



Ethnic fertility and exposure to armed conflict: the case of Sri Lanka

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Received: 11 July 2022 / Accepted: 27 February 2024
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Abstract

This paper investigates the impact of exposure to armed conflict on fertility in Sri Lanka. Using a difference-in-difference methodology, I find that exposure to civil war led to a reduction in female fertility in Sri Lanka, with evidence of an increased female age at marriage in high-conflict districts as a mechanism. The paper further focuses on ethnic disparities in demographic adjustments triggered by exposure to conflict. It determines if conflict altered the fertility patterns of the Sinhalese majority and the Sri Lankan Tamil minority differently. Estimates suggest that there is a differential in fertility adjustments of the two ethnic groups in response to conflict: the reduction in crude birth rate was significantly smaller for the Sri Lankan Tamils compared to the Sinhalese across various model specifications. The presence of an ethnic group-level replacement effect led to a lesser reduction in fertility for Sri Lankan Tamils. These results contribute to the literature on the impact of armed conflict and underscore the importance of studying demographic adjustments by sub-groups, specifically ethnicity in this context, as the intensity of adjustment often varies with the socio-political vulnerability of the group. Understanding these disparities is crucial as a sustained demographic differential has the potential to impact the ethnic composition of Sri Lanka and may further crystallize the ethnic divide in an already volatile political setting.

Keywords Fertility · Armed conflict · Ethnicity · Replacement effect · Age at marriage · Sri Lanka

JEL classification I12 · J11 · J13 · J15 · N45

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1 Introduction

Wars have far-reaching effects on various aspects of politics, the economy, and society. On a direct level, wars lead to morbidity, mortality, the destruction of infrastructure and healthcare systems, and the displacement of populations. However, their repercussions often extend beyond the immediate aftermath. According to Catani (2018), war-affected populations may experience long-term psychological stressors. Studies by Devakumar et al. (2014) and Phadera (2021) highlight inter-generational health consequences, indicating that the impact goes deeper and persists across generations.

With rising global instability, understanding the impact of war on demographic changes is crucial. Previous studies have found mixed evidence on the effect of conflict exposure on fertility. For instance, Lindstrom and Berhanu (1999), Agadjanian and Prata (2002), and Blanc (2004) provide evidence of a reduction in fertility due to conflict. On the other hand, Kulczycki and Prem (1999) and Ladier-Fouladi and Hourcade (1997) find no overall effect, while Kraehnert et al. (2018) identify evidence of increased fertility resulting from conflict. Despite a growing body of literature on the impact of war on fertility, the consequences of the Sri Lankan civil war remain relatively unexplored in this context.

This paper aims to explore the effect of exposure to armed conflict on female fertility in Sri Lanka and highlights the role of ethnicity in this context. The 26-year-long civil war in Sri Lanka (1983–2009) is considered one of the world's most violent and prolonged secessionist movements since the end of the Second World War (DeVotta, 2004). Using the Uppsala Conflict Data Program Georeferenced Event Dataset (UCDP GED) on conflict events, I classify districts above the mean of the total number of conflict events during 1992–2009 as treatment districts (high-conflict zone) and the others as control (low-conflict zone). Using vital statistics data, I compute crude birth rates as a measure of fertility. Employing a difference-in-difference approach, estimates suggest that on average fertility declined by 5.42 births per 1000 people in the high-conflict districts of Sri Lanka. Moreover, the study suggests that an increase in female age at marriage in these areas may contribute to this observed fertility decline.

This paper emphasizes that, as one of the understudied aspects of heterogeneity in conflict literature, the effects of exposure to armed conflict differ across ethnic groups. The history of the Sri Lankan conflict suggests that ethnicity had a major role in shaping the dynamics of the conflict. The divide between the Sri Lankan Tamil minority and the Sinhalese majority percolated through the years and ultimately manifested into intolerance between the two communities, resulting in war in 1983. Consequently, exploring heterogeneity across ethnic groups is valuable in understanding their sensitivities and their ability to adjust their fertility preferences or responses to such shocks, which is further useful to guide policymakers.

The difference-in-difference estimates in the study provide evidence of differential fertility adjustments of the two ethnic groups in response to the conflict. Across various specifications, the estimates suggest that the Sinhalese reduced their fertility by 8–10 live births per 1000 people while Sri Lankan Tamils reduced theirs by 0–4 live births per 1000 people in response to exposure to armed conflict. This implies that the Sinhalese had a more pronounced fertility reduction. Additionally, using data

on conflict-specific mortality from the UCDP database, this study finds evidence of a replacement effect among the Sri Lankan Tamils, contrasting with the absence of such an effect for the Sinhalese.

This paper contributes to a growing literature by evaluating the dynamics between conflict, ethnicity, and fertility outcomes. In line with recent studies (Schindler & Brück, 2011; Kraehnert et al. 2018; Thiede et al., 2020; Boehnke & Gay, 2020), this paper finds that changes in female age at marriage contribute to an overall reduction in fertility in Sri Lanka and evidence of ethnic group level replacement effects explaining a lower reduction in fertility for Sri Lankan Tamils. To the best of my knowledge, this is the first paper to focus on the effect of exposure to conflict on fertility in Sri Lanka.

The rest of the paper is organized as follows: Section 2 discusses related literature; Section 3 details the history of the ethnic divide and evolution of the conflict; Section 4 describes the data and the methodology; Section 5 discusses the overall effect in Sri Lanka and a related mechanism of increasing female age at marriage; Section 6 focuses on the ethnic group differential and the presence of replacement effect for Sri Lankan Tamils; Section 7 concludes.

2 Related literature

In general, fertility behaviors are governed by a plethora of factors such as income, education, age, and other socio-economic factors. Bongaarts' model of the proximate determinants of fertility categorizes the set of factors affecting fertility levels into two broad categories: behavioral and biological (Bongaarts, 1987). Within this framework, three biological factors influence fertility decisions: permanent sterility, the probability of conception, and intrauterine mortality. Behavioral determinants, on the other hand, include factors like the prevalence of contraceptive use and effectiveness, duration of breastfeeding, practice of induced abortion, and patterns of union formation.

The literature on conflict identifies both biological and behavioral mechanisms through which armed conflict exposure can impact fertility. The four major pathways discussed in previous studies are income effect, marriage market effect, sexual violence against women, and replacement effect.

The income effect posits that factoring in the cost of raising children, coupled with a reduction in wealth during the war (Collier et al., 2003), can often result in reduced fertility. For instance, Kraehnert et al. (2018) found that the death of a woman's sibling during the civil war in Rwanda lowered the probability of giving birth. The study suggests that if the deceased person played a role in monetarily supporting the upbringing of the child, the income effect would explain the reduction in fertility.

Conflicts can also exert an impact on the marriage market and thus impact fertility. This occurs when the conflict results in a demographic deprivation of young men/husbands, either by reduced spousal cohabitation with men recruited and away at war (Blanc, 2004; Urdal & Che, 2013; Vandenbroucke, 2014) or by altering the sex ratio (Boehnke & Gay, 2020; Kraehnert et al., 2018). Exposure to armed conflict can also result in a shift in marriage patterns due to a change in bride prices (Corno et al., 2017) or a change in the age at marriage. The increased uncertainty and absence of

men could encourage postponement in marriage and thus delay marital fertility (Thiede et al., 2020). On the contrary, Hacker et al. (2010) also emphasize that in some situations, war can be a catalyst for marriages. Faust (1996) underscored that war resulted in a dread of “spinsterhood” in southern women during the American Civil War. Barber (2000) reported that the American Civil War had led to a “marriage frenzy” in Richmond.

Additionally, conflict may positively affect fertility rates due to increased sexual and gender-based violence against women by armed combatants or perpetrated by intimate partners (McGinn, 2000; Østby, 2016; Leatherman, 2011; United Nations, 2014, Wood, 2018). Kottegoda et al. (2008) provide accounts of increased vulnerabilities of women and higher intimate partner violence in Sri Lanka during the civil war. The repercussions of conflict extend to the accessibility of reproductive health care for women (Kottegoda et al. 2008; Urdal & Che, 2013; Lindskog, 2016). On the contrary, conflict can also result in psychological stressors as well as poor nutritional status of the women and thus negatively impact fertility (Nowrojee, 1996; McKay, 1998; Abu-Musa et al. 2008; Dossa et al. 2015; Catani, 2018).

Finally, the effect of higher mortality on fertility is ambiguous (Schultz, 1997; Ben-Porath, 1976). The presence of a positive correlation suggests a replacement mechanism. Replacement effects can arise at an individual level if children are considered old-age insurance for the parent and an increase in mortality leads individuals to have more children in the expectation that only some of their kids will survive (Nugent, 1985; Rossi & Godard, 2019) or if people are trying to replace the loss of their loved ones (Schindler & Brück, 2011; Kraehnert et al., 2018). At the group level replacement effects can arise if pronatalist sentiments emerge during conflicts among the minority community to maintain the size of their group in the population (Chi et al., 2015; Palmer & Storeng, 2016; Albrez-Gutierrez, 2019). In the Sri Lankan context, there may be a replacement effect in place for the Sri Lankan Tamils based on the qualitative findings of Jordan and Denov (2007) who report evidence of marriage between members of opposite genders being strongly encouraged amongst LTTE militants to inspire a greater sense of commitment and to ensure traditional Tamil customs are practiced in the larger society.

With many counteracting mechanisms, the net effect of conflict on fertility remains to be tested empirically for Sri Lanka.

3 The Sri Lankan civil war

In 1981, Sri Lanka had a total population of approximately 14.8 million. The Sinhalese comprised 74% of the population, followed by Sri Lankan Tamils who were 12.7% of the population, and Indian Tamils who were 5.5% among other groups (Census of Population and Housing Report, 1981). Historically, the Sinhalese have inhabited the western, southern, and central districts, whereas the Sri Lankan Tamils were a majority in the northern and eastern parts of the country (Census of Population and Housing Report, 1971; Keethaponcalan, 2002). In line with that, the Census of Population and Housing Report (1981) finds that 65% of the Sri Lankan Tamils resided in the northern and eastern districts in 1981.

