Country of Women? Repercussions of the Triple Alliance War in Paraguay*

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Abstract

The War of the Triple Alliance (1864–1870) in South America killed up to 70% of the Paraguayan male population. According to Paraguayan national lore, the skewed sex ratios resulting from the conflict are the cause of present-day low marriage rates and high rates of out-of-wedlock births. We collate historical and modern data to test this conventional wisdom in the short, medium, and long run. We examine both cross-border and within-country variation in child-rearing, education, labor force participation, and gender norms in Paraguay over a 150 year period. We find that more skewed post-war sex ratios are associated with more out-of-wedlock births, more female-headed households, better female educational outcomes, higher female labor force participation, and more gender-equal gender norms. The impacts of the war persist into the present, and are seemingly unaffected by variation in economic openness or ties to indigenous culture, which suggests cultural mechanisms of transmission.

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1 Introduction

Across the world, biased sex ratios emerge as a result of war, migration, and household choices. Men outnumber women in China and India due to a preference for sons, and in Europe as a result of refugee inflows. Women outnumber men in parts of the Middle East due to the refugee exodus and in Mexico because of northward migration flows. Distorted sex ratios will likely continue as a result of sustained civil conflicts and general migration trends, hence it is important to investigate the short and long-run impacts of these imbalances. History provides a window through which we can understand the potential effects of such current situations, and illuminates the causes behind existing variation in women's status across countries (Giuliano 2018).

In this paper, we examine one of the largest sex ratio shocks in history, the War of the Triple Alliance (1864–1870). During the course of this war, Paraguay fought and lost against an alliance composed of Brazil, Argentina, and Uruguay. The conflict was estimated to have killed 60% of Paraguay's total population (Whigham & Potthast 1999). Indeed, Pinker (2011) classifies the Triple Alliance war as proportionately the most destructive anywhere in modern times. Some historians posit that up to 90% of Paraguay's male population died as a result, greatly skewing the sex ratio towards women. While there have been extensive qualitative discussions around both the causes and effects of this disaster, there has not been a systematic quantitative assessment of the war's legacy.[1]

Here we examine the impacts of these conflict-driven skewed sex ratios over a period of 150 years. We begin by documenting the extent of sex ratio skewness caused by the conflict. We then look at the short-run effects of these distorted ratios on out-of-wedlock births, education, and labor force participation. Next we explore the footprint of this dynamic today on the same outcomes as well as on demographic patterns and gender norms. Finally, we study factors that may have broken the persistence trend (as in Giuliano & Nunn (2021) and Voigtländer & Voth (2012)), finding evidence for cultural mechanisms of transmission.

We bring together a combination of historical and modern data to shed light on these questions. We first construct a dataset of out-of-wedlock births using historical church records. We also digitize Paraguayan censuses from the late 19th century. To evaluate long-term impacts we employ microdata extracts from the Integrated Public Use Microdata Series, International (IPUMS), starting in the 1970s. To study modern gender norms we employ the Latin American Public Opinion Project (LAPOP) AmericasBarometer surveys from the 2010s.

We apply two empirical strategies. First, we compare outcomes of interest in Paraguay to

[1] A lone exception is Boggiano (2021), discussed at greater length in the literature section.

outcomes in bordering regions of Argentina and Brazil, which include areas under territorial dispute that were eventually lost by Paraguay. Second, we exploit variation at the intensive margin by constructing digitized maps of the conflict and calculating distance to battles and marches. We examine variation in outcomes within Paraguay in response to this measure of conflict intensity, which serves to approximate the post-war level of skewness in the sex ratio, as we show empirically. Importantly, we rely in differences by gender in our estimations.

First, we document the extreme gender imbalances resulting from the war. We find that in the short run, the sex ratios among cohorts born in Paraguay before the war, and thus affected by the conflict, were high—around four women per man. We then examine the patterns in out-of-wedlock births, and show that Post-war Paraguay had higher out-of-wedlock birth rates than areas across the border in Argentina and Brazil. Moreover, within Paraguay, a greater proximity to conflicts was associated with more skewed sex ratios, higher school attendance for girls, more female teachers, and greater shares of out-of-wedlock births during the aftermath of the war.

