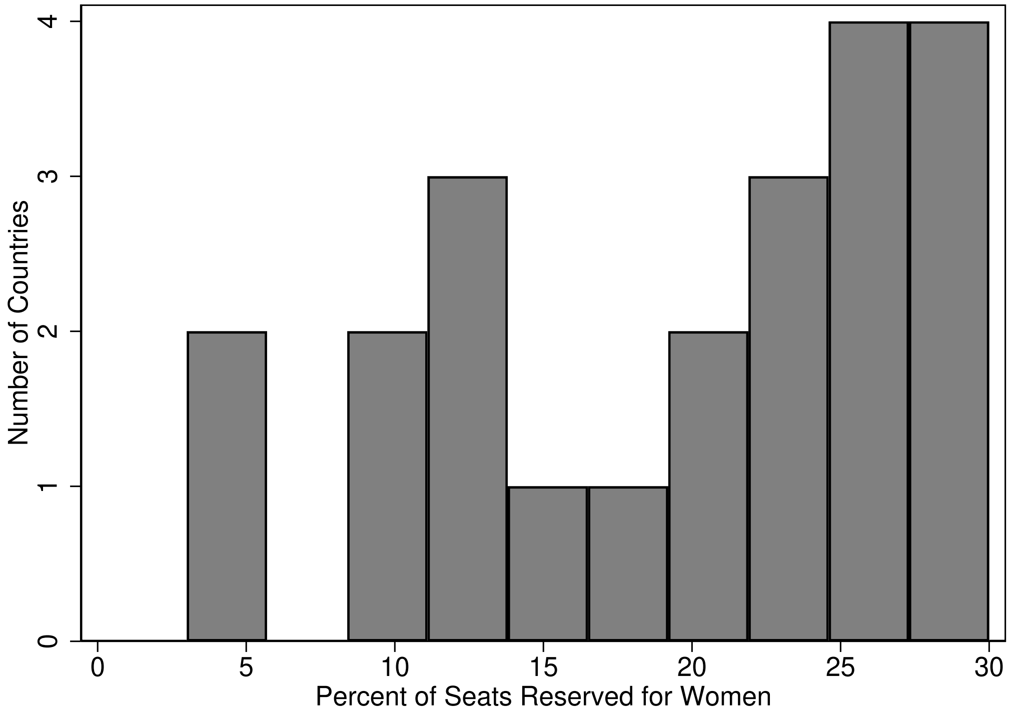
Notes: Geographic distribution of countries implementing a quota for reserved seats in parliament and candidate list quotas. Data compiled from Dahlerup (2005) and updated with information for recent years from the online quotaproject.org database developed and maintained by the International Institute for Democracy and Electoral Assistance (IDEA), the Inter-Parliamentary Union, and Stockholm University. This database was consulted on 19th of July, 2016.

Figure A3: Reserved seat quota timing: 1990–2012



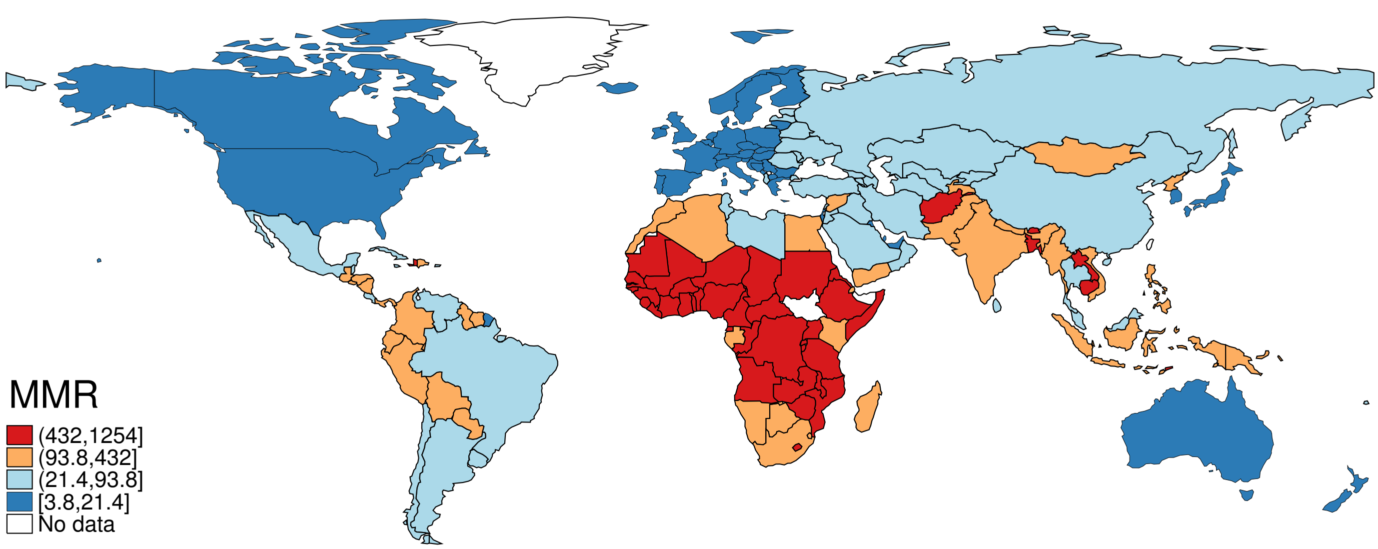
Notes: Timing of the implementation of reserved seats by geographic area. Additional notes in Figure A2.

Figure A4: Reserved seat quota sizes



Notes: This histogram describes the quota size for each country which adopts a reserved seat quota. Each country (quota) is included as a single observation.

Figure A5: Maternal mortality ratio: 1990–2015



Notes: Average rates by country for the period 1990–2015. Values are calculated as deaths per 100,000 live births, and are provided by WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division.

Table A1: Summary statistics for reserved seat analysis

	N	Mean	Std. Dev.	Min	Max
% Women in Parliament	4170	14.10	10.47	0.00	63.80
Maternal Mortality Ratio	4170	232.94	325.80	3.00	2890.00
Reserved Seats	4170	0.06	0.23	0.00	1.00
Male Mortality Rate (15-60)	4084	238.38	117.23	58.80	688.96
ln(GDP per capita)	4170	8.90	1.22	5.51	11.82
Polity IV Democracy score	3211	5.60	3.86	0.00	10.00
Percent of Pregnancies Receiving Prenatal Care	659	84.10	17.84	15.40	100.00
Percent of Births Attended by Skilled Staff	1191	83.42	24.22	5.00	100.00
Health Expenditure as a % of GDP	3139	6.23	2.39	0.72	17.10

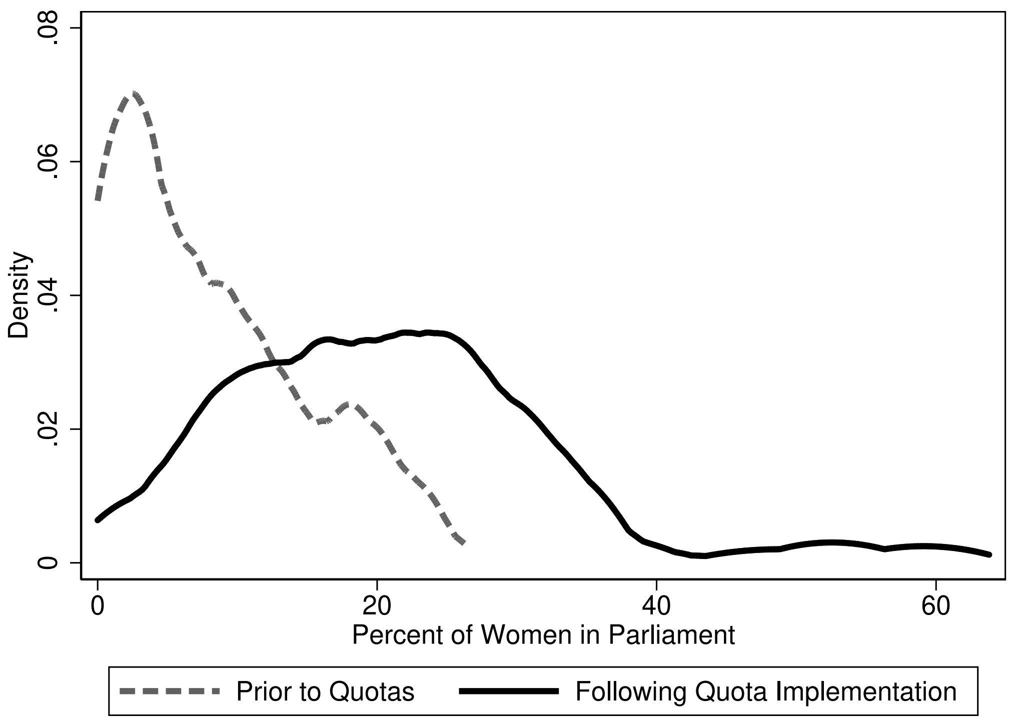
Notes: Refer to Data Appendix A for a full description of each variable and its source. The Maternal Mortality Ratio is measured as deaths per 100,000 live births. For comparison, the male mortality rate for 15–60 year-olds is expressed as per 1,000 male adults. Reserved seats is a binary variable taking one for each country and year pair where a quota was implemented, and 0 otherwise.

Table A2: Gender quotas: DD impacts on women in parliament and maternal mortality

	% Women in Parliament			ln(Maternal Mortality Ratio)			Maternal Mortality Ratio		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Reserved Seats	4.911**	5.544**	5.849***	-0.088*	-0.093*	-0.120*	-102.169**	-114.949**	-106.907***
	[2.220]	[2.247]	[1.761]	[0.050]	[0.052]	[0.068]	[47.491]	[48.218]	[24.260]
Mean of Dep. Var.	13.647	13.632	13.632	4.397	4.389	4.389	249.190	249.707	249.707
Observations	3212	3167	3167	3212	3167	3167	3212	3167	3167
Number of Countries	156	154	154	156	154	154	156	154	154
R-Squared	0.475	0.482	0.565	0.596	0.587	0.619	0.373	0.378	0.449
Population Weights	N	N	Y	N	N	Y	N	N	Y

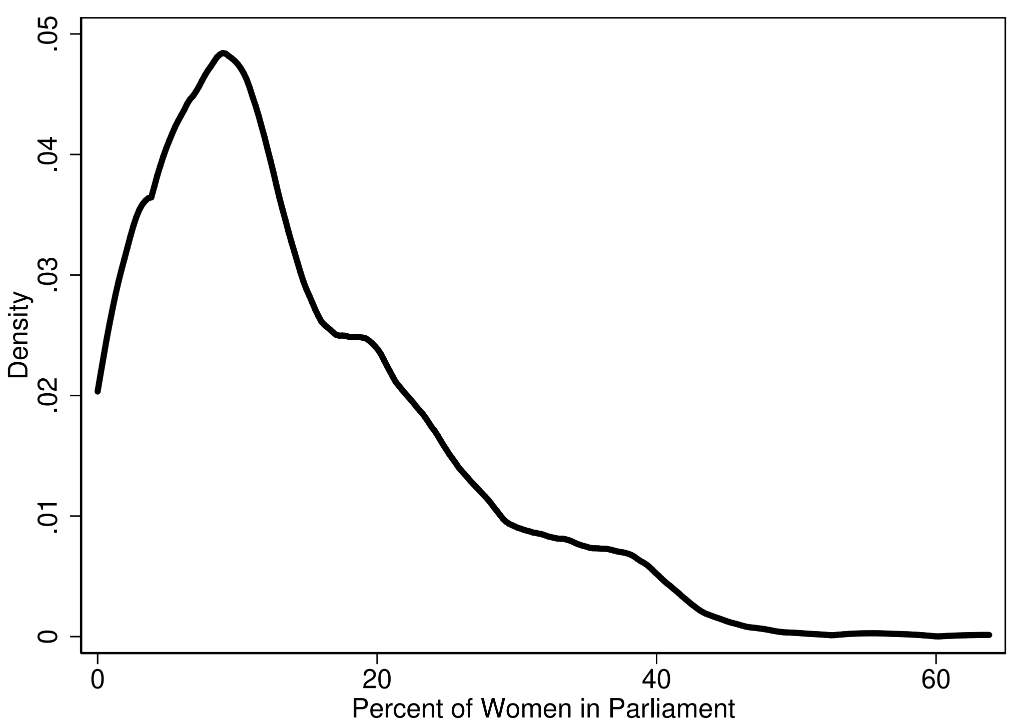
Difference-in-differences estimates of the impact of reserved seats in parliament on women in parliament (columns 1-3), the log of the maternal mortality ratio (columns 4-6), and MMR in levels (columns 7-9). In each case country and year fixed effects are included, and time-varying controls consist of the log of PPP adjusted GDP per capita, and a democracy score. Unweighted (columns 1-2, 4-5, and 7-8), and population weighted specifications (column 3, 6 and 9) are displayed. When weighting, China and India are removed from the estimation sample, to avoid regression results being largely driven by these two countries, with a population an order of magnitude larger than other countries. The unweighted specification without these countries is displayed in columns 2, 5 and 8. Standard errors clustered by country are displayed in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