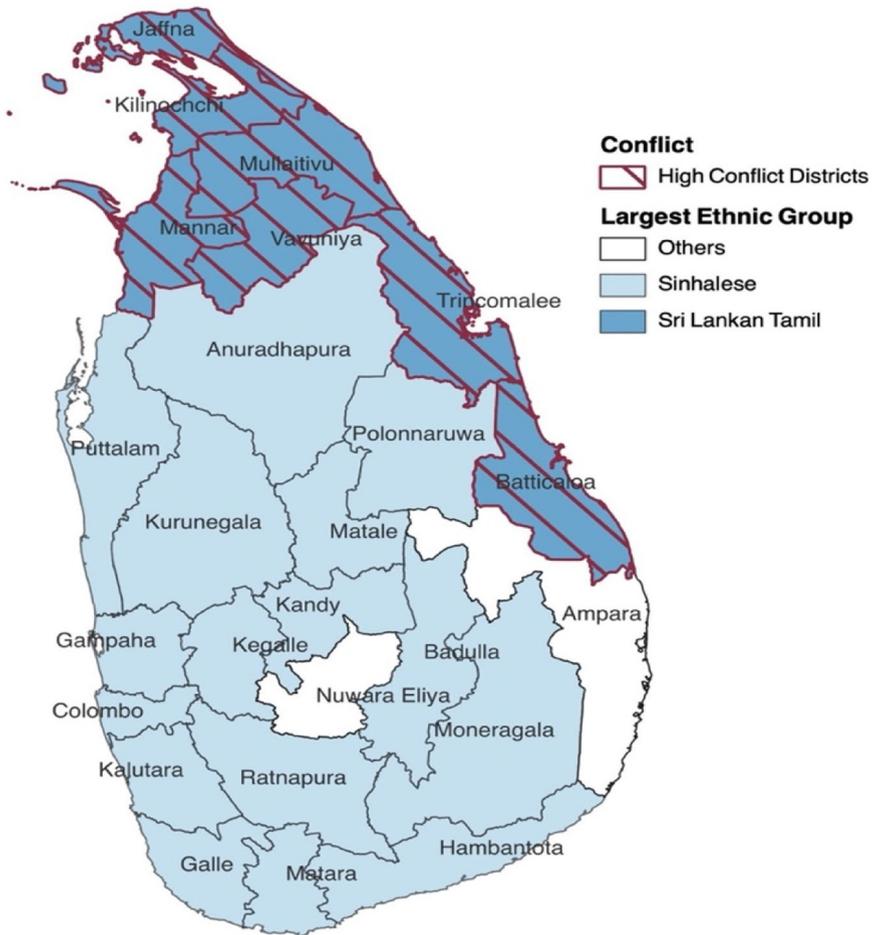


Fig. 1 Map of Sri Lanka - areas of high-conflict and largest ethnic group in each district. Note: The classification of districts as high and low conflict is based on Appendix Table 4 using the UCDP conflict dataset. Data for the size of ethnic groups by district is obtained from the Census of Population and Housing Report (1981) and is provided in Appendix Table 5. This allows a graphical depiction of the largest ethnic group in each district, mapped with the conflict status of the district

Keethaponcalan (2002) describes that the districts in the Northern and Eastern Provinces (Jaffna, Kilinochchi, Mullaitivu, Mannar, Vavuniya, Trincomalee, Batticaloa, and Ampara) were referred to as the “traditional homeland” by Sri Lankan Tamils. These areas were under the direct control of the Liberation Tigers of Tamil Eelam (LTTE) during the war and had to therefore witness a large amount of conflict between the LTTE and the Government of Sri Lanka (GoSL)¹. Figure 1 identifies the geographic variation in conflict intensity in the districts along with the dominant ethnic group in the district. The figure points to an overlap between the conflict zone and the dominant ethnic group in the district being the Sri Lankan Tamils. While

¹ Source: <https://samsn.ifj.org/northern-and-eastern-provinces-sri-lanka-legacy-of-conflict/>

there were some instances of conflict reported in almost all districts of Sri Lanka, they were largely concentrated in the Sri Lankan Tamil dominant districts (Appendix Table 4).

Though the war began in 1983, the roots of the ethnic conflict in Sri Lanka go back to the former as Ceylon under British Rule. With the ‘divide and rule’ policy underway, there were tensions between the communities even before 1983. It is claimed that there was an over-representation of Tamils in the colonial administrative positions, owing to British favoritism. The British often constructed English medium schools in Tamil areas that allowed greater access for Tamils to it and government jobs at the time. Tamils comprised about 30 percent of upper-level civil service jobs while comprising 22.7 percent of the population as per the census in 1946. The Sinhalese comprised 69.4 percent of the population and 57.6 percent of the upper levels of civil service (Keethaponcalan, 2002). This over-representation was considered unjust by the Sinhalese.

Post-independence in 1948, the bulk of the power in government landed in the hands of the Sinhalese elite who resented Sri Lankan Tamils. They passed several laws that were detrimental to Tamil representation and interests. They disenfranchised Tamil migrant plantation workers from India, also known as the Estate Tamils or Indian Tamils, or Upcountry Tamils. This meant the Tamils lost 40% of their parliamentarians because Estate Tamils could not be represented under this law. The Sinhala Only Act of 1956 declared Sinhala as the only official language of Sri Lanka. This made it mandatory for Tamils in the public sector to qualify in Sinhala within a designated short period, a lack thereof meant losing their jobs. The Sinhalese considered it as a move to reclaim the true Sri Lankan identity that was lost during British Rule. However, to the Tamils, this was an attempt to limit their economic opportunities, as from 1956–1976 of the 189,000 people recruited in the public sector, 95% were Sinhalese. From the 1970s there was virtually no employment of Tamils in the armed forces and police which are 99.9 and 95% respectively Sinhalese. In 1972, the government changed the country’s name from Ceylon to Sri Lanka and made Buddhism the nation’s primary religion, emphasizing a sense of culture and national identity. In an attempt to bridge a gap between educational disparities in the country, the ‘standardization policy’ of 1972 required Tamil students to score higher marks than their Sinhalese counterparts to get admission into Sri Lankan Universities. This act was aimed at providing support to the previously disadvantaged Sinhalese youth. Hoping to undo the injustice to the Sinhalese under the British Era, standardization ended up creating a further rift between Sinhalese and Tamils. Demands for equal status by Tamils radicalized over the years and led to the formation of a militant organization called LTTE in 1976 under the leadership of Velupillai Prabhakaran. Their demands for self-government and an independent state called the Tamil Eelam waged war in 1983.

3.1 Eelam War-I (1983–1987)

The first of four Eelam Wars began in 1983 and lasted 4 years. While it was the northern and eastern provinces that were direct conflict zones under direct control of LTTE, there were some instances of violence reported across Sri Lanka. In July 1983- known as “black July”- riots broke out in Colombo and other cities. LTTE had

killed 13 army soldiers. In retaliation by the Government of Sri Lanka (GoSL), about 2500–3000 Tamils likely died. Violence escalated over the years as Tamil insurgents used car bombs, human bombs, and landmines against Sinhalese civilians and the military. India tried to intervene by sending peacekeepers in 1987, but its troops had to withdraw by 1990 as Tamil guerillas refused to step back.

3.2 Eelam War-II (1990–1995)

After the withdrawal of the Indian Peace Keeping Forces, the war got more intense. LTTE killed about 600–700 Sinhalese police officers in June 1990. A female LTTE suicide bomber assassinated India's Prime Minister Rajiv Gandhi at an election rally in 1991. The government cut off shipments of food and medicines to the Jaffna peninsula and started intensive aerial bombardment. The LTTE responded by massacres of Sinhalese and Muslim villagers which led to Muslim self-defense units doing the same in Tamil villages.

3.3 Eelam War-III (1995–2002)

In January 1995, a peace agreement was signed with the new government. This however was violated after 3 months when LTTE destroyed ships and naval gunboats. This was followed by massacres in refugee camps in the Jaffna Peninsula and other civilian sites. By December, Jaffna was under government control for the first time. However, in July 1996, the LTTE carried an 8-day strike in Mullaitivu against 1400 government troops. More than 1200 government soldiers were killed and the LTTE also lost about 332 troops. Suicide bombers attacked Colombo, the Central Bank in Colombo, the Sri Lankan World Trade Center, and other southern cities repeatedly during the late 1990s. 1999 also saw an attempt on President Kumaratunga's life by a bomber. Norway tried to negotiate a peace settlement in December 2000. After various rounds of negotiations, LTTE and GoSL signed a peace treaty with LTTE foregoing the demand for a separate Tamil state. However, in October 2003, GoSL declared a state of emergency when Tigers announced their full control over Northern and Eastern Sri Lanka. Norway reports about 300 violations of the ceasefire by the GoSL and 3000 by LTTE during that period.

3.4 Eelam War-IV (2006–2009)

Eelam War IV from 2006–2009 was the final war that culminated in peace, and GoSL declared victory. After the October 2006 peace talks in Geneva failed, the government launched a major attack against the LTTE. The next few years were called a bloodbath as thousands died on both sides. Ultimately in May 2009, the GoSL declared victory. The estimated death toll by the UN over the years is 75,000–100,000 people with many other victims of kidnappings, sexual abuse, and disabilities due to war.

4 Data

The dataset for this analysis was created by digitizing the data from the Annual Reports of Vital Statistics from 1967–1980 (Vital Statistics, 1967–1980) and 1992–2009 (Vital Statistics, 1992–2009) and Census Reports over the years 1963–2012 (Census of Population and Housing Report, 1963, 1971, 1981, 2001, and 2012). Registration data exists for 1981–1991 as well, but I am unable to obtain the vital statistics for 1981–1991. The data on vital statistics has information on births and deaths at the district level disaggregated by ethnicity. Appendix Table 6 provides the descriptive statistics of the data for all ethnic groups in Sri Lanka. The registration system for births and deaths in Sri Lanka has been in place since 1867 and is of good quality (Levine, 2007; Jayachandran & Lleras-Muney, 2009) with completeness of at least 90% in most of the years of this analysis (United Nations Statistics Division, 1970–2010; United Nations Statistics Division, 2006). Assuming exponential population growth, I use the census year population by ethnic group for each district to interpolate the population for intercensal years.² Using the data on births at the ethnicity-district level, I create measures of crude birth rates. While crude rates have the drawback of not accounting for the age composition of the population, which may be consequential for the size of the next birth cohort, data availability restricts the analysis to using the said measure.