While sex ratios returned relatively quickly to around unity — as we document for the postwar cohorts — outcomes in more war-affected areas continue to differ over a century later, after all individuals who experienced the war themselves had passed on. To this end, we employ decadal census data from IPUMS from the 1970s to the 2000s. Compared to bordering areas in Argentina and Brazil, Paraguay has more female-headed households and more unmarried women living with a child. Within Paraguay, closeness to historical Triple Alliance War locations is associated with more female-headed households, more unmarried women living with a child, more women who have completed at least primary education, and more women who are employed. These impacts are consistent with the lore in Paraguay and the qualitative literature.[2] The scarcity of potential husbands changed women's marriage market outcomes and altered women's educational achievements.

Lastly, we attempt to uncover the mechanism and heterogeneity behind this persistence. Evidence supports gender norms as the conduit of persistence. Paraguayans residing closer to a historical march line are more likely to believe that women are not less deserving of jobs compared to men. We examine heterogeneous impacts across proxies for openness (foreign immigration) and indigenous cultural traditions (a dominance of the Guaraní language). This last source of heterogeneity is of particular interest, since some historical demographers have argued that Paraguayan gender norms were distinct before the war and the effect of the war is overstated (Potthast-Jutkeit 1991). They assert that women's sexual freedom,

[2]This lore is strong –*The Economist* posits that the paternity scandal which complicated Paraguayan President Lugo's presidency in 2009 can be traced back to the Triple Alliance War (Economist 2012). Similarly, *The Guardian* states as fact that "one of the war's most lasting legacies is its contribution to the extremely strong machismo and gender violence seen in modern Paraguay." (The Guardian 2020).

high rates of labor force participation in agriculture, and low propensity to marry all stem from Guaraní traditions in the pre-colonial period. We find no evidence that openness or indigenous culture affect the persistence of outcomes, whilst gender norms appear to be a stronger determinant of persistence.

1.1 Related literature

The contributions of this paper to the literature are twofold. First, while the causes and immediate effects of the War of the Triple Alliance have received substantial attention in the historical literature (Bethell 1996, Ganson 1990, Potthast 2005, Potthast-Jutkeit 1991, 1996), there are almost no examinations of its long run impact. This is an important omission for a war that remains the largest inter-state conflict in Latin America. A notable exception is Boggiano (2021) who finds that the Triple Alliance War increased intimate partner violence in modern Paraguay. This is hypothesized to be due to the backlash by men who felt their role as breadwinner in household was threatened. We instead examine the impact on female-headed households, out-of-wedlock births, female labor force participation, and female educational attainment in the short, medium, and long run. Some important differences between our paper and Boggiano (2021) in addition to the difference in outcome variables are: 1) she uses distance to military camps as her measure of exposure to war while we use distance to march lines and battle points, 2) she does not find an effect of distance to military camps on sex ratios after the war while we find an impact of distance to marches and battles on post-war sex ratios, 3) her analysis focuses within Paraguay, while we conduct both within-Paraguay and cross-border analysis.

Second, we contribute to the broader literature studying the impacts of sex ratio imbalances caused by conflicts.[3] Our paper is unique in this literature on a few dimensions. First, the conflict we study occurred a longer time ago than many of the other conflicts studied, which allows us to assess short, medium, and long-term outcomes. No individuals included in the long-run analysis could even have a parent who experienced the war. As such, the study provides a window into the effects of historical warfare and inter-generational transmission. Second, the Triple Alliance War led to more extremely biased sex ratios than many of the other conflicts studied. Finally, the conflict we examine occurred in a developing rather than developed country.