Figure A6: Proportion of women in parliament in countries with reserved seats



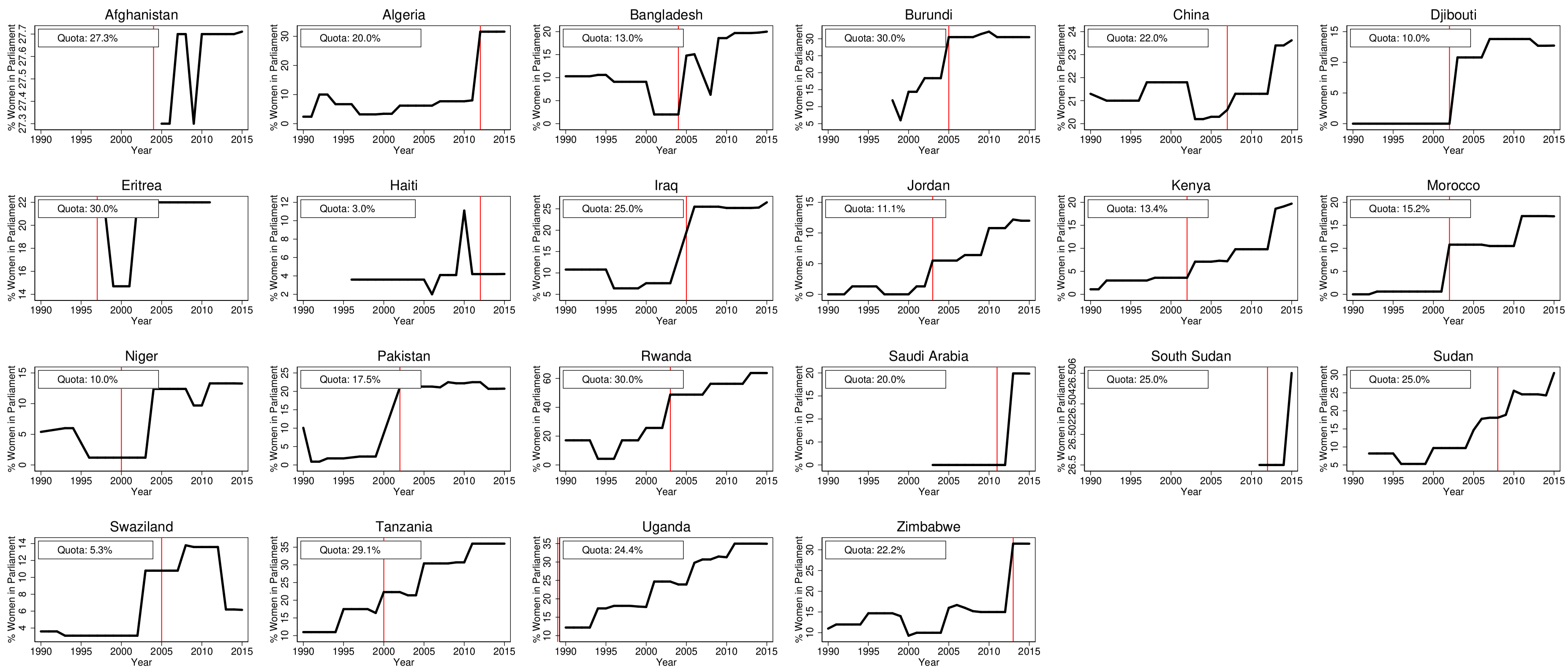
Notes: Density plots for the proportion of women in parliament in countries which at some point adopt a reserved seat quota. Plots are based on each country by year observation in the women in parliament data.

Figure A7: Proportion of women in parliament in all countries



Notes: Density plots describe the proportion of women in parliament in all countries and years under study.

Figure A8: Country-specific changes in women in parliament after reserved seat quotas

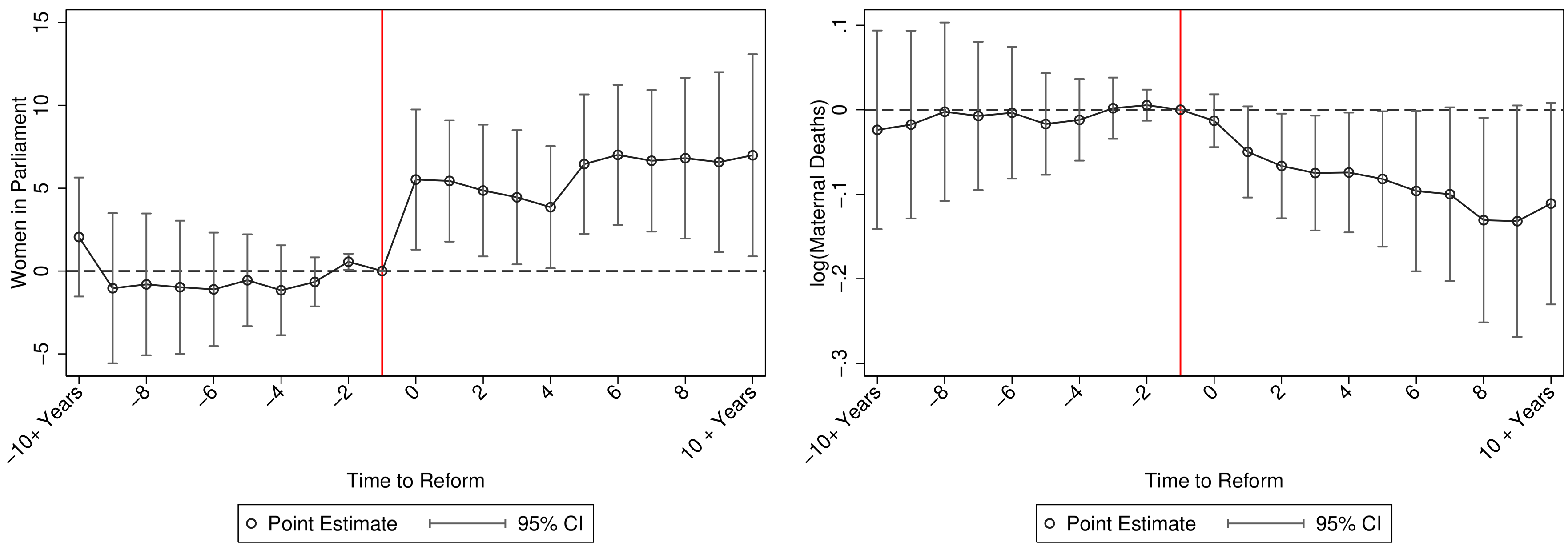


Notes: In each panel, the vertical lines display the recorded date of the passage of a reserved seat quota for women in the national parliament, and the plots show the evolution of the percentage of women in parliament.

Figure A9: Gender quotas: Event studies for women in parliament and maternal mortality without high-income countries

(a) Percent of women in parliament

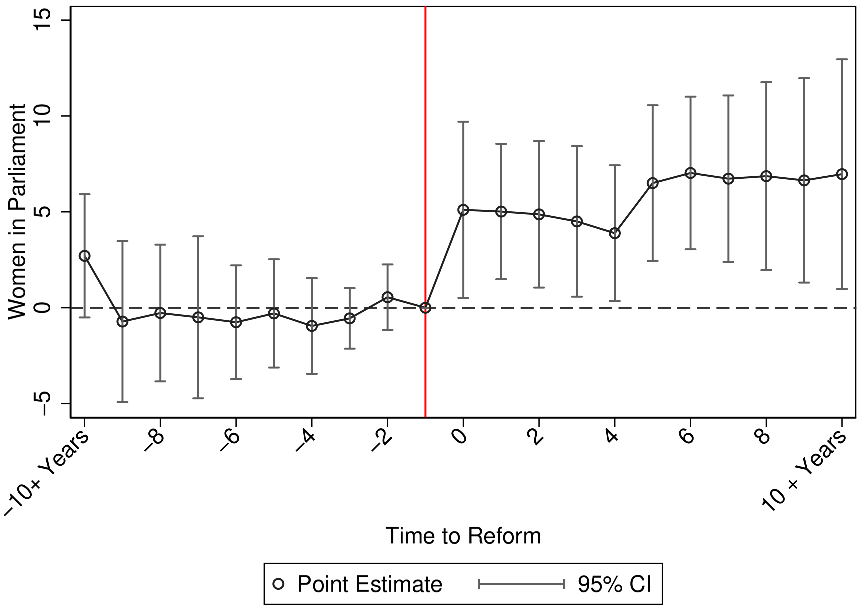
(b) ln(maternal mortality ratio)



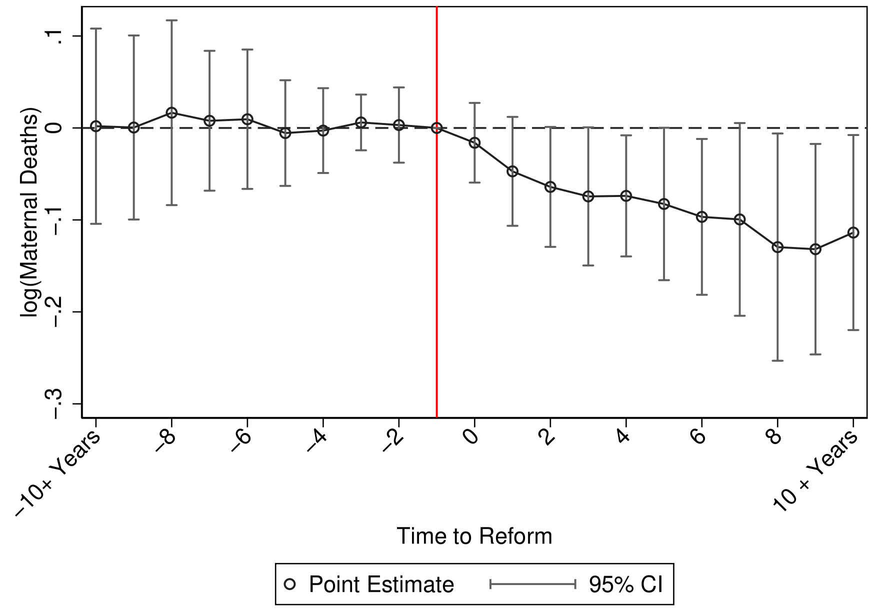
Notes: Event studies replicate those in Figure 2, however now without any countries classified as “high income” based on the World Bank’s income classification in 2015. A static (2015) measure of high income is used to ensure consistency of the sample across years. The estimation sample of non-high-income countries consists 2,309 yearly observations in 112 countries.

Figure A10: Gender quotas: Event studies for women in parliament and maternal mortality clustering by country and time

(a) Percent of women in parliament



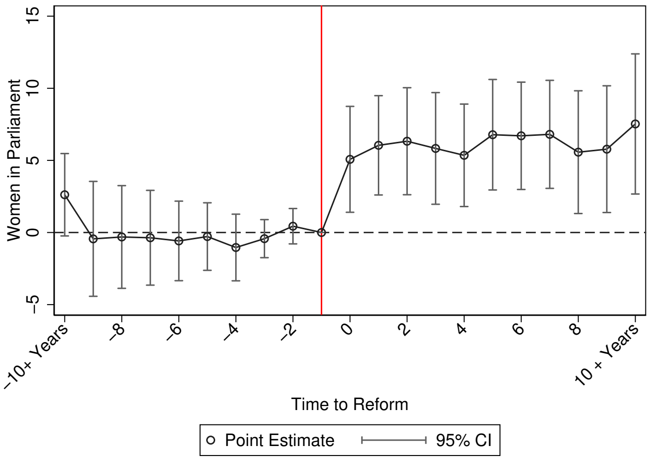
(b) ln(maternal mortality ratio)



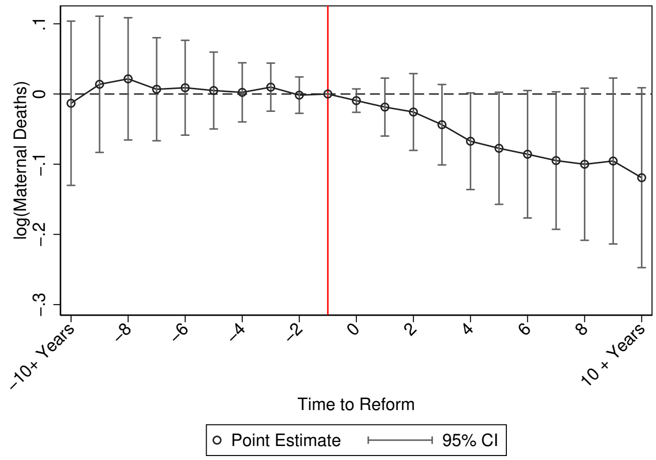
Notes: Specification replicate Figure 2, however now cluster by country and by year allowing temporal correlation in the stochastic error due to the wave of quota laws and additionally correlation within countries over time. Remaining details are identical to Figure 2.