To create a panel dataset of female age at marriage, district-level data on pre-war years female singulate mean age at marriage (SMAM) has been collected for years 1953, 1971, and 1981 from the Census of Population and Housing Report (1981). The vital statistics dataset by GoSL provides information on female age at marriage for the post-war years of this analysis from 1992–2006 (Vital Statistics, 1992–2009). The data classifies females getting married into 3 categories based on their prior marital status: females who were never married, females who were divorcees, and females who were widows. For consistency in age at marriage information before and during the war, since SMAM reports mean age at first marriage, I use the information of female age at marriage for women who were previously never married so that this can mimic SMAM data in war years. This dataset is not available at disaggregated levels by ethnic groups.

I obtain conflict data from the UCDP GED database. UCDP is the world's major data source for organized violence with the oldest ongoing data collection project for civil wars. It defines an armed conflict as a contested incompatibility that concerns government and/or territory over which the use of armed force between the military forces of two parties, of which at least one is the government of a state, has resulted in at least 25 battle-related deaths each year. UCDP has global coverage and provides data on three types of organized violence: state-based conflict, non-state conflict, and one-sided violence, both spatially and temporally. I aggregate conflict events at the district level. Appendix Table 4 provides the number of conflict events aggregated at the district level over the years 1992–2009. The district with the greatest number of conflict events is Mullaitivu with 806 total conflict events reported. Jaffna

² United Nations Population Fund report 'Population Situation Analysis: Sri Lanka', describes that the population of Sri Lanka has been growing exponentially overtime. *Source:* https://www.unfpa.org/sites/default/files/admin-resource/Sri-Lanka-Population-Situation-Analysis_0.pdf.

experienced about 559 of all conflict events reported in the dataset. The districts with the lowest conflict events were Ratnapura and Kalutara which reported 0 conflict events as per the dataset. The dataset classifies each conflict event as organized violence with at least one fatality in either the best, low, or high estimate categories and provides its date and location (Sundberg and Melander, 2013). Using the best estimates of conflict-specific fatalities from the dataset, I obtain an estimate of conflict-specific death rates at the district-year level.

Since the boundary of districts changed over time, I adjust the data based on the area of the district in 2012 to allow for comparability over time and thus have 25 districts in this analysis. Wherever districts were split to create new ones, I adjust its population to be based on its share of the parent district's area. For instance, the Gampaha district with a 1387 km sq area was carved from the Colombo district which had an area of 2051 km sq area before the split. So, the population assigned to Gampaha before the split has been adjusted in proportion to the areas of the two districts (i.e., approximately 65% of the Colombo population before the split).

5 Overview: impact in Sri Lanka

Few studies on Sri Lanka have examined trends in fertility (Abeykoon, 1987; Puvanarajan & DeSilva, 2001), but none through the lens of the effect of armed conflict. To identify the causal effect of exposure to conflict on fertility, I estimate a difference-in-difference model with crude birth rate as the dependent variable. Using the information on conflict events, I classify districts above the mean of the total number of conflict events during 1992–2009 as treatment districts (high-conflict zone) and the others as control (low-conflict zone) in Appendix Table 4. Alternatively, given that conflict per capita may be a more appropriate measure of conflict exposure, for each district I calculate the average of the lagged number of conflict events per capita per year. Using this measure of conflict per capita, I assign districts as treatment group if the conflict intensity was greater than the mean across districts and as control group if they are below the mean intensity. Both these classifications result in the same districts being assigned to treatment and control groups. Appendix Fig. 4 demonstrates parallel trends in the average crude birth rate for the treatment and control group in the pre-treatment years. Since the timing and duration of conflict are unpredictable, the treatment can be considered exogenous.

I estimate the following equation to identify the effect of armed conflict exposure on the crude birth rate in Sri Lanka:

$$br_{gdt} = \beta_0 + \beta_1 treated_d \times post_t + \theta_d + \delta_t + \epsilon_{gdt} \quad (1)$$

where br is the crude birth rate for ethnic group g in district d at time t , θ_d and δ_t represent district and time fixed effects respectively. $treated$ is a dummy variable that takes a value of 1 for high-conflict districts and 0 for others, $post$ is a dummy that takes a value of 1 for years after 1983 that mark the beginning of the civil war (i.e., for 1992–2009, due to data constraints I do not have data from 1983–1991). Thus, $treated \times post$ is 1 for treatment districts that are the high-conflict districts for years after 1983 (i.e., for 1992–2009). β_1 in this setup is the relevant coefficient, measuring

Table 1 Impact of conflict on fertility

Dependent variable: crude birth rate	Overall effect		Heterogeneity by ethnicity	
	(1)	(2)	(3)	(4)
	Independent variable			
treated x post	-5.42*** (1.131)	-3.96*** (0.963)	-8.247*** (1.159)	-10.66*** (0.864)
treated x post x Sri Lankan Tamil	-	-	4.072** (1.879)	11.41*** (1.657)
treated x post x Others	-	-	4.422* (2.534)	7.15*** (1.614)
N	2400	2400	2400	2400
R ²	0.326	0.319	0.536	0.694

Note: Treatment is assigned based on classification in Appendix Table 4. The regression in column 1 reports the coefficient for Eq. 1, giving the effect of war on fertility in Sri Lanka. The regression includes district and year-fixed effects. Robust standard errors are reported in the parenthesis. Column 2 adds district population weights. Columns 3 and 4 correspond to estimates from Eq. (3), exploring heterogeneity by ethnic groups. Column 3 does not include district-ethnic group population weights whereas column 4 does. Columns 3 and 4 control for district, year, ethnicity, district \times ethnicity, and year \times ethnicity fixed effects. Robust standard errors are reported in the parenthesis

*significant at 10%; **significant at 5%; ***significant at 1%

the impact of exposure to conflict on the crude birth rate in Sri Lanka. I estimate the model using robust standard errors (Castelló-Climent et al., 2018).³

Estimates from Table 1 column 1 and column 2 report the overall average effect of conflict on fertility in Sri Lanka. While Column 1 provides the unweighted estimates, column 2 provides district population weighted estimates.⁴ On average, the effect of exposure to high conflict was a reduction of 3.96 to 5.42 births per 1000 people. The pre-conflict average crude birth rate in Sri Lanka was 27.95 and a reduction of approximately 3.96 to 5.42 in the crude birth rate is a moderate response of 14.16–19.39% fertility reduction compared to some other estimates in the literature. A Population Reference Bureau report (Madsen and Finlay, 2019) documents that fertility in conflict usually drops by up to one-third. For instance, it dropped by one-third due to the Khmer Rouge conflict in Cambodia in the 1970s. Curlin et al. (1976) find a similar response of the age-specific fertility rate of women aged 10–14 in Bangladesh which fell by 33% due to conflict. A much larger reduction is documented by Vandembroucke (2014) who finds that WWI led to a 50% reduction in France's birthrate.

As a robustness check to this overall estimate, I explore alternative specifications in Appendix Table 7. There, column 1 assigns treatment based on Li et al. (2019), with an alternative measure assigning 8 districts as high-conflict (with more than

³ As a robustness check, columns 1 and 2 of Appendix Table 12 report the estimates corresponding to columns 1 and 2 of Table 1 with clustered standard errors at the district level and estimated p-values from the wild cluster bootstrap recommended by Cameron et al. (2008) as a solution to the problem of a few clusters (Angrist & Pischke, 2009).

⁴ Estimates with population weights are preferable as these account for heterogeneity in the population size across districts. Using population weights in this case ensures that small population sizes do not contribute disproportionately to the result. The rest of the paper will thus report weighted estimates.

Table 2 Impact of conflict on age at marriage

<i>Dependent variable: female age at marriage</i>	
	(1)
Independent variable	
treated x post	1.93*** (0.376)
<i>N</i>	441
<i>R</i> ²	0.853

Note: Treatment is assigned based on classification in Appendix Table 4. The regression in column 1 reports the coefficient for Eq. (2), giving the effect of war on female age at marriage in Sri Lanka. The regression includes district and year-fixed effects. Robust standard errors are reported in the parenthesis. Estimates are weighted by district population. The mean, minimum, maximum, and standard deviation for mean age at marriage is (24.062, 17.3, 30, 1.728)

*significant at 10%; **significant at 5%; ***significant at 1%

95% of all conflict events occurring in these districts and a larger presence of LTTE) and the rest as low-conflict zone. Column 2 assigns treatment and control districts to top and bottom quartile districts (6 in each group) ranked by the mean level of conflict per capita per year. Columns 3 and 4 remove the top 5% and top 10% of conflict districts respectively. The result remains qualitatively similar.

As highlighted by Bongaarts' model (Bongaarts, 1987), one key determinant of fertility is age at marriage (operating via the marriage market effect). Early marriage or cohabitation tends to lead to longer reproductive periods and, therefore, higher fertility rates. In line with this hypothesis, prior studies have found that age at marriage has been an important determinant of fertility in Sri Lanka with a negative relationship for all ethnic groups (Abeykoon, 1987).

To understand if conflict resulted in an increased age at marriage that exerted a negative effect on overall fertility noted in Table 1, I estimate the following equation:

$$aam_{dt} = \beta_0 + \beta_1 treated_d \times post_t + \theta_d + \delta_t + \epsilon_{dt} \quad (2)$$

where aam is the female age at marriage in district d and year t . As before, $treated$ is a dummy variable that takes a value of 1 for high-conflict districts and 0 for others, $post$ is a dummy that takes a value of 1 for years after 1983 that mark the beginning of the civil war (i.e., for 1992–2006) and 0 for pre-war years (1953, 1971, and 1981). The coefficient β_1 measures the effect of conflict on age at marriage. θ_d and δ_t represent district and time fixed effects respectively. I estimate the model using robust standard errors (Castelló-Climent et al., 2018).⁵

The estimate in Table 2 suggests that on average, exposure to high-conflict led to an increase in female age at marriage by approximately 2 years in high-conflict zones in Sri Lanka. A higher age at marriage would delay fertility and thus result in a lower birth rate. This increased age at marriage could be driven by a marriage market squeeze if war impacted the local sex ratio and resulted in demographic deprivation

⁵ As a robustness check, Appendix Table 13 reports the estimates corresponding to Table 2 with clustered standard errors at the district level and estimated p-values from the wild cluster bootstrap recommended by Cameron et al. (2008) as a solution to the problem of a few clusters (Angrist & Pischke, 2009).

of young men/husbands either due to men being increasingly recruited in combat or due to spousal deaths.