Most of the literature on this topic has focused on Europe. Abramitzky et al. (2011) study the impact of WWI in France and find that the lack of men led to fewer females marrying, especially those from lower social classes. It also led to more out-of-wedlock births,

[3]Angrist (2002) looks at sex ratio imbalances caused by immigration flows and Teso (2019) looks at sex ratio imbalances caused by the transatlantic slave trade.

lower divorce rates, and smaller between-spouse age gaps. Using this same historical context, Knowles & Vandenbroucke (2019) find instead an increase in female marriage probabilities. Gay (2021) and Boehnke & Gay (2020) show that the warfare shocks resulted in both short- and long-term increases in female labor force participation through a mechanism of inter-generational cultural transmission. For WWII in Germany, Bethmann & Kvasnicka (2013) find that the scarcity of men led to more out-of-wedlock childbearing. For the same conflict in Russia, Brainerd (2017) finds that male shortages resulted in lower rates of marriage and fertility, and more out-of-wedlock births. Fernández et al. (2004) find a long-term increase in female labor force participation in the US due to WWII. Finally, Ramos-Toro (2019) studies conflicts across the globe and finds that they lead to long-term norms of gender inequality, and not to sustained increases in female labor force participation. Though we confirm some of the findings for developed countries, we also describe new dynamics for developing ones.[4] Unlike the literature on WWI and II, the Triple Alliance War happened long enough ago that there is nobody who appears in our modern census data starting in 1970 who would have been alive to experience the war first-hand. Also, our setting involves much more skewed sex ratios than these other examples.

There are a number of papers that look at extremely male-biased sex ratios, instead of extremely female-biased sex ratios as in our case. Aguilar-Gomez & Benshaul-Tolonen (2018) measure a ratio of 12 men for every woman during the Gold Rush in the United States, and Grosjean & Khattar (2019) estimate a ratio of three men for every woman in Australian penal colonies. In the Australian case, women in areas with more male-biased sex ratios were more likely to follow traditional gender roles and less likely to work in high-ranking occupations (Grosjean & Khattar 2019), while men were more likely to adhere to extreme norms of masculinity (Baranov et al. 2021). Those effects persist through the present day. An extant question is whether the effects for female and male scarcity are symmetric. Brodeur & Haddad (2021) find the Gold Rush also led to more LGBT communities in the modern era. It is worth noting that the loss of men due to the war in Paraguay was less selective than these other events. For example, the California Gold Rush attracted courageous spirited men as well as bandits and claim jumpers, while penal colonies in Australia imported criminals from the UK, potentially making our results more generalizable.

To summarize, our work differs from these other papers in three dimensions: the magnitude of the female-biased sex ratios, the time passed since the historical event, and the fact that it occurred in a developing country. In Paraguay in the immediate aftermath of the war, the sex ratio (men per woman) was around 0.3. This is almost four women for every man.

[4]More recently, Rogall & Zárate-Barrera (2020) show that the Rwandan genocide led to female empowerment.

For comparison, the female-skewed sex ratios studied post-WWI and post-WWII are 0.7 and 0.9, respectively. One can imagine a much larger or non-linear effect on gender norms when the majority of women cannot find a spouse compared to when the majority of women can.

Our paper studies a historical episode that occurred further back in the past. The Triple Alliance conflict ended in 1870, compared to the end of WWI in 1918, and WWII in 1945. This allows us to examine a century and a half of impacts on childbearing, education, and labor force participation. Our results are consistent with the literature in terms of out-of-wedlock childbearing and labor force participation. This is a particularly important finding given that the bulk of the evidence on sex ratio impacts comes from high income countries. In contrast, much of the world's conflict is currently occurring in developing country settings where labor markets may suffer from greater frictions, making our historical results informative.

In the next section, we expand on the economic framework by which skewed sex ratios may lead to persistent changes in outcomes. Section 3 provides the historical background on the Triple Alliance War. Section 4 describes the data and Section 5 presents the empirical strategies. The empirical result are divided into short- and medium-term impacts in Section 6 and long-term impacts and potential mechanisms in Section 7. Section 8 concludes.