Figure A11: Alternative specification of quota event study

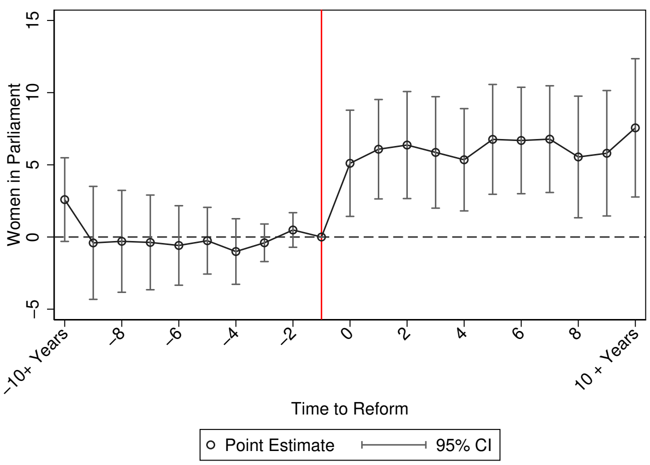
(a) Women in parliament with no controls



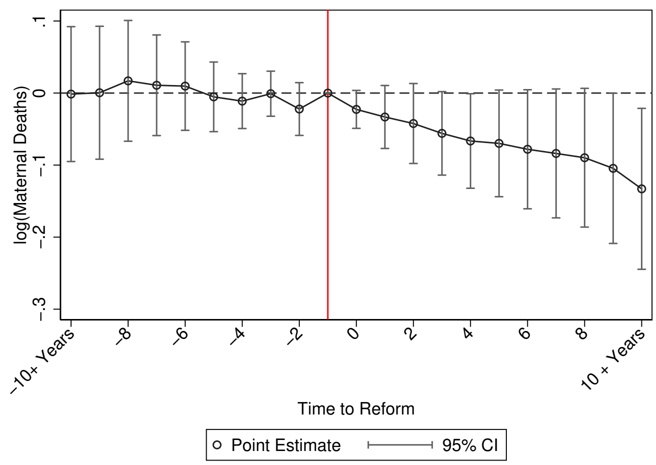
(b) ln(MMR) with no controls



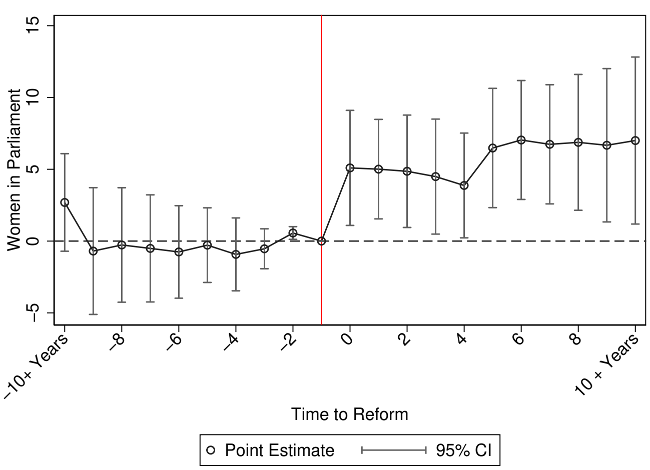
(c) Women in parliament with GDP control only



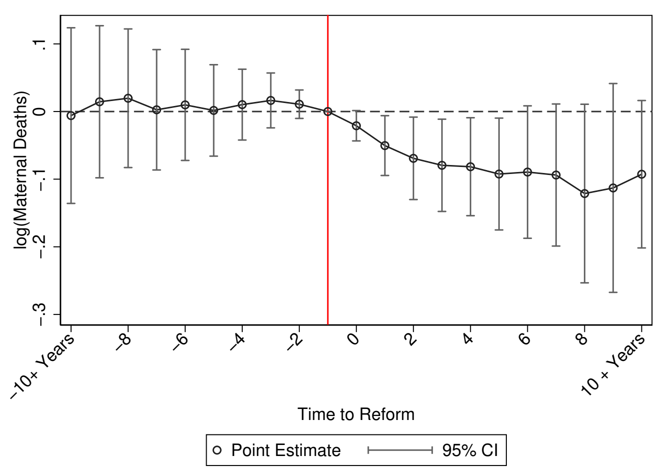
(d) ln(MMR) with GDP control only



(e) Women in parliament with democracy control only



(f) ln(MMR) with democracy control only



Notes: Alternative specifications of the event study shown in Figure 2. Specifications are shown with and without included controls, and with only GDP or only democracy controls. Results are robust to population weights, and additionally controlling for health spending per capita. Additional notes in Figure 2.

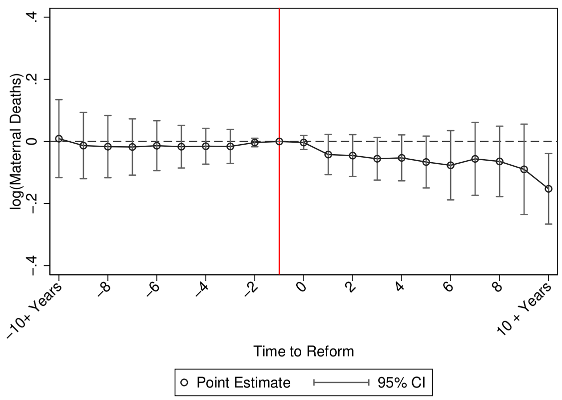
Table A3: Intensive margin impacts of reserved seats (binned by quota size)

	% Women in Parliament			ln(Maternal Mortality Ratio)		
	(1)	(2)	(3)	(4)	(5)	(6)
Reserved Seats (0-15]%	1.535	1.553	1.305**	-0.012	-0.013	-0.073
	[1.098]	[1.110]	[0.586]	[0.049]	[0.049]	[0.095]
Reserved Seats (15-20]%	5.526***	5.429***	7.322***	-0.086**	-0.088**	-0.174**
	[1.730]	[1.728]	[1.275]	[0.040]	[0.041]	[0.082]
Reserved Seats (20-30]%	7.679*	9.563**	10.362***	-0.175**	-0.199**	-0.120*
	[4.522]	[4.608]	[2.339]	[0.087]	[0.093]	[0.073]
Mean of Dep. Var.	13.647	13.632	13.632	4.397	4.389	4.389
Observations	3212	3167	3167	3212	3167	3167
Number of Countries	156	154	154	156	154	154
R-Squared	0.477	0.487	0.570	0.598	0.590	0.620
Population Weights	N	N	Y	N	N	Y

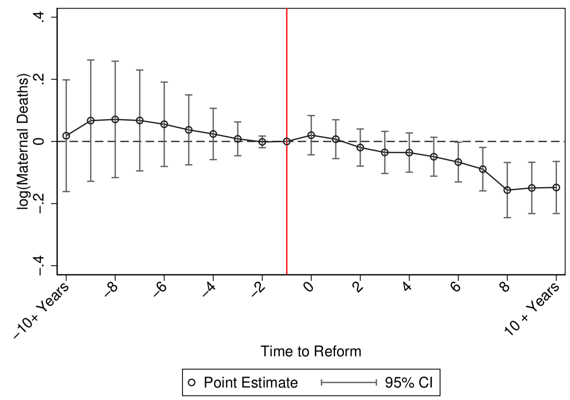
Difference-in-difference estimates of the impact of the size of the gender quota on women in parliament (columns 1-3) and maternal mortality (columns 4-6). Specifications follow Table A2, replacing the binary quota indicator with a binned indicator for quota size. Bins approximately seperate quotas into three equal groups. Each independent variable shown is equal to zero whenever reserved seats for women are not in place in a country, and equal to one when a reserved seat quota is in place, and is of the magnitude indicated in the independent variable listed in the table. Remaining details are available as notes to Table A2. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

Figure A12: Impact of Quotas on MMR by Baseline MMR

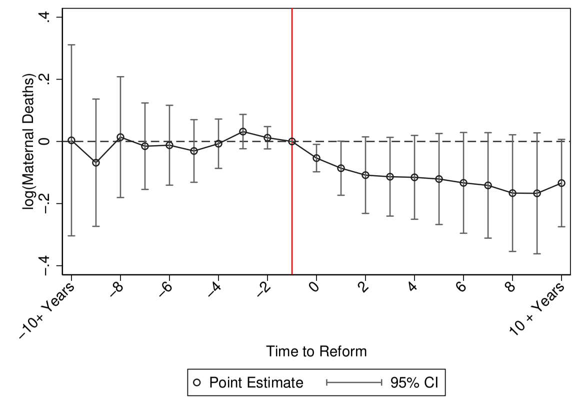
(a) “Low” baseline Rates (MMR <375)



(b) “Medium” baseline Rates (MMR [375,650))



(c) “High” baseline Rates (MMR ≥)



Notes: Baseline maternal mortality rates are calculated as average values in countries prior to the year 2000. Ranges above are chosen to approximately equally split the number quota-passing countries into each of the three groups. Each set of lags and leads are estimated in a single model, implying that each panel is conditional on the full set quota lags/leads in each country type.

Table A4: Reserved seats as an IV for women in parliament

	(1) ln(MMR)	(2) ln(MMR)	(3) ln(MMR)
% Women in Parliament	-0.018**	-0.017**	-0.021*
	[0.008]	[0.007]	[0.012]
F-Statistic First Stage	4.654	5.792	10.494
p-value First Stage	0.033	0.017	0.001
95% CI from Conley et al. (2012)	[-0.032;-0.001]	[-0.030;-0.002]	[-0.047;0.054]
Mean of Dep. Var.	4.397	4.389	4.389
Observations	3212	3167	3167
Number of Countries	156	154	154
Population Weights	N	N	Y

Instrumental variables regressions are run where gender quotas are used to instrument women in parliament. The first stage regression of women in parliament on reserved seats is displayed in columns 1-3 of Table A2. F-Statistic of the first stage and the associated p-value are traditional tests of instrumental relevance. Displayed coefficients give the effect of an additional percentage of women in parliament on rates of maternal mortality, where women in parliament is instrumented with reserved seats. The 95% confidence interval from Conley et al. (2012) is a robustness test, where we allow the instrument to be imperfect in the sense that the exclusion restriction is only close to holding. These confidence intervals are associated with the estimates where quotas are able to have a direct effect in reducing MMR that is *not* mediated by women in parliament of 0.01 (or 1%) using Conley et al. (2012)'s Union of Confidence Intervals (UCI) approach. Each regression includes country and year fixed effects and clusters standard errors by country. * p<0.10; ** p<0.05; *** p<0.01.