6 Digging Deeper: Heterogeneity & Replacement Effect

6.1 Heterogeneity by Ethnicity

Next, I evaluate the heterogeneity by ethnic groups. Appendix Figs. 5–9 present preliminary evidence of the differential in fertility trends using the size of the birth cohort and the crude birth rate.⁶

To formally estimate the heterogeneity in fertility adjustments to conflict, I estimate the following equation:

$$br_{gdt} = \beta_0 + \beta_1 treated_d \times post_t + \sum_{g=2}^n \beta_g ethnicity_g \times treated_d \times post_t + \gamma_g + \theta_d + \delta_t + \alpha_{gt} + \mu_{dg} + \epsilon_{gdt} \quad (3)$$

where β_g captures the heterogeneity in the effect of conflict by ethnic group. Since my interests lie in looking at the two ethnic groups that were directly involved in the conflict, I simplify my analysis as follows: in the main specification, I classify ethnic groups as Sinhalese, Sri Lankan Tamils, and Others (non-Sri Lankan Tamil and non-Sinhalese category).⁷ As a robustness check, in an alternate specification in Appendix Table 9, I also disaggregate ethnic groups as Sinhalese, Indian Tamils and Sri Lankan Tamils, Moors and Others (aggregating any remaining ethnic groups, <1% of the total population).⁸ Regardless of specification, I included the dummy of $n-1$ ethnic groups interacted with $treated \times post$, omitting it for Sinhalese and making Sinhalese the reference or base category. β_1 in this setup is the average effect of being in a high-conflict zone on Sinhalese fertility. $\beta_1 + \beta_g$ would give the net effect of conflict for community g . I estimate the model using robust standard errors (Castelló-Climent et al., 2018).⁹ γ_g , θ_d and

⁶ Appendix Fig. 5 plots the ratio of the size of the birth cohort over time to the size of the birth cohort in 1967 for both ethnic groups. The graph suggests that there was no apparent trend in birth cohort sizes for either ethnic group in the pre-war years. However, during the war years, there is a marked increase in the size of the birth cohort of the Sri Lankan Tamils relative to 1967. Appendix Figs. 7 and 8 plot the trend in the absolute cohort sizes over time for both ethnic groups as a robustness check. They yield similar trends to those in Appendix Fig. 5. The measure of relative cohort sizes in Appendix Fig. 5 is preferred as it normalizes the scale and allows analyzing trends for both ethnic groups using the same figure. Appendix Fig. 6 graphs the ratio of the birth rate over time to the birth rate in 1967 for both ethnic groups. The differential response to war is evident. The declining trend in the birth rate for Sri Lankan Tamils almost reverses during the war years. On the contrary, Sinhalese birth rates continue on a downward trajectory even during the war years. Appendix Fig. 9 plots the trend in the absolute birth rates over time for both ethnic groups as a robustness check and yields similar trends as in Appendix Fig. 6.

⁷ This gives a total of 2400 observations (25 districts \times 32 years \times 3 ethnic groups = 2400).

⁸ This gives a total of 4000 observations (25 districts \times 32 years \times 5 ethnic groups = 4000).

⁹ As a robustness check, columns 3 and 4 of Appendix Table 12 report the estimates corresponding to columns 3 and 4 of Table 1 with clustered standard errors at the district level and estimated p-values from the wild cluster bootstrap recommended by Cameron et al. (2008) as a solution to the problem of a few clusters (Angrist & Pischke, 2009).

δ_i represent ethnic group, district, and time fixed effects respectively. I further control for district-ethnic group fixed effects, μ_{dg} and year-ethnic group fixed effects, α_{gt} to account for unobservables and prevent omitted variable bias such as accounting for some geographic differences within ethnic groups (for instance accounting for some behavioral differences between Sri Lankan Tamils in the northern part relative to those Sri Lankans who lived elsewhere) or for accounting for shocks/policy in some years across Sri Lanka that could have affected ethnic groups differently respectively (for instance the introduction of a nationwide family planning program that could differentially affect ethnic groups based on their cultural acceptance of contraceptives).

The regions marked by intense conflict were predominantly populated by Sri Lankan Tamils.¹⁰ The high conflict districts were the districts that represented the traditional Tamil homeland and were fought over to create the independent state of Tamil Eelam. Given that ethnicity played a crucial role in the evolution of the conflict, I hypothesize that the Sri Lankan Tamils and the Sinhalese would *not* have a similar demographic response since one of them is a majority and the other is a minority. The socio-political vulnerability of the group could shape its demographic adjustments to shocks. As per Table 1 column 3, the effect of high-conflict exposure leads to a decline in Sinhalese fertility by 8 live births per 1000 people. Column 4 which accounts for population weights suggests a similar effect.¹¹ For the effect on Sri Lankan Tamils, the *treated* \times *post* \times *Sri Lankan Tamil* coefficient is positive and significant. While the net effect on Sri Lankan Tamils as per column 3 is of reduction in fertility by 4 live births per 1000 people, column 4 suggests that the net effect on Sri Lankan Tamils is equivalent to a null effect ($-10.66 + 11.41 = 0.75 \sim 0$). These estimates in Table 1 underscore that considering only the overall effect on the population masks the heterogeneity by the ethnic groups. Sri Lankan Tamils experienced a significantly lesser reduction in their fertility in response to the conflict compared to the Sinhalese. For the Sri Lankan Tamils, their behavioral responses could be driven by not just an effort to maintain the size of their community and thus their political representation (De Silva et al., 2020), but to also preserve their culture and tradition (Jordan and Denov, 2007). But to the contrary, a majority community would not necessarily be under such pressure and can thus reduce their fertility much more in response to the war.

As a robustness check for these heterogeneous effects by ethnicity, Appendix Table 8 explores alternative specifications. There, to explore an alternative treatment classification, column 1 assigns treatment based on Li et al. (2019), assigning 8 districts as high-conflict (with more than 95% of all conflict events being in these districts and a larger presence of LTTE) and the rest as the low-conflict zone. Column 2 assigns treatment and control districts to top and bottom quartile districts (6 in each

¹⁰ In the high-conflict districts, the Sinhalese ethnic group had an average population size of around 15438.8, while the Sri Lankan Tamils had a considerably larger average size of 151326.9 (before the war). In districts characterized by low conflict, the Sinhalese constituted the majority, with an average population size of 523724.5, in contrast to the Sri Lankan Tamils, whose average size was approximately 25416.78 (before the war).

¹¹ Estimates with population weights are preferable as there is heterogeneity in the population of ethnic groups across districts and some districts have a lower-than-average minority share of population. Using population weights in this case ensures that small population sizes do not contribute disproportionately to the result.

group) ranked by the mean level of conflict per capita per year. Lastly, columns 3 and 4 remove the top 5% and top 10% of conflict districts respectively to ensure that these are not driving the main results. Across these columns, the result remains qualitatively similar to the main estimates in Table 1 suggesting that there was a lesser fertility reduction for the Sri Lankan Tamils relative to the Sinhalese.

Appendix Table 9 describes additional results for a finer disaggregated effect across all 5 ethnic groups as a further robustness check. Columns 1-4 are similar to those in Appendix Table 8 described above. The estimates for Sinhalese and Sri Lankan Tamils are qualitatively and quantitatively similar to those in Table 1 and Appendix Table 8, suggesting that aggregating remaining ethnic groups into the 'Other' category does not bias the main estimates.

For completeness, Appendix Table 10 explores estimates with a continuous treatment intensity which allows variation in treatment intensity and timing across districts in column 1. A placebo check based on this continuous specification in column 2 confirms that changing the timing of treatment intensity to pre-war years produces a null effect of war on fertility. The estimates here are obtained by dropping observations during the war and as a placebo, imposing the continuous conflict intensity from the years 1992 to 2005 on the years pre-war (1967 to 1980). This null estimate using a placebo conflict intensity suggests that the main estimates are not caused by some spurious pre-conflict trends. However, there are several reasons why it is not favorable to consider the continuous treatment specification as the main specification.¹²

As an extension of the difference-in-differences model, I examine the dynamic effects of war on fertility trends using the event-study design. I estimate the following specification to look at ethnicity-specific effects¹³:

$$\begin{aligned}
 br_{gdt} = & \beta_0 + \sum_{i=1967}^{1979} \beta_i \text{treated}_{d,i} + \sum_{i=1992}^{2009} \beta_i \text{treated}_{d,i} \\
 & + \left\{ \sum_{j=1967}^{1979} \beta_j \text{treated}_{d,j} + \sum_{j=1992}^{2009} \beta_j \text{treated}_{d,j} \right\} x \text{ sri lankan tamil}_g \\
 & + \left\{ \sum_{k=1967}^{1979} \beta_k \text{treated}_{d,k} + \sum_{k=1992}^{2009} \beta_k \text{treated}_{d,k} \right\} x \text{ other}_g + \theta_d + \delta_t + \gamma_g + \epsilon_{gdt}
 \end{aligned} \tag{4}$$

¹² There are two reasons to prefer the DiD specification. The first one is that a continuous treatment effect DiD requires a much stronger assumption than parallel trends has undesirable properties in heterogeneous treatment effect estimation, and has parameters harder to interpret, confounded with selection bias (Callaway et al., 2021). Second, while having more variation in the conflict intensity may be valuable, the UCDP dataset restricts its domain to events that were reported in secondary sources like newspapers, reports, and other media outlets. So arguably, any media bias in reporting these events can lead to biased estimates. Collapsing the information into a binary variable would make estimates less sensitive as I am then identifying a broader intensity of conflict in the district. Therefore, the binary variable of conflict is the preferred specification for this analysis.

¹³ Appendix Table 11 reports the estimates for the overall effect on Sri Lanka in column 1. These estimates are obtained by estimating the following Eq. (4'): $br_{gdt} = \beta_0 + \sum_{i=1967}^{1979} \beta_i \text{treated}_{d,i} + \sum_{i=1992}^{2009} \beta_i \text{treated}_{d,i} + \theta_d + \delta_t + \epsilon_{gdt}$ for the whole population. The estimates are hovering around 0 pre-war and become negative for several years in the war period. Appendix Fig. 10 is the corresponding figure for these estimates.