2 Economic perspectives on short- and long-term impacts of female-skewed sex ratios

In the short run, traditional marriage models show that when the sex ratio is approximately unity, monogamous marriages are most efficient, but when it is biased toward women, polygamy will be preferred to monogamy (Becker 1974). Willis (1999) constructs an economic model showing that when sex ratios are near unity or even when they are skewed toward men, a traditional equilibrium with marriage and childbearing therein will be obtained. When sex ratios are relatively skewed toward women, and especially if women's income-earning capacity is high enough, the results are quite different. High income men and women will marry one another, while less well-to-do men will father children with multiple women (also found at the lower end of the female income distribution) without marrying the women and without offering their children financial support thereafter. This scenario seems particularly relevant for Paraguay since sex ratios were quite skewed toward women while women were relatively self-sufficient economically speaking.

Conceptually, in terms of labor force participation, an obvious impact of the scarcity of men is that it opens up room in the labor market for women (Acemoglu et al. 2004,

Grossbard-Shechtman 1984). Returns to education for women could also rise, leading to increases in both female education and labor force participation. These increased returns to female education could be either due to increased wages, or to women's importance in educating the next generation of males when there are fewer fathers around, as specifically suggested in the Paraguayan case (Potthast 2005, Potthast-Jutkeit 1996).

Could short-term shocks to sex ratios have long-term impacts on the status of women? There is some evidence that temporarily female-skewed populations due to conflict can have medium-term impacts on female labor force participation (Fernández et al. 2004, Gay 2021, Ramos-Toro 2019). This is potentially due to changes in women's preferences, opportunities, or information (Acemoglu et al. 2004). It could also be due to changes in men's preferences (Fernández et al. 2004). We study whether these effects last for a longer time than previous examples, and for outcomes such as out-of-wedlock childbearing.

There are a variety of views on possible sources of persistence. A number of researchers have investigated the possibility that gender roles arise from pre-existing geographic conditions (Alesina et al. 2013, Boserup 1970, Carranza 2014, Giuliano 2015, Goldin & Sokoloff 1984). These conditions determine the nature of production technology, generate incentives that favor the employment of women in agriculture, and have long-lasting effects on labor force participation of women. Other authors point to the importance of language, religion, and matrilineal traditions in creating unshiftable gender norms (Giuliano 2018). These explanations, however, do not help clarify why temporary shocks might have long-term impacts.

One compelling explanation for why shocks might persist is that cultural beliefs are inherently sticky (Alesina et al. 2013). Once formed, they may continue to exist because they are reinforced by institutions or production structures that grow to support a particular norm. In confirmation of the stickiness of parent-to-child transmission, Grosjean & Khattar (2019) find that gender norms are more strongly embedded in Australian families whose household head was born in Australia. In a similar vein, Fernández & Fogli (2009) find that the fertility rates of second-generation immigrants to the US are strongly associated with the fertility rates in their parents' country of origin. Gay (2021) finds evidence of parent-child transmission, husband-wife transmission, and transmission through social interactions. In the context of gender, Miho et al. (2020) study Stalin's ethnic deportations and find impacts on the gender norms of the local populations where deportees were sent. These empirical results are consistent with the theoretical predictions of Bisin & Verdier (2001), Boyd & Richerson (1988), and Cavalli-Sforza & Feldman (1981).[5] We will explore empirically

[5]There is a rich literature in sociology on inter-generational transmission of out-of-wedlock childbearing. See Högnäs & Carlson (2012), McLanahan & Bumpass (1988), and Musick & Mare (2006) for some key references. This inter-generational transmission of childbearing is often found to be due to socialization and social norms, and is independent of inter-generational transmission of socioeconomic background.

whether gender norms related to labor force participation are sources of persistence.

Related work points out that in more open environments, traditional beliefs may be less helpful for predicting success in the present. This suggests norms may be more likely to persist in closed environments (Giuliano & Nunn 2021). Voigtländer & Voth (2012) use data from Germany and find that while anti-Semitic attitudes and behavior persisted for more than 600 years, persistence was lower in cities that had high levels of trade or immigration. We will empirically examine whether openness and a weak sense of indigenous identity attenuate our results.