Table A5: The passage of reserved seat legislation

	No Country Fixed Effects			Country Fixed Effects		
	(1)	(2)	(3)	(4)	(5)	(6)
Overseas Development Assistance	0.002	-0.007	-0.021	-0.026	-0.021	-0.034
	[0.016]	[0.020]	[0.029]	[0.020]	[0.031]	[0.036]
Peace Keepers	0.002	0.015**	0.018*	0.003**	0.017**	0.020**
	[0.001]	[0.008]	[0.010]	[0.001]	[0.008]	[0.010]
Change in Women's Rights	0.006*	0.006*	0.006*	0.006*	0.006*	0.006*
	[0.003]	[0.003]	[0.004]	[0.003]	[0.003]	[0.003]
Right Wing Executive	-0.001	-0.001	-0.001	-0.001	-0.000	-0.001
	[0.001]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Left Wing Executive	-0.002	-0.002	-0.002	-0.002	-0.003	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.003]	[0.002]
Years in Power	-0.000	-0.000	-0.000	-0.001	-0.001	-0.001
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Herfindahl Index	-0.001	-0.003	-0.003	-0.003	-0.004	-0.004
	[0.005]	[0.005]	[0.005]	[0.006]	[0.007]	[0.008]
Vote Share Opposition	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Transitioning Regime	0.006	0.007	0.008	0.007	0.009	0.010
	[0.005]	[0.005]	[0.006]	[0.006]	[0.007]	[0.008]
First Lag (ODA)		0.025	0.003		0.004	-0.009
		[0.030]	[0.030]		[0.029]	[0.028]
First Lag (peace keepers)		-0.015**	-0.021		-0.015*	-0.022
		[0.008]	[0.015]		[0.008]	[0.015]
First Lag (Δ Womens Rights)		0.001	0.000		0.001	0.000
		[0.002]	[0.002]		[0.002]	[0.002]
Second Lag (ODA)			0.038			0.020
			[0.029]			[0.024]
Second Lag (peace keepers)			0.004			0.006
			[0.007]			[0.008]
Second Lag (Δ Womens Rights)			-0.001			-0.001
			[0.004]			[0.004]
Observations	2786	2628	2472	2786	2628	2472
Number of Countries	165	164	164	165	164	164
R-Squared	0.019	0.037	0.040	0.018	0.035	0.038

Each column regresses a variable indicating whether a quota law was passed in a given year on potential predictors of quota adoption suggested in the political science literature. Each specification includes year fixed effects and standard errors are clustered by country. Overseas Development Assistance (ODA) measured as net inflows in current US dollars divided by GDP in current US dollars is generated from the World Bank Data Bank. Peacekeepers (measured in 1000s) are from the IPI Peacekeeping Database, changes in women's rights refer to changes in economic rights for women as compiled by the CIRI Human Rights Data Project, and political measures including the orientation of leader's party, the time in power, Herfindahl Index of parties, vote shares and regime types and changes are recorded by the Database of Political Institutions. Additional lags of relevant variables are included in columns 2 and 3, and 5 and 6. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

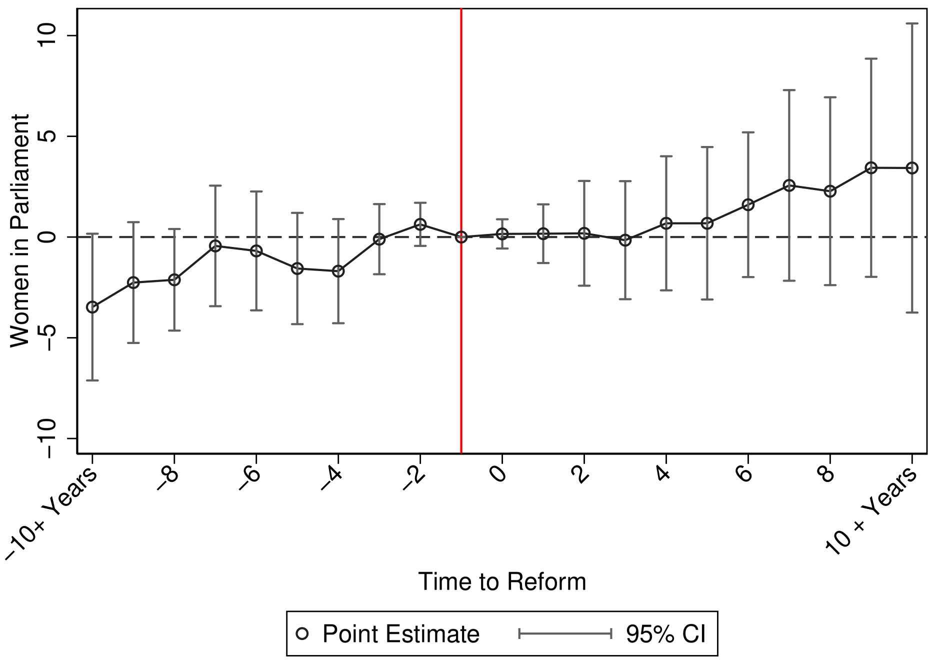
Table A6: Estimates including all potential quota predictors

	ln(Maternal Mortality Ratio)		% Women in Parliament	
	(1)	(2)	(3)	(4)
Reserved Seats	-0.088*	-0.090*	4.911**	6.184**
	[0.050]	[0.051]	[2.220]	[2.677]
Overseas Development Assistance		0.079		-4.154
		[0.080]		[4.181]
Peace Keepers		-0.002		0.066
		[0.002]		[0.147]
Change in Women's Rights		0.005		0.227
		[0.005]		[0.187]
Right Wing Executive		0.013		-0.356
		[0.021]		[0.418]
Left Wing Executive		-0.054		0.429
		[0.037]		[0.605]
Years in Power		0.000		0.084**
		[0.001]		[0.037]
Herfindahl Index		-0.046		1.083
		[0.043]		[1.178]
Vote Share Opposition		-0.001**		-0.025**
		[0.000]		[0.011]
Transitioning Regime		-0.008		1.020**
		[0.013]		[0.457]
First Lag (ODA)		0.052		-1.565
		[0.051]		[2.349]
Second Lag (ODA)		0.011		0.372
		[0.074]		[2.436]
First Lag (peace keepers)		-0.000		-0.079
		[0.003]		[0.209]
Second Lag (peace keepers)		-0.000		0.019
		[0.004]		[0.180]
First Lag (Δ Womens Rights)		0.006		0.159
		[0.006]		[0.215]
Second Lag (Δ Womens Rights)		0.001		0.180
		[0.005]		[0.162]
Observations	3212	2347	3212	2347
Number of Countries	156	152	156	152
R-Squared	0.596	0.597	0.475	0.494
Proposed Predictors	N	Y	N	Y

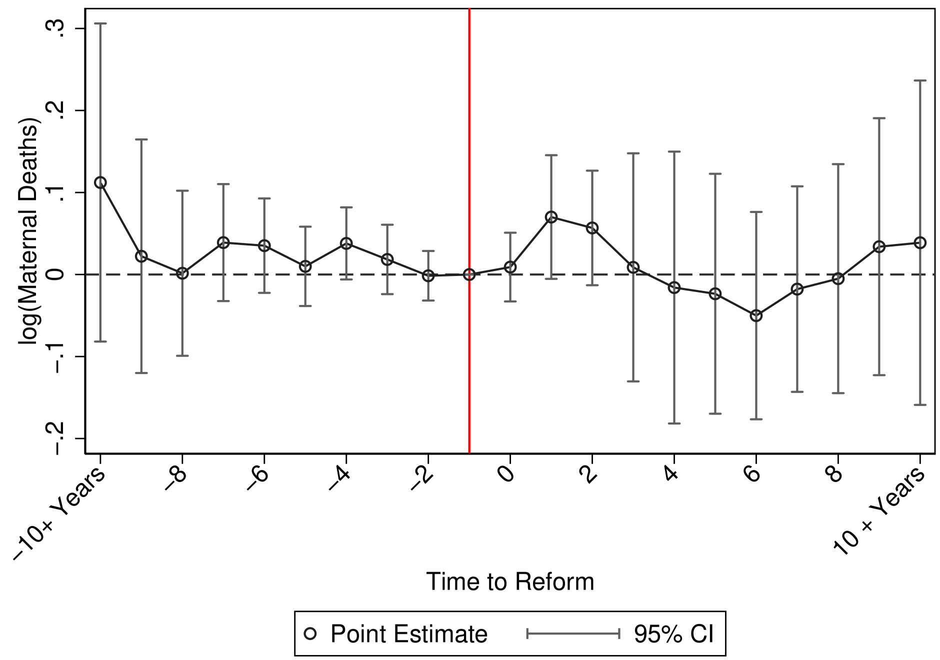
The regressions include country and year fixed effects and controls for log GDP and a democracy index. All potential predictors of quotas, described in Table A5, are included as controls. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

Figure A13: Candidate List Quotas: Event studies for women in parliament and maternal mortality

(a) Women in parliament



(b) ln(MMR)



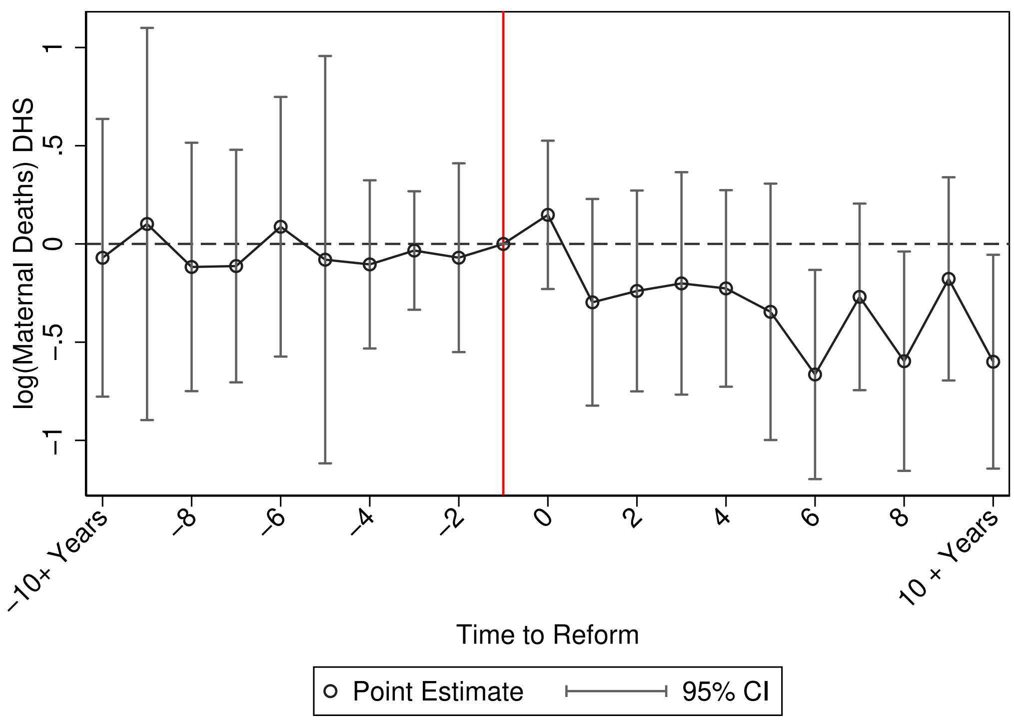
Notes: Identical specifications are estimated as in Figure 2, however now with countries passing candidate list quotas. Each event study is weighted using country populations, however results are similar without population weights. Difference-in-difference estimates from a single-coefficient model suggest an increase in 1.776 (standard error 2.172) in the proportion of women in parliament following reserved seat quotas, and a reduction of 0.017 (standard error 0.071) in log(MMR). Analogous values for unweighted estimates are 3.569 (s.e. 1.180) for women in parliament, and 0.032 (s.e. 0.055) for log(MMR). Countries implementing candidate list quotas in the period under study are Albania, Angola, Argentina, Armenia, Belgium, Bolivia, Bosnia and Herzegovina, Brazil, Burkina Faso, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, France, Greece, Guinea, Guyana, Honduras, Indonesia, Ireland, South Korea, Kyrgyz Republic, Lesotho, Macedonia, Mauritania, Mexico, Mongolia, Montenegro, Nepal, Nicaragua, Panama, Paraguay, Peru, Poland, Portugal, Senegal, Serbia, Slovenia, Spain, Tunisia and Uruguay.

Table A7: Alternative Inference Procedures for Measures of Maternal Mortality in Principal Diff-in-Diff Specification

	ln(Maternal Mortality Ratio)			Maternal Mortality Ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
Reserved Seats (Point Estimate)	-0.088	-0.093	-0.120	-102.169	-114.949	-106.907
p-value Bootstrap	0.096	0.090	0.115	0.040	0.020	0.002
p-value Triangular Correction	0.117	0.112	0.149	0.044	0.022	0.002
p-value Triangular Correction by Country	0.098	0.091	0.118	0.046	0.024	0.002
p-value Normal Correction	0.200	0.190	0.226	0.055	0.030	0.007
p-value Normal Correction by Country	0.097	0.092	0.113	0.069	0.039	0.005
Mean of Dep. Var.	4.397	4.389	4.389	249.190	249.707	249.707
Observations	3212	3167	3167	3212	3167	3167
Number of Countries	156	154	154	156	154	154
R-Squared	0.596	0.587	0.619	0.373	0.378	0.449
Population Weights	N	N	Y	N	N	Y

Difference-in-differences estimates of the impact of reserved seats in parliament on log of the maternal mortality ratio (columns 1-3), and MMR in levels (columns 4-6) replicate results from Table A2 of the working paper. Point estimates are presented, and below p-values associated with each point estimate, based on different procedures for re-sampling the uncertainty of measures of maternal mortality. In each case, re-samples are taken over country clusters, as treatment is defined at the level of the country.