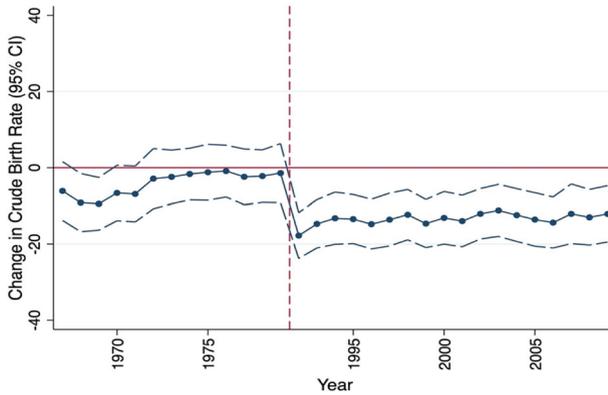


Fig. 2 Dynamic effect of conflict on crude birth rate of Sinhalese. Note: This figure plots the coefficient and 95% CI of the effect of conflict on the crude birth rate for the Sinhalese ethnic group

Here, $treated_{d,i}$ is a dummy variable that takes a value of 1 high-conflict districts for year i and 0 otherwise. The years 1967–1979 form the lag years and the year 1980 is the base category and is therefore dropped from the specification. The years 1992 to 2009 comprise the lead years of this analysis. Sinhalese are the omitted base category, as before. $sri\ lankan\ tamil_g$ is a binary variable that takes the value 1 for Sri Lankan Tamil ethnic group and 0 otherwise. $other_g$ takes a value of 1 for the other ethnic groups. γ_g , θ_d , and δ_t represent the ethnicity, district and time fixed effects respectively.

The estimates from Eq. (4) are reported in Appendix Table 11. Column 2 provides the coefficients for the Sinhalese ethnic group over the years (β_i). Column 3 provides the heterogeneity estimates from the interaction term in Eq. (4) for the Sri Lankan Tamils (β_j). This represents the differential between the fertility of the two ethnic groups. Adding column 2 and column 3 gives the total effect on Sri Lankan Tamils, which is listed in column 4 ($\beta_i + \beta_j$). The estimates from columns 2 and 4 have been graphed in Figs. 2 and 3 to show the dynamic effect for the two groups.

For the Sinhalese, Fig. 2 depicts that the effect of conflict on the Sinhalese birth rate was negative. The coefficient remains negative through all war years, whereas pre-war years saw a fluctuation around 0. A close look at Fig. 3 suggests that for the Sri Lankan Tamils, fertility did not drop much in the war years. Therefore, comparing Figs. 2 and 3, it is evident that the reduction in fertility was of a larger magnitude for the Sinhalese. The estimates from column 3 of Appendix Table 11 further indicate that the difference in fertility behavior between the two groups during war years is statistically significant. These results are in line with the heterogeneity evidence from the difference-in-difference estimates of the two groups presented in Table 1. Therefore, the dynamic effects are largely consistent with the difference-in-difference estimates.

Overall, estimates are qualitatively robust across the definition of treatment assignment. Estimates of the interaction term coefficient for Sri Lankan Tamils across the specifications are significant and positive which implies Sri Lankan Tamils did have a significantly different behavioral response to the war, and most specifications suggest a lesser reduction

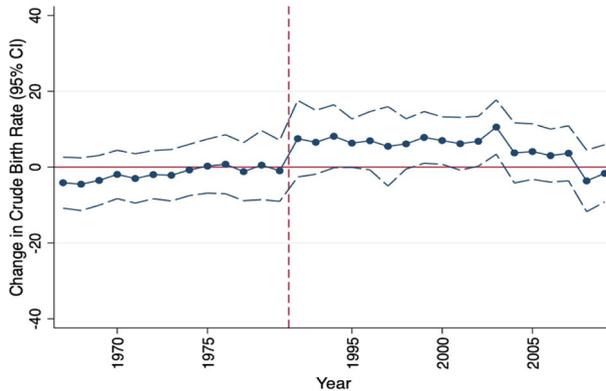


Fig. 3 Dynamic effect of conflict on crude birth rate of Sri Lankan Tamils. Note: This figure plots the coefficient and 95% CI of the effect of conflict on the crude birth rate for the Sri Lankan Tamil ethnic group

in fertility compared to Sinhalese. These results are in line with the overall findings of Puvanarajan and De Silva (2001). While their study does not estimate the impact of civil war on fertility, they broadly trace trends in fertility by ethnicity in Sri Lanka and find that the Sinhalese witnessed a stronger reduction in fertility than Sri Lankan Tamils during the 1990s. They also find evidence of an increasing age at marriage in Sri Lanka.

To the extent that I am unable to control for migration, these results should be interpreted with some caution. Several sources highlight that the civil war had resulted in large emigration from Sri Lanka (Fazil, 2019; Ibrahim et al., 2021; Sen, 2020). Sriskandarajah (2002) reports that about 25% of the entire Sri Lankan Tamil population left the country. It is possible that those who left were the ones who had access to wealth and higher education which increased their possibility of finding refuge elsewhere. One might argue if the more educated/wealthy had higher fertility rates because they could afford to have kids, then their exit could artificially cause the fertility estimates of my analysis. For instance, Zimmerman and Carter (2003), Thiede et al. (2020) and Dehejia and Lleras-Muney (2004) find evidence that with access to greater resources, the educated and wealthy could be more able to afford to raise children in the presence of exogenous shocks like wars and famines. However, if 25% of the Sri Lankan Tamils left, because the number leaving is so large, there were likely people from across the entire income distribution who left and not just those on the top (which typically comprises 1% of the population). Further, there is also evidence in the literature that the more educated have a lower fertility rate (Schultz, 1994; Duflo et al., 2015; Jayachandran, 2017). So a priori, it is unclear as to what was the composition of the people who left during war and what it would mean in terms of bias in the estimates of this study.

6.2 Replacement effect

I test for the presence of a replacement effect at the ethnic group level as a mechanism for the heterogeneity findings. Previous studies often utilize survey data

to measure this effect at the individual level where they trace the woman's family history to see if she experienced any wartime deaths and altered her fertility in response to it. In this study, since I don't have access to individual-level survey data, I measure the response of fertility at the ethnic group level to lagged conflict-specific mortality rate at the district level.^{14,15}

I estimate the following equation:

$$\begin{aligned}
 br_{gdt} = & \beta_0 + \beta_1 treated_d \times post_t + \beta_2 treated_d \times post_t \times dr_{d,t-1} \\
 & + \beta'_g \sum_{g=2}^n ethnicity_g \times treated_d \times post_t \\
 & + \beta''_g \sum_{g=2}^n ethnicity_g \times treated_d \times post_t \times dr_{d,t-1} \\
 & + \text{Pairwise Interaction terms} + \gamma_g + \theta_d \\
 & + \delta_t + \nu dr_{d,t-1} + \alpha_{gt} + \mu_{dg} + \epsilon_{gdt}
 \end{aligned} \tag{5}$$

where br is the crude birth rate for ethnic group g in district d at time t . Likewise, dr is the conflict-specific death rate for ethnic group g in district d at time $t-1$. $treated$ is a dummy variable that takes a value of 1 for high-conflict districts and 0 for others, $post$ is a dummy that takes a value of 1 for years after 1983 that mark the beginning of the civil war. As before, I include the dummy variables of $n-1$ ethnic groups interacted with $treated \times post$, omitting it for Sinhalese and making Sinhalese the reference or base category. Thus, as in the main specification, I include the dummy for Sri Lankan Tamils and for others category ($n = 3$). Pairwise interactions include the interaction of $treated$ with ethnicity dummies, $post$ with ethnicity dummies, $treated$ with death rate and its lag, $post$ with a lag of death rate, as well as ethnicity dummies with a lag of death rates. γ_g , θ_d and δ_t represent ethnic group, district, and time fixed effects respectively. I further control for district-ethnic group fixed effects, μ_{dg} and year-ethnic group fixed effects, α_{gt} .¹⁶

There would be evidence of a replacement effect if an ethnic group's fertility response was positive in high-conflict zones in response to the lagged conflict-specific death rate. Table 3 presents these estimates. The sign of the coefficient $treated \times post \times death\ rate\ lag$ (i.e. β_2) would reflect replacement effects or lack thereof for Sinhalese, which was the reference category ethnic group. Lagged death rates seemed to negatively impact fertility for Sinhalese in conflict zones which implied that with an increase in conflict-specific mortality, Sinhalese in high-conflict districts reduced fertility and thus points to the absence of any replacement mechanism. This could be possible due to various reasons such as

¹⁴ The DHS of Sri Lanka data are not publicly available and could not be obtained for this empirical exercise. Further limitations of the DHS are that most rounds of the survey did not cover high conflict districts in the North and East, making it difficult to study health in conflict zones.

¹⁵ Since behavioral effects such as fertility require a minimum of 9 months to reflect in data, I consider lagged conflict-specific mortality rate by one year to measure replacement effects.

¹⁶ As a robustness check, Appendix Table 14 reports the estimates corresponding to Table 3 with clustered standard errors at the district level and estimated p -values from the wild cluster bootstrap recommended by Cameron et al. (2008) as a solution to the problem of a few clusters (Angrist & Pischke, 2009).

Table 3 Replacement effect mechanism: impact of conflict on fertility*Dependent variable: crude birth rate*

	(1)
Independent variable:	
treated x post	-10.336*** (0.877)
treated x post x deathrate lag	-6.496* (3.692)
treated x post x Sri Lankan Tamil	8.001*** (1.771)
treated x post x death rate lag x Sri Lankan Tamil	38.996*** (11.279)
<i>N</i>	2250
<i>R</i> ²	0.703

Note: Treatment is assigned based on classification in Appendix Table 4. The regression includes all pairwise interactions of post, treated, ethnicity, and lag of death rate. The regression also includes district, year, ethnicity, district \times ethnic group, and year \times ethnic group fixed effects. Robust standard errors are reported in the parenthesis. Estimates are population weighted. The mean, minimum, maximum, and standard deviation for lag of death rate is (0.187, 0, 20.818, 1.135)

*significant at 10%; **significant at 5%; ***significant at 1%

the majority status of the ethnic group which allows it to reduce fertility without any immediate threat to its group's political representation in the country. Other reasons for increased mortality resulting in lower fertility could include fear and uncertainty that manifest into psychological and physiological stress and trauma.

On the other hand, *treated \times post \times Sri Lankan Tamil \times death rate lag*, which is the relevant coefficient for Sri Lankan Tamils, is positive (i.e. β''_2). It seems that there is a high responsiveness of Sri Lankan Tamils to the conflict-specific mortality around them. The replacement effect coefficients suggest that due to 1 additional conflict-related death per 1000 people in the district, Sri Lankan Tamils responded by increasing their fertility by 32.5 births per 1000 people while the Sinhalese responded by reducing their fertility by 6.496 births per 1000 people. This could reflect some pro-natal sentiments in the minority group to try and maintain their group size during the war, an effort to replace the loss of a loved one or it may even reflect the insurance effect wherein parents increase fertility as a means of securing insurance for their old age if they fear only some of their kids would survive. Thus, there is evidence to suggest that there was an ethnic-group level replacement effect in place for the Sri Lankan Tamils, but not for the Sinhalese.