The effects of skewed sex ratios specifically, and conflict more generally, may be confounded after a large conflict. Much of the previous literature focuses only on female outcomes or only on male outcomes, studying outcomes such as female labor force participation or female childbearing patterns. Our analysis focuses on differential effects across the sexes. Thus we difference out effects on labor markets and educational trends which are common to both sexes and might have been affected by the war, to look at just those effects which are differential by sex, helping assuage potential identification concerns.

3 The Triple Alliance War and its aftermath

The Paraguayan War, which pitted Paraguay against Brazil, Argentina, and Uruguay, lasted from 1864 to 1870 and is considered the bloodiest inter-state war in Latin America (Bethell 1996). Estimates of the death toll in Paraguay vary from 8.7% (Reber 1988) to 87% (Washburn 1871), with a consensus figure of nearly 70% (Whigham & Potthast 1999). Even more important is the relative decimation of the Paraguayan male population, leading to extremely skewed sex ratios, which motivates the title of the paper. We document ratios of up to seven females per male. Overall, historians of Latin America agree that the conflict was the most damaging of any in the history of the region.

The conflict emerged from a perfect storm of clashing economic interests, evolving power structures, and serious misjudgment. The initial Paraguayan assault on Uruguay began as a result of Brazil's invasion of Uruguay under the pretext of protecting Brazilian settlements. Paraguay, threatened by a perceived hesitance on the part of Argentina to recognize its sovereignty and Brazil's growing economic power in the region, declared war on Brazil. When Argentina refused permission to Paraguay to cross through its territory in order to invade Uruguay, Paraguay also declared war on Argentina. Within a year, after a change of government in Uruguay to the political party aligned with Brazilian and Argentinean influence, all three neighbors had united into a Triple Alliance against Paraguay (Bethell 1996). Seemingly through sheer force of will, Solano López repeatedly led his troops into

battles where they were outnumbered but managed to succeed. These successes significantly prolonged the conflict, which ended only with Solano López's death at the hands of Brazilian troops in 1870. A detailed timeline of the Triple Alliance War is provided in Appendix A.

Though there is some debate on the nature of Solano López's motivations for entering the war, there is widespread consensus regarding its results: it led to massive population loss and generated a substantial sex imbalance. A postwar census conducted by the winning armies found 221,079 people remaining: 106,254 women, 86,079 children, and 28,746 men (Potthast-Jutkeit 1991). Washburn (1871) puts the sex ratio at seven women for every man, Potthast (2005) puts it at four to one, and Ganson (1990) at three to one. Even a ratio of three women for every man is unprecedented.[6] This imbalance, while severe, did not endure. The 1886 census reported a female to male ratio of 1.39 to one, and the 1899 census one of 1.16 to one (Carrasco 1905).

While the war itself took place in Paraguay, Argentina, and Brazil, the effect of the conflict on sex ratios in Argentina and Brazil was comparatively small. Even in the neighboring Corrientes province of Argentina, where some large early battles took place, the Argentine sex ratio after the war was closer to 1.25 women for every man relative to Paraguay's ratio of well over three. This is both because Paraguay's population was smaller than that of the allied countries and so a higher share of the population was involved in fighting, and because most of the allied troops did not come from the areas bordering Paraguay. Though greater in absolute numbers, the Argentinean and Brazilian troops were a much smaller share of their countries' population. The Brazilian soldiers (many of whom were freed slaves) tended to be brought from all across the nation to the remote and sparsely inhabited border locations (Bethell 1996, Whigham 2002). This is in contrast to the Paraguayan troops, who formed a much larger share of the population and came from all over the country (Bethell 1996).[7] Capdevila (2010) describes the process of mass conscription for those 17-40 and how by the end of the war younger children from 13 onwards and older men were also recruited.[8] This combination of factors suggests that comparisons across these borders could help to isolate the effects of skewed sex ratios from the effect of conflict more generally.

Historians believe that the war had a significant impact on the ways in which Paraguayan women engaged with society. Potthast (2005) describes the elevated level of freedom that many women enjoyed during the war. They created businesses and engaged in types of

[6]Grosjean & Khattar (2019) and Aguilar-Gomez & Benshaul-Tolonen (2018) cite ratios of one woman for every three or twelve men in Australia and the US West respectively, but it is more difficult to find examples of such severely female skewed imbalances, especially at the national level.