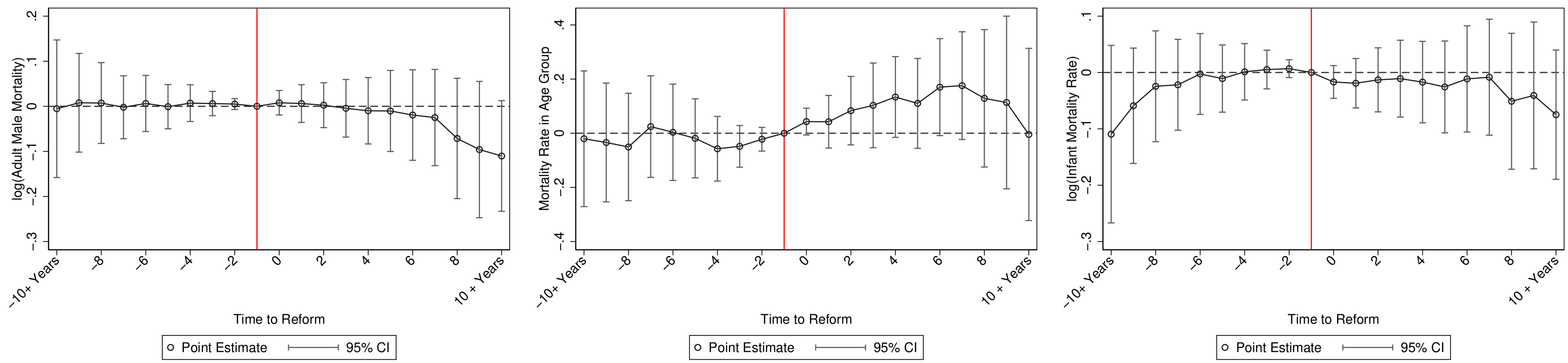
Figure A14: Event studies for maternal mortality using crude DHS microdata



Notes: Maternal mortality is recorded from Demographic and Health Survey (DHS) microdata where surveyed women report all of their sisters, as well as any whether any sisters died for causes related to child birth, and the year of death (if relevant). We generate maternal mortality rates using retrospective sisterhood survival histories from DHS surveys in the 68 publicly available DHS countries which additionally have included the maternal mortality module, asking surveyed women about their sisters' survival status. This data module was implemented in 44 DHS countries.

Figure A15: Event Studies for the impact of gender quotas on male or gender neutral health outcomes

(a) Male adult mortality (b) Tuberculosis mortality (c) Infant mortality



Notes: Identical event studies are plotted to those in Figure 2, however alternative male or gender neutral health outcomes are used. These outcomes are male mortality per 1,000 adult males (ages 15–60) the rate of death due to TB per 100,000 individuals, and infant mortality per 1,000 live births. For comparison with Figure 2b, the natural logarithm of each variable is used, with the exception of TB mortality, where an inverse sine transformation is used, given a small number of country-year observations where a rate of zero is observed.

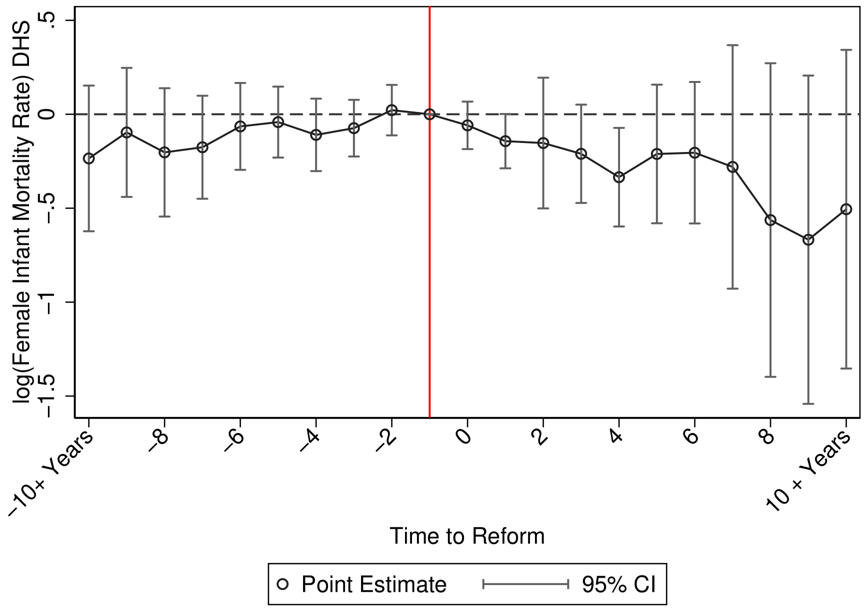
Table A8: Gender quotas: DD impacts on TB mortality, Adult Male Mortality and Infant Mortality

	inv sin(TB Mortality)			ln(Male Mortality)			ln(Infant Mortality)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Reserved Seats	0.123	0.149	0.024	-0.034	-0.035	-0.018	0.004	0.016	0.024
	[0.119]	[0.121]	[0.096]	[0.055]	[0.058]	[0.057]	[0.049]	[0.051]	[0.072]
Mean of Dep. Var.	2.691	2.680	2.680	5.391	5.394	5.394	3.164	3.156	3.156
Observations	3212	3167	3167	3208	3163	3163	3212	3167	3167
Number of Countries	156	154	154	156	154	154	156	154	154
R-Squared	0.411	0.405	0.544	0.496	0.492	0.588	0.799	0.796	0.849
Population Weights	N	N	Y	N	N	Y	N	N	Y

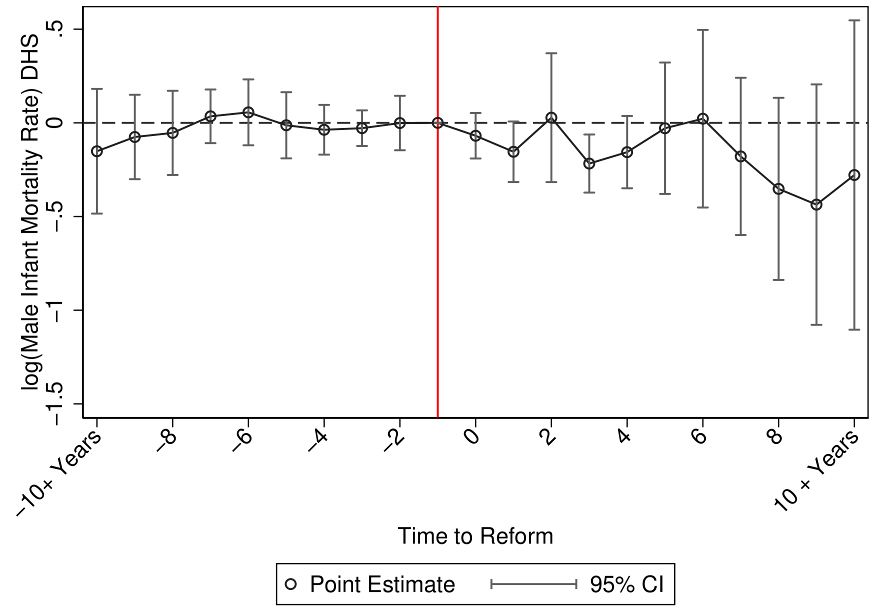
Difference in difference specification following that in Table A2, with identical controls and fixed effects. We now examine estimates for impacts of gender quotas on tuberculosis and male and the infant mortality rates. Tuberculosis is measured as incidence per 100,000 people, and mortality is measured as per 1,000 male adults (15-60). In the case of TB mortality, an inverse hyperbolic sine transformation is taken rather than a logarithmic transformation given a small number of zero outcomes which would otherwise be omitted from the sample. This transformation allows for a similar interpretation as a logarithmic transformation, but is defined at zero. Further notes are available in Table A2. Standard errors clustered by country are displayed in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

Figure A16: Event studies for female and male infant mortality using DHS microdata

(a) ln(female infant mortality)



(b) ln(male infant mortality ratio)

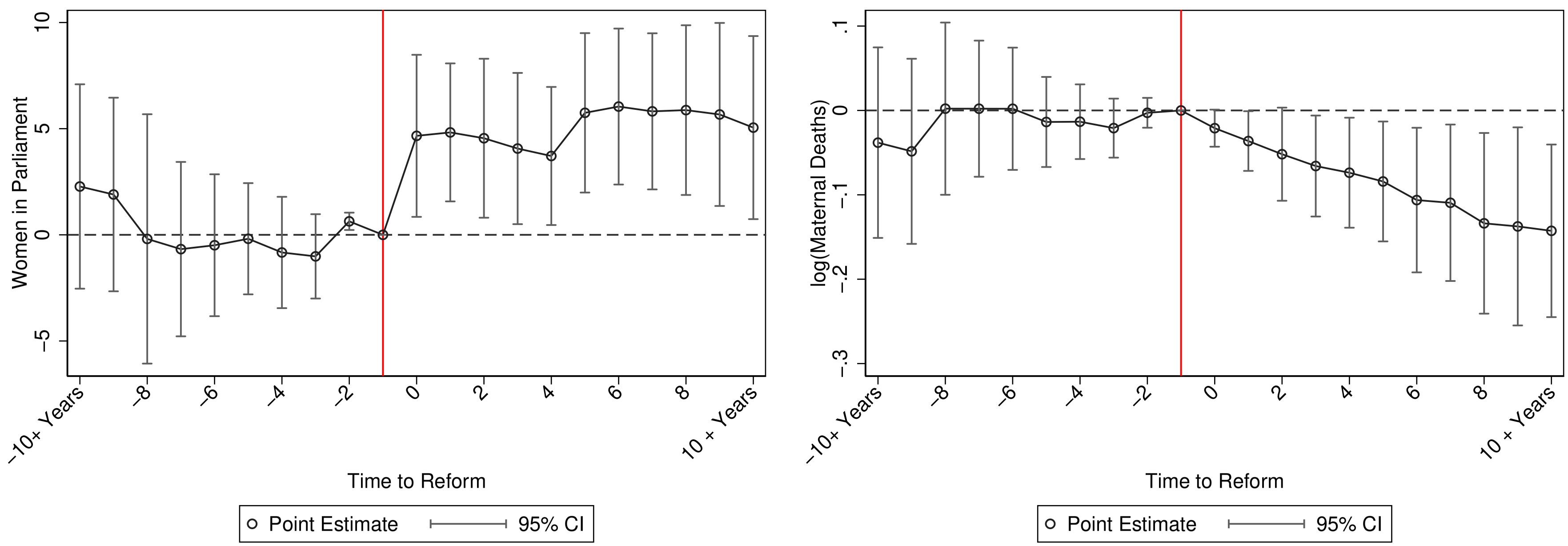


Notes: Infant mortality is recorded from Demographic and Health Survey (DHS) microdata where mothers report their full fertility history, any children who have died, their child's age at death (if relevant) and the year of death (if relevant). We generate infant mortality rates using retrospective fertility and survival histories for DHS surveys in the 68 publicly available DHS countries.

Figure A17: Gender quotas: Event studies for women in parliament and maternal mortality controlling for health expenditure

(a) Percent of women in parliament

(b) ln(maternal mortality ratio)



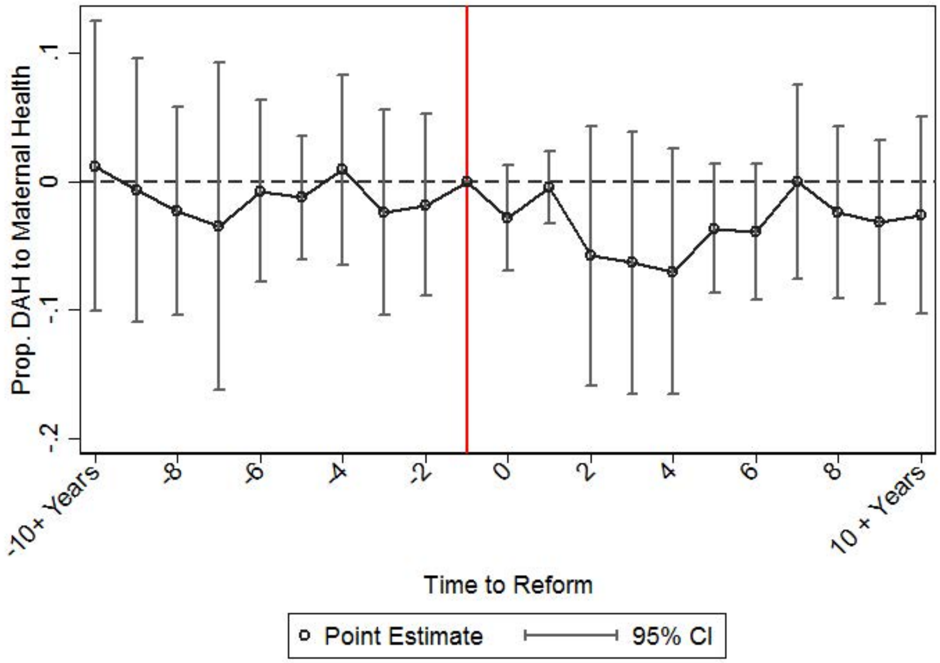
Notes: Event studies replicate Figure 2, controlling for the time-varying measure of health spending as a proportion of GDP per-capita.