While this mechanism is not exhaustive, it is still indicative of a replacement effect partially contributing to the differential in fertility trends. Apart from this mechanism, other potential explanations include an increased risk of intimate partner violence and assault in conflict areas coupled with lower usage of contraceptives by Sri Lankan Tamils relative to Sinhalese. GoSL estimates suggest that 2% of all births in 1991–1998 were illegitimate and could potentially account for sexual violence channel during the war, however, that information is

not available by ethnic groups at the district level for further analysis.¹⁷ For the most part provision of healthcare was taken up by the LTTE in war zones (Stokke, 2006; Mampilly, 2011). If they were biased in the provision, access to health care in conflict zones might be selectively more available to Sri Lankan Tamils than to Sinhalese since social welfare provision was one aspect of LTTE state-building. This could have further contributed to a lesser negative effect on Sri Lankan Tamil fertility.

7 Conclusion

This paper provides evidence of a negative relationship between fertility and war in Sri Lanka on average. The increased female age at marriage in high-conflict zones contributes to this lower fertility. An exploration of the ethnic heterogeneity unveils that in response to high-conflict exposure, the Sinhalese had a larger reduction in fertility than their Sri Lankan Tamil counterparts. This study further contributes to the literature by finding evidence of the presence of a replacement effect for the Sri Lankan Tamils. This could reflect pronatalist sentiments in the minority group to maintain their group size during the civil war, an effort to replace the loss of a loved one or it may even reflect the insurance effect wherein parents increase fertility as a means of insurance for their old age if they fear only some of their kids would survive. Future research should explore these in more detail with survey micro-data which often ask questions on desired fertility, and record female fertility history along with information on the loss of loved ones. Future research may also study the marriage market channel disaggregated by the ethnic group if data becomes available.

From a policy perspective, there is enough evidence in the literature (Li et al., 2019) to suggest that children born during such a crisis can often suffer from lower birth weight and lower height-for-age (HAZ) or weight-for-age (WAZ) scores under age 5. If births are not well spaced apart, it can negatively impact the health of the mother and the child. Lower health outcomes could potentially transform into lower human capital in adulthood. So reproductive health policies and accessibility of neonatal care need to be targeted towards high-conflict areas.

It is also key for future research to analyze fertility trends post-war. Jayasundara-Smiths (2018) highlights the sense of vulnerability in the minority post-war. She finds that war areas report a dominance of bodily grave crimes relative to the non-war areas where material grave crimes were dominant. With a distinct pattern in the nature of post-war crime in the two regions, the minority may continue to feel threatened. If the replacement effect in Sri Lankan Tamils was in part due to a fear of

¹⁷ The estimates for total births, based on vital statistics, include instances of births outside of marriage if they are officially registered. Consequently, these occurrences aren't distinctly singled out as specific mechanisms. Unfortunately, this statistic on births lacks an ethnic breakdown of illegitimate births, which limits the possibility of conducting an in-depth analysis regarding its implications for the two ethnic groups. Nonetheless, it's conceivable that illegitimate births could be linked to the avenue of sexual violence during the war. However, due to limitations in data availability, I am presently unable to account for this factor.

diminished old-age insurance due to war deaths or due to a pronatalist sentiment to maintain their identity in Sri Lanka, then the differential nature of the post-war crimes in conflict-affected areas could sustain this fertility differential. This has far-reaching consequences in the long term. It can change the demographic composition of the country and thus has the potential to impact the possibility of a future war in an already volatile political environment.

Data availability The data that support the findings of this study are publicly available: the conflict data is available at Uppsala Conflict Data Program (<https://ucdp.uu.se/encyclopedia>), information on vital statistics and age at marriage has been obtained from the website of the Ministry of Census and Statistics, GoSL (<http://www.statistics.gov.lk/VitalStatistics>), the book ‘Vital Statistics, (1967–1980) Sri Lanka: Marriages, Births, and Deaths’ (published by: Department of Census & Statistics, GoSL) and Census of Population and Housing Report (1963, 1971, 1981, 2001, 2012). The dataset digitized for this analysis can be made available upon request.

Acknowledgements I am grateful to Priyaranjan Jha, Vellore Arthi, Damon Clark, Meera Mahadevan, and Tim Bruckner for their valuable feedback. I would also like to thank the participants of the Graduate Student Applied Microeconomics Workshop, UCI, and the Annual Center for Global Peace and Conflict Studies Conference, UCI. This study was funded by the Center for Global Peace and Conflict Studies, UCI. All errors are my own.

Author contributions The author, M.S., confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Funding This study was funded by the Center for Global Peace and Conflict Studies, University of California, Irvine.

Compliance with ethical standards

Conflict of interest The author declare no competing interests.

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8 Appendix

Figures 4–10; Tables 4–14

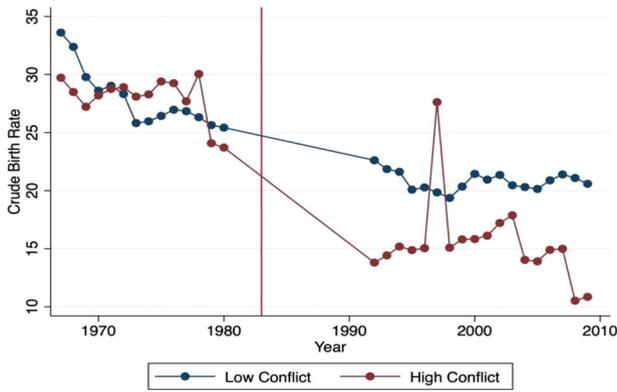


Fig. 4 Parallel trends in crude birth rate pre-war. Note: This figure graphs the average crude birth rate (calculated over all ethnic groups) for the low and high-conflict zones over the years. It depicts parallel trends in the pre-war years as the two curves trend closely together. During the war, there was a divergence, and the high-conflict areas witnessed a larger reduction in fertility

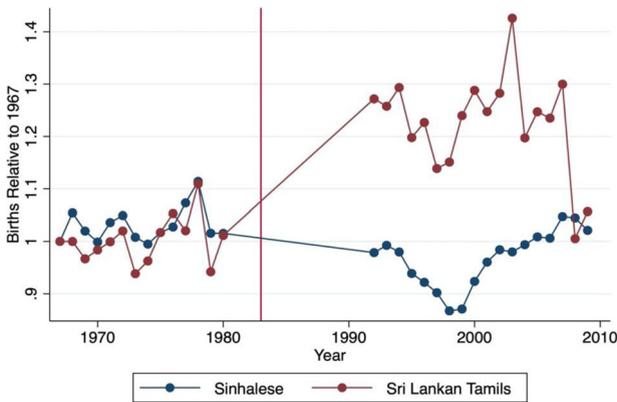


Fig. 5 Trend in size of relative birth cohort for Sri Lankan Tamils and Sinhalese. Note: This figure depicts the size of the birth cohort over time relative to 1967 levels for the two ethnic groups across Sri Lanka

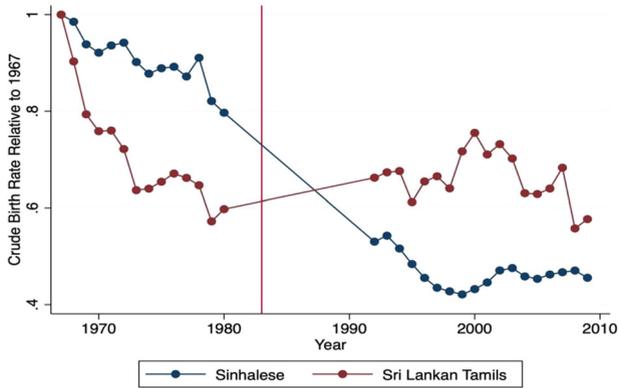


Fig. 6 Trend in relative crude birth rate for Sri Lankan Tamils and Sinhalese. Note: This figure depicts a trend in crude birth rate over time relative to 1967 levels for the two ethnic groups across Sri Lanka

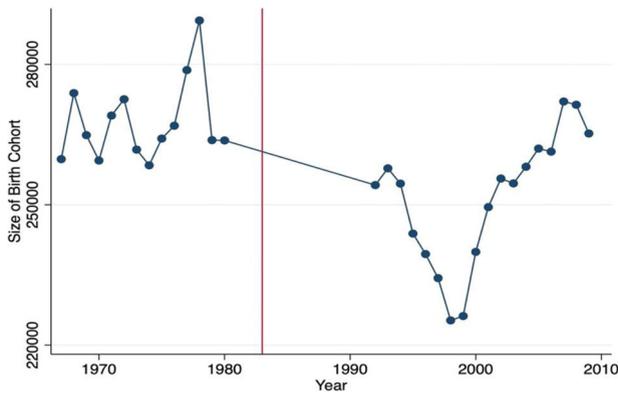


Fig. 7 Trend in size of absolute birth cohort for Sinhalese. Note: This figure depicts the absolute size of the birth cohort over time for Sinhalese across Sri Lanka

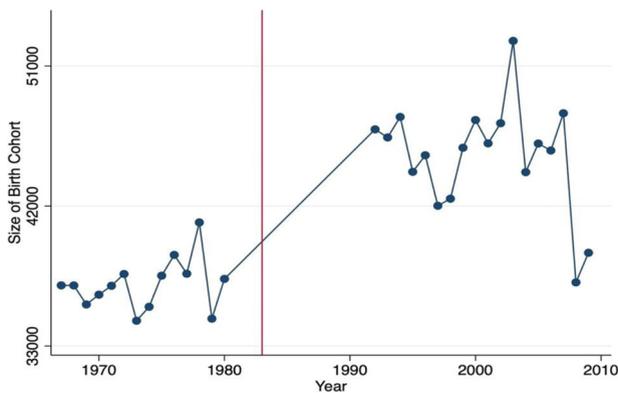


Fig. 8 Trend in size of absolute birth cohort for Sri Lankan Tamils. Note: This figure depicts the absolute size of the birth cohort over time for Sri Lankan Tamils across Sri Lanka