Table A9: Mechanisms: impacts of gender quotas on intermediate outcomes

	Antenatal Care			Attended Births			Health Spending		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Reserved Seats	4.661	7.414**	9.184***	6.374**	8.819***	7.746***	0.626	0.624	-0.277
	[3.383]	[3.055]	[2.523]	[3.148]	[2.843]	[2.275]	[0.468]	[0.498]	[0.323]
Mean of Dep. Var.	82.673	82.641	82.641	83.024	82.964	82.964	6.132	6.157	6.157
Observations	526	500	500	996	970	970	2586	2550	2550
Number of Countries	134	132	132	149	147	147	155	153	153
R-Squared	0.506	0.521	0.721	0.360	0.370	0.687	0.226	0.227	0.452
Population Weights	N	N	Y	N	N	Y	N	N	Y

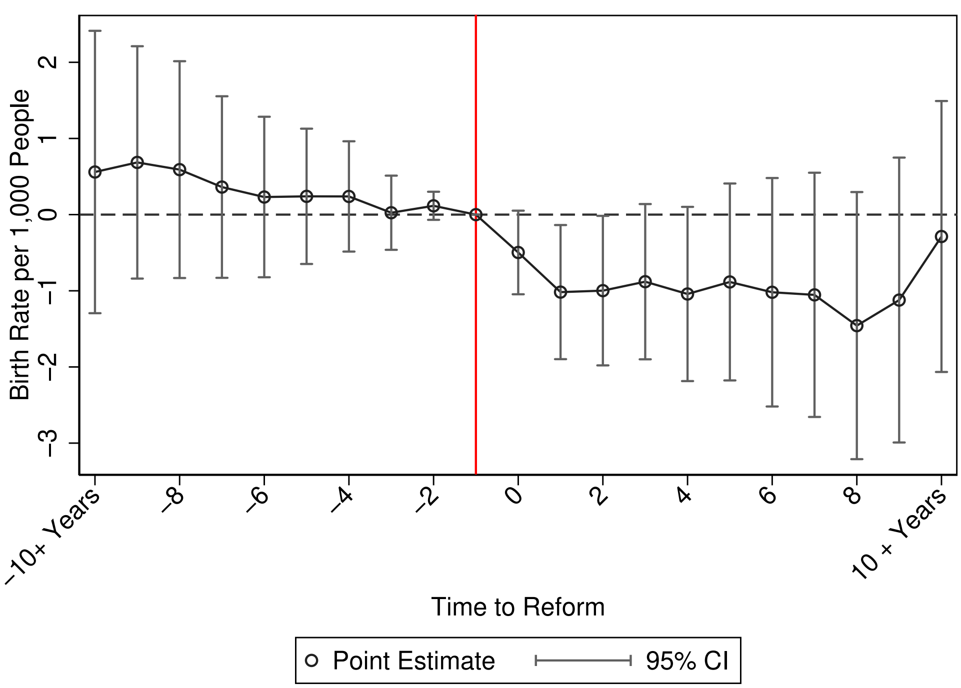
Difference in difference models of intermediate outcomes as a function of the passage of gender quotas, where gender quotas is the second lag of the passage of quota laws. In each case, we control for the log of PPP adjusted GDP per capita, and a democracy score. Antenatal care coverage and birth attendance are newly harmonized data available for 1990-2015, however only available in a sub-sample of years for each particular country. Health spending is measured as expenditure as a percent of GDP, and is produced by the World Health Organization Global Health Expenditure database. Unweighted, and population weighted specifications are displayed. When weighting, China and India are removed from the estimation sample, to avoid regression results being largely driven by these two countries with a population an order of magnitude larger than other countries. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

Figure A18: Development Assistance for Maternal Health and Quota Passage



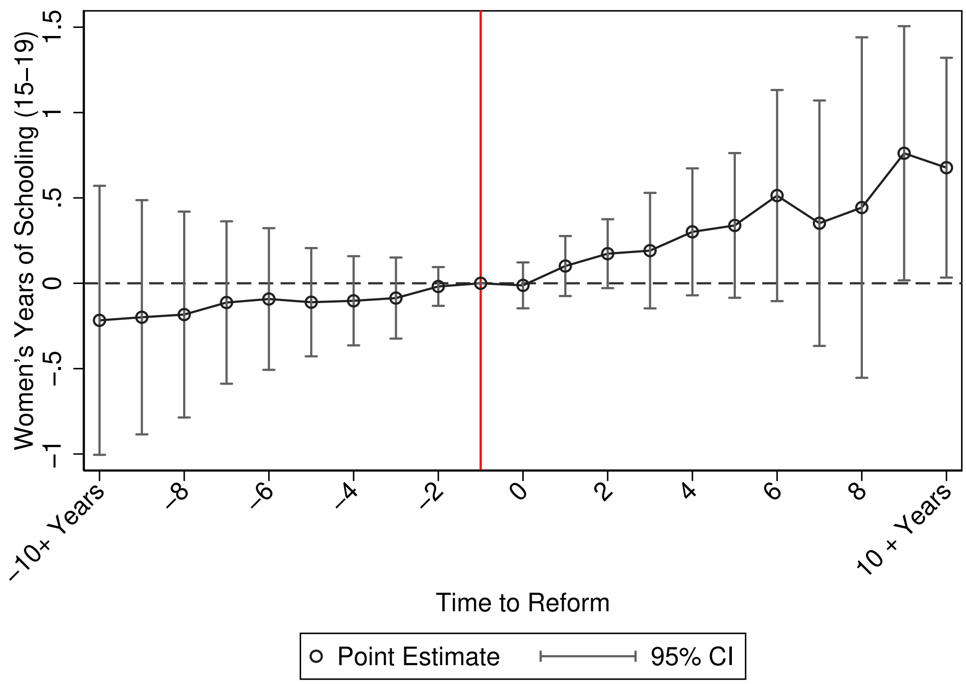
Notes: Proportion of development assistance for health that goes towards maternal health based on the Institute for Health Metrics and Evaluation (IHME) Development Assistance for Health Database

Figure A19: Birth Rates and Quota Passage



Notes: Birth rates are expressed as per the full population, and are available as World Bank indicator SP.DYN.CBRT.IN.

Figure A20: Women's Years of Schooling (Average Years for 15-19 Year Olds)



Notes: These values are taken from Barro-Lee which gives average years of schooling for women aged 15-19 years. Barro-Lee is only available quinquennially from 1950 to 2015. We use the sample from 1990–2015, and linearly interpolate by country between 5 year periods.

Figure A21: log(GDP per capita) and Quota Passage

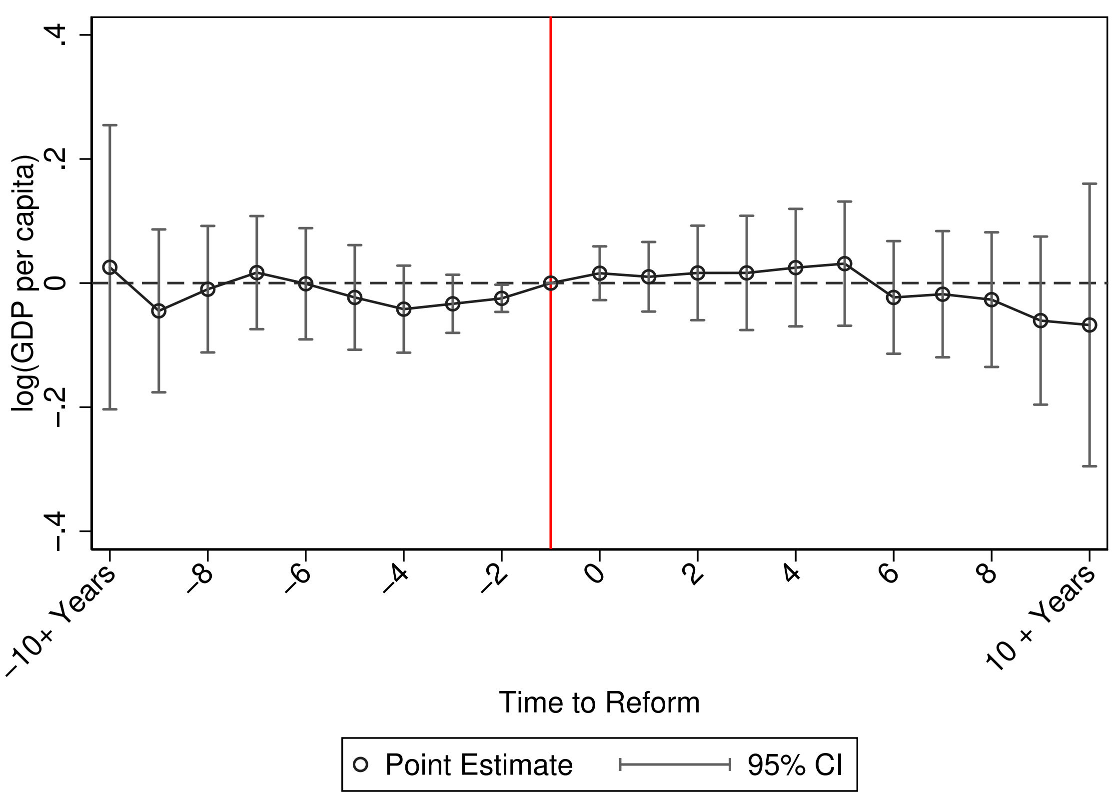
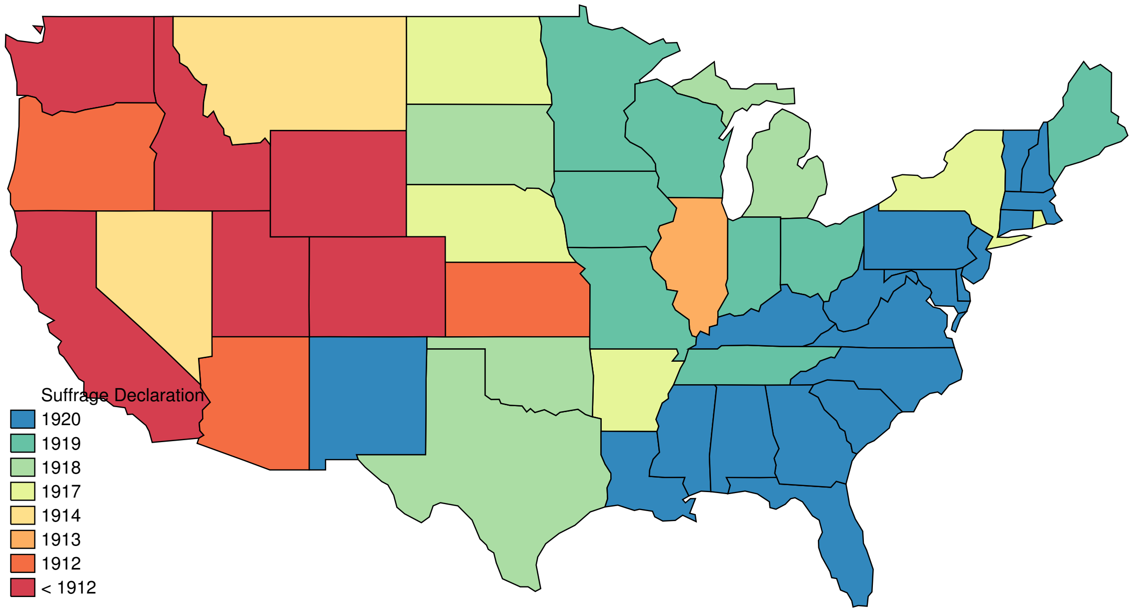


Figure A22: Suffrage timing by state



Notes: States declaring Suffrage in 1920 with the passing of the 19th Amendment (dark blue color) are "late suffrage" states. Suffrage data are from Miller (2008).

Table A10: Summary statistics for suffrage/sulfa analysis

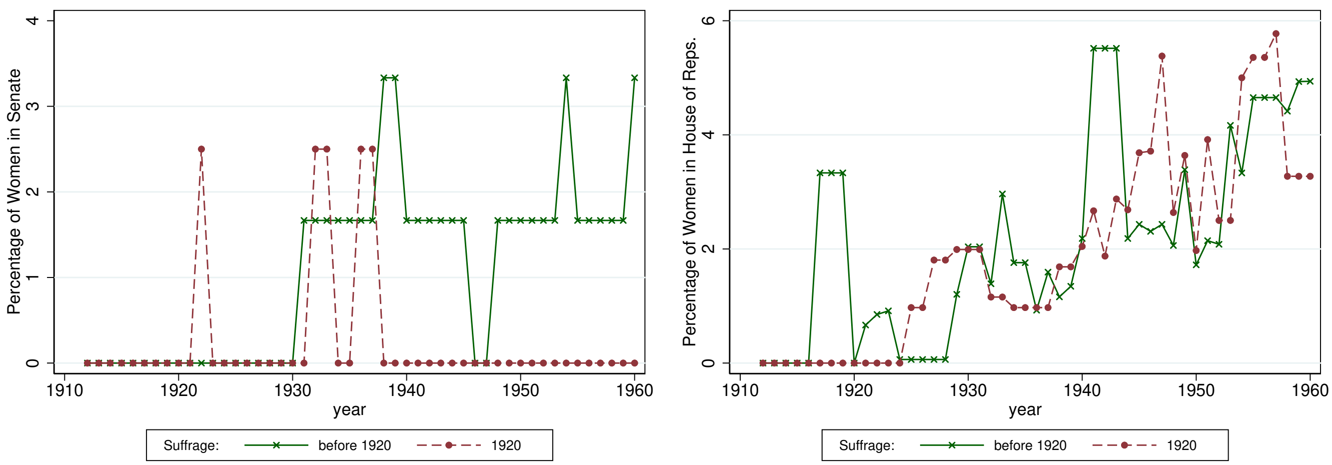
	N	Mean	Std. Dev.	Min	Max
Maternal Mortality Ratio	868	539.57	206.35	70.00	1210.00
Infant Pneumonia Mortality Ratio	868	102.58	34.46	36.24	236.48
Year of Birth	868	1934.37	5.34	1925.00	1943.00
Post Sulfa	868	0.39	0.49	0.00	1.00
Early Suffrage Adopter	868	0.60	0.49	0.00	1.00
Female Labour Force Participation Rate	868	0.29	0.07	0.17	0.40

Notes: Maternal Mortality Ratio and Infant Pneumonia Mortality Ratio are measured as deaths per 100,000 live births. Sulfa drugs arrived in the US in 1937, and post-sulfa takes the value of one in all years including and following 1937. The analysis sample consists of all years in 1925-1943.

Figure A23: Suffrage and subsequent women representatives in national legislature

(a) Percentage of women in the senate

(b) Percentage of women in the house of representatives



Notes: Plots depict the percentage of female representatives in the National Senate (left-hand panel) and National House of Representatives of the USA from 1912 to 1960 for each of the early (pre-Nineteenth Amendment) and late (post-Nineteenth Amendment) states.

Table A11: Early suffrage and subsequent female representation

	1920-1960		1937-1943	
	(1) Senate	(2) House	(3) Senate	(4) House
Early Suffrage	0.996***	0.040	1.786**	1.290
	[0.265]	[0.345]	[0.786]	[1.022]
Mean of Dep. Var.	0.902	2.329	1.429	2.746
Observations	2050	2050	350	350
R-Squared	0.005	0.000	0.011	0.003

We display the coefficients of a regression of the percent of a state's representatives in the National Senate and House of Representatives on the state's suffrage status (early vs late). The percent of representation is a value from 0 to 100, and is calculated as the number of female representatives of a state in a given year divided by the total number of seats assigned to the state, multiplied by 100. For example, column 3 shows that in the 1920-1960 period, states adopting suffrage early went on to have nearly 1.8 % point more women representatives in the Senate than states which adopted in 1920. The left-hand columns are for the entire post-suffrage period up until 1960, and the right-hand columns are for the post-antibiotic period under study in this paper, of 1937-1943. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

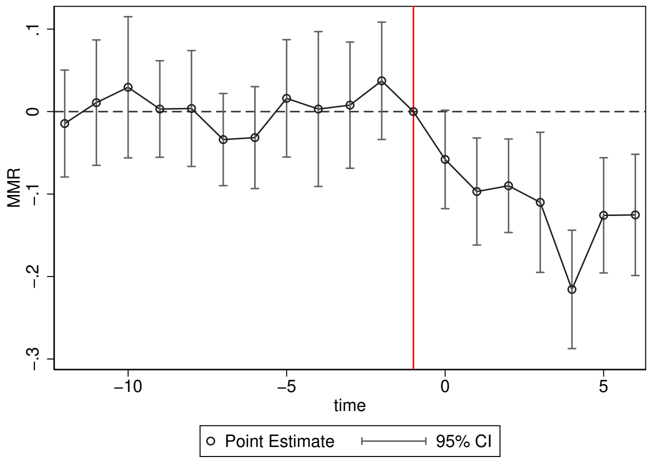
Table A12: DD estimates: Early adopters of suffrage had faster MMR decline in the post-antibiotic era

	ln(Maternal Mortality Ratio)		ln(Pneumonia Mortality)	
	(1)	(2)	(3)	(4)
Post Sulfa	-0.092***	-0.097***	0.009	0.011
	[0.030]	[0.029]	[0.022]	[0.022]
Early Suffrage × Post Sulfa	-0.085**	-0.046	-0.046	-0.060*
	[0.036]	[0.041]	[0.028]	[0.031]
Early Suffrage × Post Sulfa × Time	-0.015**	-0.019	-0.007	-0.012
	[0.006]	[0.012]	[0.013]	[0.011]
Early Suffrage × Time	0.001	-0.002	0.005	0.008
	[0.003]	[0.003]	[0.008]	[0.006]
Time	-0.023***	-0.024***	-0.029***	-0.024***
	[0.002]	[0.002]	[0.006]	[0.005]
Post Sulfa × Time	-0.089***	-0.090***	-0.061***	-0.069***
	[0.005]	[0.008]	[0.011]	[0.008]
Constant	6.294***	6.307***	4.559***	4.618***
	[0.012]	[0.011]	[0.015]	[0.015]
Mean of Dep. Var.	6.206	6.206	4.573	4.573
Observations	868	868	868	868
R-Squared	0.951	0.906	0.780	0.757
State Population Weights	Y	N	Y	N

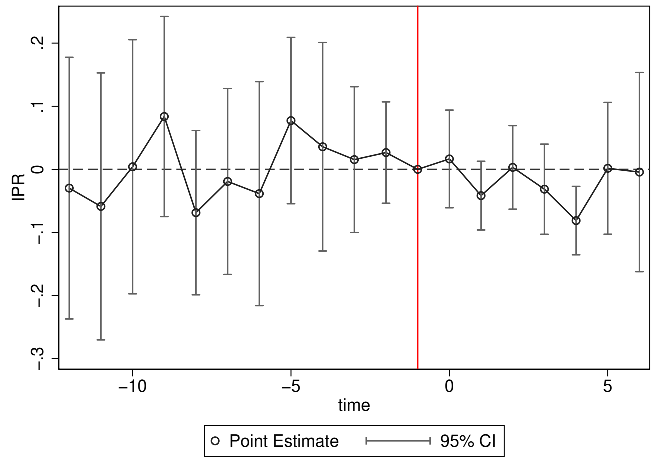
Estimation sample consists of state by year mortality data from 1925 to 1943 (inclusive) Each regression includes state and year fixed effects and clusters standard errors by state. * p<0.10; ** p<0.05; *** p<0.01.

Figure A24: Alternative specification of sulfa/suffrage event study

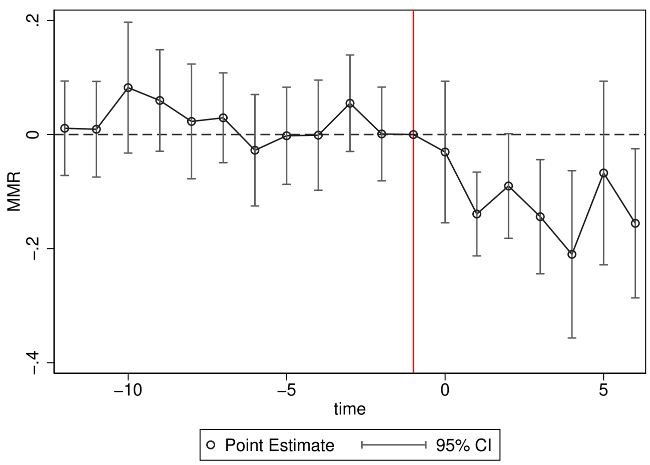
(a) ln(MMR) weighted by state population



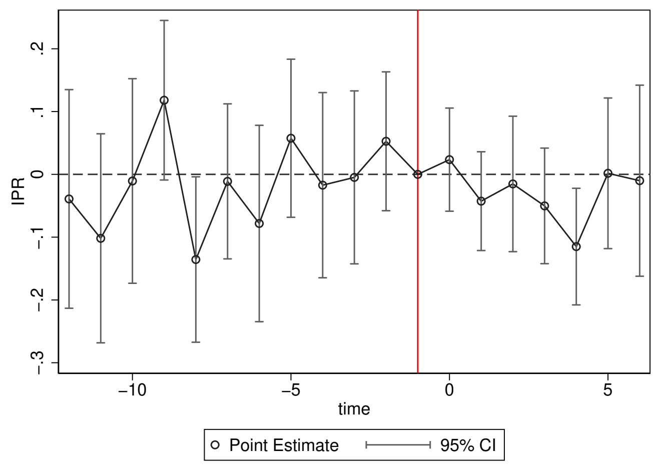
(b) ln(IPR) weighted by state population



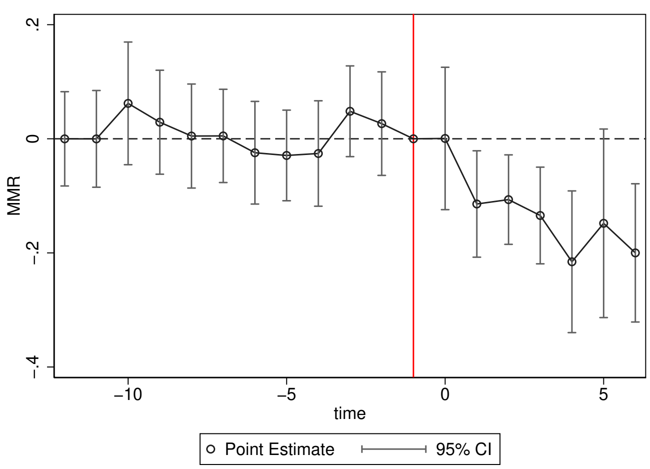
(c) ln(MMR) with balanced sample only



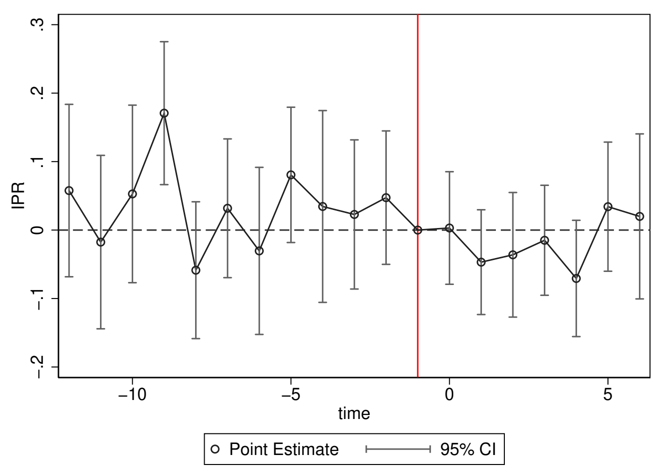
(d) ln(IPR) with balanced sample only



(e) ln(MMR) with FLFP controls and trends

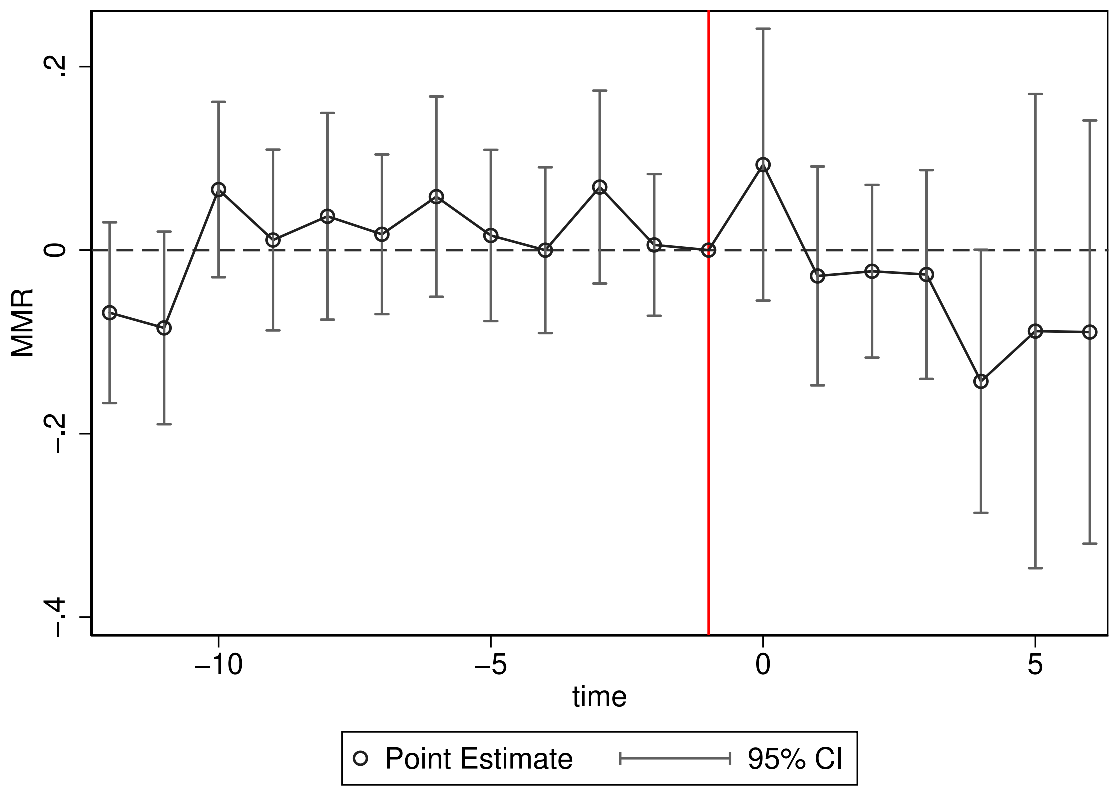


(f) ln(IPR) with FLFP controls and trends



Notes: Alternative specifications of the event study shown in Figure 4. The balanced sample refers to states with mortality data in all years under study, and the final two figures augment the event study specification in equation 2 with the following controls and interactions to capture any differences in baseline women's labor force participation: a post sulfa times FLFP interaction $Post1937_t \times FLFP_s$, an interaction between FLFP and time, $year_t \times FLFP_s$ and an interaction between FLFP, time, and post sulfa $Post1937_t \times year_t \times FLFP_s$.