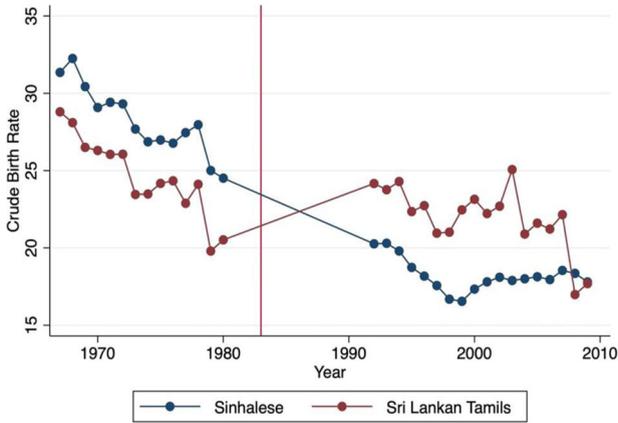


Fig. 9 Trend in absolute crude birth rate for Sri Lankan Tamils and Sinhalese. Note: This figure depicts the absolute crude birth rate over time for Sri Lankan Tamils and Sinhalese across Sri Lanka

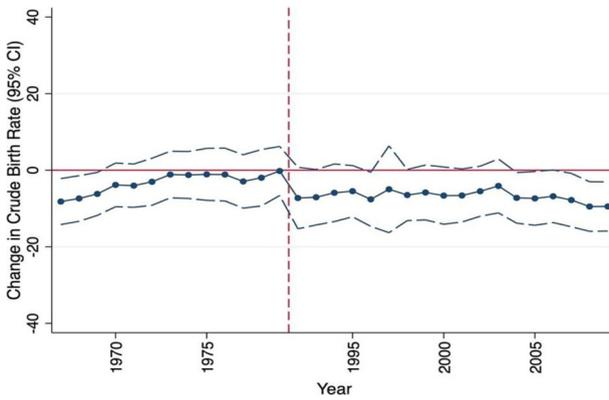


Fig. 10 Dynamic effect of conflict on crude birth rate of Sri Lanka. Note: This figure plots the coefficient and 95% CI of the effect of conflict on the crude birth rate of Sri Lanka (calculated over all ethnic groups)

Table 4 Classification of districts into high and low-conflict zones

District	Number of conflict events	Zone
Kalutara	0	Low-conflict (Control Group)
Ratnapura	0	
Nuwara Eliya	1	
Hambantota	1	
Matara	1	
Gampaha	2	
Badulla	2	
Galle	2	
Matale	3	
Kurunegala	3	
Kegalle	4	
Kandy	5	
Puttalam	17	
Monaragala	17	
Anuradhapura	38	
Polonnaruwa	65	
Colombo	71	
Ampara	122	
Trincomalee	259	High-conflict (Treatment Group)
Kilinochchi	311	
Batticaloa	363	
Vavuniya	442	
Mannar	455	
Jaffna	559	
Mullaitivu	806	
Total	3549	

Note: The number of conflict events are calculated by district for years 1992–2009 using the UCDP dataset. This table classifies districts as high (treatment) and low-conflict zones (control) based on being above or below the average number of conflict events (141.96)

Table 5 Distribution of ethnic groups by district in 1981

District	All	Sinhalese	Sri Lankan Tamils	Others
Colombo	1,699,241	1,318,835	170,590	209,816
Gampaha	1,390,862	1,279,512	48,182	63,168
Kalutara	829,704	723,483	9744	96,477
Kandy	1,048,317	778,801	52,791	216,725
Matale	357,354	285,354	20,579	51,421
Nuwara Eliya	603,577	254,375	76,449	272,753
Galle	814,531	769,343	7271	37,917
Matara	643,786	608,516	4683	30,587
Hambantota	424,344	412,055	2500	9789
Jaffna	394,512	3163	375,433	15,916
Kilinochchi	436,040	3496	414,952	17,592
Mannar	106,235	8683	54,474	43,078
Vavuniya	95,428	15,794	54,179	25,455
Mullativu	77,189	3992	58,209	14,988
Batticaloa	330,333	11,255	233,713	85,365
Trincomalee	255,948	85,503	87,760	82,685
Kurunegala	1,211,801	1,125,912	14,920	70,969
Puttalam	492,533	407,067	32,282	53,184
Anuradhapura	587,929	535,834	8026	44,069
Polonnaruwa	261,563	238,965	5267	17,331
Badulla	640,952	443,024	37520	160,408
Monaragala	273,570	253,572	5346	14,652
Ratnapura	797,087	677,510	19,094	100,483
Kegalle	684,944	588,581	15,074	81,289
Total	14,846,750	10,979,568	1,886,864	1,980,318

Note: This table provides a snapshot of the ethnic group population across the districts of Sri Lanka. It has been created using the data from the Census of Population and Housing Report (1981)

Table 6 Summary statistics of vital statistics data

Variable	No. of obs	Mean	std	Min	Max
<i>A. Sinhalese</i>					
Live Births	800	10339.82	10010.64	0.00	50265.00
Population	800	477723.20	457954.90	1461.38	2027287.00
Crude Birth Rate	800	20.58	10.73	0.00	66.77
<i>B. Sri Lankan Tamil</i>					
Live Births	800	1664.46	2271.30	0.00	14102.00
Population	800	72974.71	103768.70	1227.13	553787.60
Crude Birth Rate	800	24.00	12.10	0.00	102.69
<i>C. Indian Tamil</i>					
Live Births	800	950.58	1896.42	0.00	9390.00
Population	800	37561.45	71098.86	152.94	371560.40
Crude Birth Rate	800	17.92	15.93	0.00	159.77
<i>D. Moors</i>					
Live Births	800	1456.48	1672.21	0.00	7574.00
Population	800	50939.47	55437.06	791.99	271064.30
Crude Birth Rate	800	27.27	28.92	0.00	783.23
<i>E. Others</i>					
Live Births	800	87.78	209.73	0.00	1389.00
Population	800	4577.92	10020.36	32.93	51524.00
Crude Birth Rate	800	25.54	57.39	0.00	702.61

Note: The summary statistics is obtained from district-ethnicity data from prewar (1967–1980) as well as postwar years (1992–2009)

Table 7 Impact of conflict on fertility: average effect on population, robustness

Dependent variable: crude birth rate				
	Alternative treatment	Compares top & bottom conflict quartile districts	Drops top 5% conflict districts	Drops top 10% conflict districts
	(1)	(2)	(3)	(4)
Independent variable				
treated x post	-4.33*** (0.848)	-2.24* (1.326)	-6.494*** (0.960)	-6.120*** (1.016)
N	2,400	1,152	2,208	2,112
R ²	0.32	0.318	0.305	0.303

Note: Robust standard errors are reported in the parenthesis. Estimates are weighted by district population. Column 1 assigns alternative treatment based on Li et al. (2019), assigning 8 districts with the large LTTE influence in the north and east as the high-conflict zone and the rest as the low-conflict zone. Column 2 assigns treatment and control districts to top and bottom quartile districts (6 in each group) ranked by the mean level of conflict per capita per year. Column 3 excludes the top 5% of the conflict districts – Mullaitivu and Jaffna. Column 4 excludes the top 10% of the conflict districts – Mullaitivu, Jaffna and Mannar

*significant at 10%; **significant at 5%; ***significant at 1%

Table 8 Impact of conflict on fertility: heterogeneity by ethnic group, robustness

Dependent variable: crude birth rate				
	Alternative treatment	Compares top & bottom conflict quartile districts	Drops top 5% conflict districts	Drops top 10% conflict districts
	(1)	(2)	(3)	(4)
Independent variable				
treated x post	-5.09*** (1.038)	-10.45*** (1.440)	-10.160*** (0.879)	-10.136*** (0.904)
treated x post x Sri Lankan Tamil	3.23* (1.767)	8.86*** (3.205)	7.033** (1.648)	7.074*** (1.709)
treated x post x Others	2.14 (1.527)	8.55*** (2.285)	6.558*** (1.504)	8.171*** (1.561)
N	2400	1152	2208	2112
R ²	0.693	0.741	0.721	0.721

Note: Robust standard errors are reported in the parenthesis. The regression includes district, year, ethnicity, district × ethnic group, and year × ethnic group fixed effects. Estimates are population weighted. Column 1 assigns alternative treatment based on Li et al. (2019), assigning 8 districts with the large LTTE influence in the north and east as the high-conflict zone and the rest as the low-conflict zone. Column 2 assigns treatment and control districts to top and bottom quartile districts (6 in each group) ranked by the mean level of conflict per capita per year. Column 3 excludes the top 5% of the conflict districts – Mullaitivu and Jaffna. Column 4 excludes the top 10% of the conflict districts – Mullaitivu, Jaffna and Mannar

*significant at 10%; **significant at 5%; ***significant at 1%

Table 9 Impact of conflict on fertility by ethnicity, robustness

		<i>Dependent variable: crude birth rate</i>					
	Main treatment	Main treatment (w/ pop. wts)	Alternative treatment	Compares top & bottom conflict quartile districts	Drops top 5% conflict districts	Drops top 10% conflict districts	
	(1)	(2)	(3)	(4)	(5)	(6)	
Independent variable							
treated x post	-8.25*** (1.159)	-10.66*** (0.864)	-5.09*** (1.038)	-10.45*** (1.440)	-10.160*** (0.879)	-10.136*** (0.904)	
treated x post x Sri Lankan Tamil	4.07*** (1.879)	11.41*** (1.657)	3.23* (1.770)	8.86*** (3.205)	7.033*** (1.648)	7.074*** (1.709)	
treated x post x Indian Tamil	1.03 (1.886)	8.23*** (1.641)	3.01* (1.723)	9.33*** (1.779)	7.657*** (1.871)	8.671*** (2.055)	
treated x post x Moors	1.14 (6.269)	3.36* (1.787)	-2.04 (1.556)	5.09* (2.887)	2.563 (1.585)	4.212** (1.640)	
treated x post x Others	-45.29*** (12.714)	-5.04 (3.071)	-10.18*** (2.747)	-1.29 (4.531)	-5.416* (3.148)	0.258 (2.547)	
N	4000	4000	4000	1920	3680	3520	
R ²	0.335	0.669	0.668	0.694	0.713	0.717	