Figure A25: Women's suffrage: Event study for maternal mortality with Census Division by Year FE's



Notes: Refer to Figure 4, panel (a). An identical specification is estimated, however additionally controlling for census division by year fixed effects. When estimating a DD specification as in Table A12, Early Suffrage × Post Sulfa estimates are very similar as those not conditioning on census division by year FEs. For reference, in the weighted specification, the coefficient on Early Suffrage × Post Sulfa is -0.075* (s.e. = 0.038), and the coefficient on Early Suffrage × Post Sulfa × Time is -0.015** (0.004). Analogous values for the specification without census division by year FEs are -0.085** and -0.015**.

A Data Appendix

Maternal Mortality Data We used recently released estimates of the maternal mortality ratio (MMR) per 100,000 live births produced by the Maternal Mortality Estimation Inter-Agency Group (MMEIG) and published in the World Bank World Development Indicators (WDI, indicator SH.STA.MMRT). These data were made available for the first time in the year 2016 and before that there were no reliable annual cross-country data on MMR. These estimates were available for 183 countries annually for the period 1990–2015. Maternal mortality is identified using ICD-10 codes O00-O99 (Pregnancy, childbirth and puerperium); the official definition is "the number of women who die from pregnancy-related causes while pregnant or within 42 days of pregnancy termination per 100,000 live births." These are widely considered the best MMR measures to date, as they address known measurement difficulties in survey and vital statistics data on maternal mortality using Bayesian methods applied to multiple, complementary data sources including vital statistics, special inquiries, surveillance sites, population-based household surveys and census files (Alkema et al., 2016, 2017). The world distribution of average MMR for the period of 1990–2015 is in Figure A5.

Political Gender Quota Data We collated measures for each country of whether the country has a legislated and binding reserved seat quota for women, its year of implementation, and the size of the quota measured as number of seats divided by all seats in the uni- or bi-cameral chamber. To create the database, we started with measures provided by Dahlerup (2005) and completed the most recent years from Global Database of Quotas for Women database (available online at quotaproject.org), which is a repository developed and maintained by the International Institute for Democracy and Electoral Assistance (IDEA), the Inter-Parliamentary Union, and Stockholm University.

Women in Parliament Data We used three distinct annual-level measures of women in parliament to construct a comprehensive panel of the percentage of women occupying seats in the national parliament. These were the WDI indicator SG.GEN.PARL.ZS ("Proportion of seats held by women in national parliaments (%)"), The UN Millennium Development Goals (MDG) Indicators ("Seats held by women in national parliament, percentage"), and the Interuniversity Consortium for Political and Social Research (ICPSR) dataset compiled by (Paxton, Green and Hughes, 2008) ("Women in Parliament, 1945–2003: Cross-National Dataset"). The first two of these datasets had partially-complete coverage for the years 1990, and then 1997–2015, while the latter had partially-complete yearly coverage for each year starting in 1945, and ending in 2003. In order to construct as comprehensive a series as possible, we began with the WDI data, and then imputed missing years where available from the MDG indicators, and Paxton, Green and Hughes (2008) data. When a missing WDI year was available in both the MDG and the ICPSR dataset, we favored the MDG measure, which was estimated using the same sample and year. Figures A6 and A7 present the distribution of the proportion of women in parliament pre- and post-quota implementation in quota countries, as well as the full distribution of the proportion of women in parliament over the period under study.

Covariates We adjusted for the natural logarithm of PPP adjusted GDP per capita measured in 2011 international dollars, and a score for the level of democracy in the country, in all models. In additional sensitivity tests, we also examined quota predictors as laid out in Krook (2010). These were the number of peacekeepers in a country from The International Peace Institute, IPI Peacekeeping Database, Net Overseas Development Assistance (World Bank Indicator DT.ODA.ODAT.CD), and a series of measures of political competition and landscape from (Beck et al., 2001). Our measure of democracy was gleaned from the Polity IV project database. This database records information on the political regime in 167 countries, between 1800 and 2014. The democracy indicator is available annually, and is a 0–10 scale based on measures of competitiveness of political participation, openness and competitiveness of executive recruitment and constraints on executive powers. Higher values reflect more open, democratic societies.

Health expenditure at the country-year level was taken from the World Health Organization the National Health Accounts (NHA) data series. These provide a measure of total health expenditure as a percent of GDP, and are available for the years 1995-2013.

The data on development assistance for health are based on the Institute for Health Metrics and Evaluation (IHME) Development Assistance for Health Database (1990–2017). These data are available at the source country $\times$ receiver country $\times$ year level. We compute the proportion Development Assistance for Health to Maternal Health as: $\frac{\text{Development Assistance for Health to Maternal Health - All Program Areas (constant 2017 US dollars)}}{\text{Development Assistance for Health disbursed from all channels (constant 2017 US dollars)}}$.

For the women's economic rights variable we exploit a previously under-exploited cross-country rights data from the Cingranelli, Richards and Clay (2013) data set, which provides data on three different variables measuring Political, Economic and Social Rights of women, for the period of 1981 to 2011 for around 127 (in 1981) to 192 (in 2011) countries.

Maternal Care Inputs Data Recent data from the World Bank Data Bank allow us to examine the state of maternal health care in a sub-set of countries and years. We use the two policy-relevant indicators measuring the percent of pregnant women receiving prenatal care (indicator SH.STA.ANVC.ZS) and the percent of all births attended by skilled health staff (indicator SH.STA.BRTC.ZS). These data are constructed and released by the World Bank using comparable measures from each country: specifically data from UNICEF, the State of the World's Children, ChildInfo, and the Demographic and Health Surveys. As such, these measures are only available in years and countries for which surveys were conducted, resulting in fewer observations than the yearly measures of maternal mortality. In our analysis we use the full set of data released in the World Bank Data Bank.

Placebo Outcomes Data on male mortality for adults are available in the World Bank Data Bank (indicator SP.DYN.AMRT.MA), based on measures from the United Nations Population Division, World Population Prospect and University of California, Berkeley, and Max Planck Institute for Demographic Research. This is measured as mortality between the ages of 15–60, per 1,000 male adults, and captures the likelihood that a male of age 15 dies by the age of 60. Tuberculosis mortality is measured as the number of deaths due to Tuberculosis among HIV-negative people, and is measured per 100,000 population. The data are from the WHO and were downloaded from: http://apps.who.int/gho/data/view.main.57020ALL?lang=en, accessed on 17/03/2016.

Women's Suffrage and Mortality Rates in the US. The state-specific adoption of women's suffrage is taken from Miller (2008), for 48 states and Washington D.C., Hawaii and Alaska had not been granted statehood during the study period. State-year maternal mortality rates were obtained from Jayachandran, Lleras-Muney and Smith

(2010), collated from US vital statistics data. These data are available for all states but Alaska, Hawaii and Washington D.C. For 21 states these data are available for the entire period of 1920 to 1950. For the remaining states mortality data are incomplete, and available only from a later year onwards.[32] In Table A10 we provide summary statistics for each relevant variable.

Women's Representation in the Senate and US House of Representative. We created a state by year database of the proportion of women in seats representing each state of the United States for the National Senate and the House of Representatives. A complete compilation of these data is available in Manning and Brudnick (2018). We calculated the proportion of women representatives in each chamber of congress for each state for the years 1917–1960. Prior to 1917, there were no female representatives in either body.

B Description of Resampling Procedure for MMR Uncertainty

Publicly available MMR data consist of a point estimate and the upper and lower points of the 80% uncertainty interval. In order to estimate standard errors and p-values based on these data, we undertake the following procedure:

Resample Algorithm

1. Take a clustered bootstrap resample from the original data $b = 1, \ldots, B$, with $B = 500$
2. Generate a random vector of size N (where N is the sample in the regression) where each element is either a) a draw of a normal variable where 80% of the probability mass falls between -1 and 1 (a draw from $\mathcal{N}(0, 0.7803)$), or b) a draw from a triangular distribution in the interval [-1,1]. Below this is ε, and in each case, these integrate to 1.
3. Generate a resampled value of maternal mortality as: $MMR_t^{b*} = MMR_{ct} + \varepsilon \frac{MMR_{ct}^{UB} - MMR_{ct}^{LB}}{2}$, where MMR_{ct}^{LB} is the lower bound estimate and MMR_{ct}^{UB} is the upper bound estimate; ie take the original measure, and draw a value from the uncertainty interval centred around this measure.
4. Estimate the original regression using the resampled data, with the re-resampled MMR measure. This results in an estimate of interest $\widehat{\beta}^{b*}$
5. if $b < 500$ return to step 1. Else go to step 6
6. Calculate the standard error of $\widehat{\beta}$ as the standard deviation of $\{\widehat{\beta}^{1*}, \widehat{\beta}^{2*}, \ldots, \widehat{\beta}^{500*}\}$. This replaces the original naive standard error, and similarly a p-value can be calculated associated with the null hypothesis of a null impact, analogous to the p-value calculated based on a standard regression coefficient.

This procedure is only necessary when estimating impacts of quotas on maternal mortality, and not for women in parliament as we are only adjusting for uncertainty in the dependent variable in cases where maternal mortality is

[32] For 4 states from 1921 onwards, for 3 from 1922 onwards, for 1 from 1925, for 2 from 1926, for 5 from 1927, for 3 from 1928, for 2 from 1929, for 1 from 1932 and finally for 1 from 1933 onwards.

used. Note that in the above we are re-sampling maternal mortality to provide full coverage of the 80% uncertainty interval, or indeed, to provide greater than full coverage in the case of the normal draw, for each country year pair. In each case, the normal or triangular distribution places more weight on the likelihood of observing a value of maternal mortality close to the stated estimate, and less weight on the likelihood of observing a value in the tails of the distribution.

The above resampling procedure assumes that uncertainty in maternal mortality is independent between countries and years. It may also be the case that uncertainty is correlated across years within a country. When undertaking inference robust to uncertainty we thus present p-values associated with a range of cases as presented in Table A7. These are:

1. Bootstrap: The bootstrap analogue of the original p-value (ie no uncertainty in MMR)

2. Triangular Correction: Resamples from the MMR uncertainty range from the WHO data (80% coverage) with a triangular distribution whose minimum and maximum are at the end points of the uncertainty range, and whose centre is at the estimate

3. Triangular Correction by Country: Resamples as above, however now instead of taking uncertainty draws by country and year, takes uncertainty draws only at the level of the country. This implies that uncertainty with regards to MMR is perfectly correlated within a country over time. It is the limit case of assuming correlation within a country in uncertainty in MMR measurement.

4. Normal Correction: Resamples from the MMR uncertainty range assuming a normal distribution, where draws are taken so that the $10^{th}/90^{th}$ quintile of the normal are at the upper and lower end points of the uncertainty range presented in the WHO data in each case. This allows for us to sample outside the 80% confidence bounds presented in the original data, and will be the most demanding of all corrections.

5. Normal Correction by Country: Resamples as above, however now instead of taking uncertainty draws by country and year, takes uncertainty draws only at the level of the country.