Note: Robust standard errors are reported in the parenthesis. The regression includes district, year, ethnicity, district x ethnic group and year x ethnic group fixed effects. Column 1 and 2 assigns treatment based on the classification in Appendix Table 4. Column 1 does not include population weights whereas column 2 does. Estimates are population weighted in columns 3–6. Column 3 assigns alternative treatment based on Li et al. (2019), assigning 8 districts with the large LTTE influence in the north and east as the high-conflict zone and the rest as the low-conflict zone. Column 4 assigns treatment and control districts to top and bottom quartile districts (6 in each group) ranked by the mean level of conflict per capita per year. Column 5 excludes the top 5% of the conflict districts – Mullaitivu and Jaffna. Column 6 excludes the top 10% of the conflict districts – Mullaitivu, Jaffna and Mannar

*significant at 10%; **significant at 5%; ***significant at 1%

Table 10 Impact of conflict on fertility by ethnicity: conflict events per 1000 inhabitants

<i>Dependent variable: crude birth rate</i>		
	Continuous treatment (1)	Placebo (2)
Independent variable		
conflict intensity	-7.831*** (2.257)	3.368 (10.6)
conflict intensity x Sri Lankan Tamil	2.149 (4.199)	3.718 (15.530)
conflict intensity x Others	2.4 (3.330)	14.29 (12.951)
<i>N</i>	2,250	975
<i>R</i> ²	0.6883	0.75

Note: Robust standard errors are reported in the parenthesis. Estimates are population weighted. The regression includes district, year, ethnicity, district \times ethnic group, and year \times ethnic group fixed effects. Estimates are population weighted. Conflict intensity is the continuous variable: conflict events per 1000 inhabitants in the district in year $t-1$. The mean, minimum, maximum, and standard deviation of the conflict intensity variable are the following (0.025, 0, 2.746, 0.159). The placebo test in column 2 shifts the conflict intensity from the actual years of occurrence in 1992–2005 to the pre-war years of 1967–1980 and finds no effect on fertility.

* significant at 10%; **significant at 5%; ***significant at 1%

Table 11 Impact of conflict on fertility: event-study

<i>Dependent variable: crude birth rate</i>				
Independent variable:	Overall <i>Treated_{it}</i> (1)	Sinhalese <i>Treated_{it}</i> (2)	Heterogeneity for Sri Lankan Tamils <i>treated_{it} \times Sri Lankan Tamil</i> (3)	Total Effect on Sri Lankan Tamils (4) = (2) + (3)
Year:				
1967	-8.18*** (3.058)	-6.10 (3.920)	1.99 (3.389)	-4.11 (3.428)
1968	-7.39** (3.039)	-9.14** (3.879)	4.64 (3.431)	-4.50 (3.546)
1969	-6.18** (2.860)	-9.46*** (3.518)	5.97** (2.839)	-3.49 (3.348)
1970	-3.83 (2.910)	-6.63* (3.696)	4.70 (2.987)	-1.92 (3.253)
1971	-4.03 (2.882)	-6.89* (3.726)	3.89 (3.079)	-3.00 (3.317)
1972	-3.02 (3.132)	-2.88 (4.021)	0.90 (3.348)	-1.98 (3.244)
1973	-1.13 (3.103)	-2.42 (3.592)	0.28 (2.986)	-2.15 (3.457)
1974	-1.24 (3.126)	-1.66 (3.452)	0.92 (2.746)	-0.74 (3.454)
1975	-1.08 (3.462)	-1.20 (3.736)	1.47 (3.192)	0.27 (3.634)
1976	-1.13 (3.515)	-0.89 (3.464)	1.65 (3.195)	0.76 (3.970)

Table 11 continued

Dependent variable: crude birth rate

Independent variable:	Overall	Sinhalese	Heterogeneity for Sri Lankan Tamils	Total Effect on Sri Lankan Tamils
	$Treated_{it}$	$Treated_{it}$	$treated_{it} \times$ Sri Lankan Tamil	(4) = (2) + (3)
	(1)	(2)	(3)	
1977	-2.93 (3.554)	-2.40 (3.723)	1.21 (3.280)	-1.19 (3.906)
1978	-1.96 (3.753)	-2.22 (3.511)	2.74 (3.812)	0.53 (4.647)
1979	-0.20 (3.267)	-1.43 (3.949)	0.46 (3.229)	-0.97 (4.112)
1992	-7.27* (4.092)	-17.76*** (3.061)	25.28*** (4.587)	7.51 (5.155)
1993	-7.06* (3.690)	-14.70*** (3.224)	21.25*** (3.694)	6.55 (4.299)
1994	-5.89 (3.831)	-13.23*** (3.483)	21.37*** (3.895)	8.14* (4.240)
1995	-5.47 (3.411)	-13.45*** (3.269)	19.77*** (2.533)	6.33* (3.263)
1996	-7.60** (3.599)	-14.76*** (3.316)	21.72*** (3.326)	6.96* (3.925)
1997	-4.97 (5.778)	-13.59*** (3.521)	19.08*** (5.078)	5.49 (5.337)
1998	-6.48* (3.406)	-12.29*** (3.356)	18.43*** (2.768)	6.13* (3.381)
1999	-5.81 (3.656)	-14.61*** (3.210)	22.45*** (2.648)	7.84** (3.480)
2000	-6.62* (3.810)	-13.13*** (3.515)	20.14*** (2.689)	7.01** (3.194)
2001	-6.60* (3.533)	-13.96*** (3.436)	20.13*** (2.998)	6.17* (3.559)
2002	-5.49* (3.331)	-12.06*** (3.362)	18.89*** (2.596)	6.83** (3.353)
2003	-4.10 (3.588)	-11.17*** (3.471)	21.75*** (3.147)	10.57*** (3.659)
2004	-7.22** (3.369)	-12.40*** (3.521)	16.16*** (3.577)	3.75 (4.043)
2005	-7.36** (3.578)	-13.57*** (3.567)	17.67*** (3.294)	4.11 (3.745)
2006	-6.80* (3.502)	-14.35*** (3.401)	17.39*** (2.972)	3.04 (3.567)
2007	-7.79** (3.553)	-12.07*** (3.978)	15.73*** (3.748)	3.65 (3.695)
2008	-9.48*** (3.300)	-12.98*** (3.710)	9.36** (3.940)	-3.62 (4.145)
2009	-9.46*** (3.273)	-12.10*** (3.757)	10.45*** (3.733)	-1.65 (3.847)
N	2400		2400	
R ²	0.322		0.640	

Note: Event-study estimates in column 1 are based on overall equation for Sri Lanka from Eq. (4'). Robust standard errors are reported in the parenthesis. Estimates in columns 2–4 are based on Eq. (4). Column 2 reports event-study estimates for Sinhalese. Column 3 reports the heterogeneity coefficient for Sri Lankan Tamils. Column 4 reports the overall effect for Sri Lankan Tamils (adding estimates from columns 2 and 3, with robust standard errors calculated using the Delta method). Treatment is assigned based on classification in Appendix Table 4

* significant at 10%; **significant at 5%; ***significant at 1%

Table 12 Impact of conflict on fertility, robustness*Dependent variable: crude birth rate*

	Overall effect		Heterogeneity by ethnicity	
	(1)	(2)	(3)	(4)
Independent variable				
treated × post	−5.42	−3.96	−8.247	−10.66
clustered SE	(2.862)*	(4.015)	(4.959)	(2.653)***
Wild bootstrap <i>p</i> -value	0.091*	0.396	0.140	0.048**
treated × post × Sri Lankan Tamil	−	−	4.072	11.41
clustered SE			(4.975)	(4.460)**
Wild bootstrap <i>p</i> -value			0.459	0.049**
treated × post × Others	−	−	4.422	7.15
clustered SE			(4.087)	(2.220)***
Wild bootstrap <i>p</i> -value			0.311	0.123
<i>N</i>	2400	2400	2400	2400
<i>R</i> ²	0.326	0.319	0.536	0.694

Note: Treatment is assigned based on classification in Appendix Table 4. The regression in column 1 reports the coefficient for Eq. (1), giving the effect of war on fertility in Sri Lanka. The regression includes district and year-fixed effects. Column 2 adds district population weights. Columns 3 and 4 correspond to estimates from Eq. (3), exploring heterogeneity by ethnic groups. Column 3 does not include population weights whereas column 4 does. Columns 3 and 4 control for district, year, ethnicity, district × ethnicity, and year × ethnicity fixed effects. Standard errors clustered at the district level are reported in the parenthesis. The wild cluster bootstrapped *p*-values are also reported for each coefficient.

*significant at 10%; **significant at 5%; ***significant at 1%

Table 13 Impact of conflict on age at marriage, robustness*Dependent variable: female age at marriage*

	(1)
Independent variable	
treated × post	1.93
SE	(0.485)***
<i>p</i> -val	0.009***
<i>N</i>	441
R ²	0.853

Note: Treatment is assigned based on classification in Appendix Table 4. The regression in column 1 reports the coefficient for Eq. (2), giving the effect of war on female age at marriage in Sri Lanka. The regression includes district and year-fixed effects. Estimates are weighted by district population. Standard errors clustered at the district level are reported in the parenthesis. The wild cluster bootstrapped *p*-values are also reported for each coefficient. The mean, minimum, maximum, and standard deviation for mean age at marriage is (24.062, 17.3, 30, 1.728)

*significant at 10%; **significant at 5%; ***significant at 1%

Table 14 Replacement effect mechanism: impact of conflict on fertility, robustness*Dependent variable: crude birth rate*

	(1)
Independent variable:	
treated × post	−10.336
SE	(2.647)***
<i>p</i> -val	0.051*
treated × post × deathrate lag	−6.496
SE	(6.461)
<i>p</i> -val	0.2773
treated × post × Sri Lankan Tamil	8.001
SE	(4.492)*
<i>p</i> -val	0.104
treated × post × Sri Lankan Tamil × death rate lag	38.996
SE	(15.328)**
<i>p</i> -val	0.275
<i>N</i>	2250
R ²	0.703

Note: Treatment is assigned based on classification in Appendix Table 4. The regression includes all pairwise interactions of post, treated, ethnicity, and lag of death rate. The regression also includes district, year, ethnicity, district × ethnic group, and year × ethnic group fixed effects. Standard errors clustered at the district level are reported in the parenthesis. The wild cluster bootstrapped *p*-values are also reported for each coefficient. The mean, minimum, maximum, and standard deviation for lag of death rate is (0.187, 0, 20.818, 1.135).

*significant at 10%; **significant at 5%; ***significant at 1%

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