[7]See Appendix B.1 for more details about the number of soldiers and deaths from each country.

[8]Baratta (2019) also describes this harsh reality of children soldiers in the infamous battle of Acosta Ñu, which is now commemorated by a celebration of Children's Day.

production that had been traditionally left to men, such as livestock husbandry, production of military uniforms, and nursing (Ganson 1990). After the war, more women gained access to higher education and thereafter became school teachers. Potthast-Jutkeit (1996) and Potthast (2005) argue that after the war it was believed that women needed to be well-educated because they were the ones who would be instructing the citizens of the future and so elementary school enrolment for girls increased. She posits that the current high percentage of women in Paraguayan universities is "the conflict's only significant and lasting positive consequence for women."[9]

However, others dispute that the unusual status of women in Paraguay is solely a result of the war, pointing instead to traditional Guaraní culture or pre-war events. Potthast-Jutkeit (1991) argues that the legendary independence of Paraguayan women has roots in the pre-colonial and colonial periods. In Guaraní society, women were traditionally in charge of farming. Guaraní society involved high rates of female-headed households and out-of-wedlock births, and divorce was particularly easy. Furthermore, in the early 1800s Rodríguez de Francia implemented various policies weakening the institution of marriage and leading to high levels of informal partnerships, locally known as *concubinato* (Potthast-Jutkeit 1991). For more excerpts from the historical literature on the standing of women in Paraguay and the effects of the war on their standing, see Appendix B.2.

4 Data description

4.1 Demographic and norm-based measures

4.1.1 Historical data

We use baptismal records to measure out-of-wedlock childbearing. Because baptism was nearly universal in Latin America during this period, there should be no selection into baptism. For example, the text of the Statistical Yearbook of the Paraguayan Republic (1886) which describes the 1886 census uses the number of baptisms as their source for the number of births, claiming this data is the most reliable. Similarly, the 1914 Argentinean census also uses baptisms as the most reliable source of retrospective data on births. Importantly, even children born out-of-wedlock were baptized.

Church records on baptisms in the 1800s and early 1900s across South America have been digitized and are accessible on the Internet. [10] The baptismal records contain information

[9] Ganson (1990) observes that there were no improvements in political equality for women due to the war.

[10] Records are available at ancestry.com. "Digitized" means that there is a photo of the record, and "indexed" means that the record has been typed up.

on the date and place of baptism. In some cases, the records also include the date of birth, and in all cases the name of the mother. They then contain either the name of the father or the phrase *hijo natural*, which means that the child was born out-of-wedlock. These church records allow us to construct the percentage of out-of-wedlock births both before and after the conflict.

We obtained all baptism records for Paraguay, Brazil, and Argentina that were uploaded and indexed as of 2016. For the econometric analysis, we restrict our sample to the eastern side and core of Paraguay (excluding Asunción and the Paraguayan Chaco, a long-disputed territory) and locations in Argentina and Brazil that are "comparable" to Paraguay. In Section 5, we discuss in more detail which years and areas of data are used in the empirical analysis.

We are missing data for churches whose records have not yet been "indexed" (the handwritten records have not been converted to typewritten content). We do not know how it was decided which church's records would be indexed for which time period. Still, while there are many churches with no indexed information at all, there is no evidence of selective indexing within churches. Appendix C shows the relationship between the information contained in the Paraguayan baptismal records and the census data in the years and municipalities where these overlap. We see a high similarity across those two data sources. This suggests that conditional on having indexed records for a certain church in a certain year, the records were not selectively indexed.

We also exploit various censuses in our historical analysis. For Paraguay, we have census data at the municipal level from 1864 (Williams 1976), 1873 (Reber 1988), and 1886. We use this data to create population counts and education and employment outcomes. For Argentina, we employ 1895 census data to calculate population sex ratios. Summary statistics of all variables used in the historical analysis can be found in Appendix Table D.1.

4.1.2 Modern data

We extracted microdata for modern censuses through the Integrated Public Use Microdata Series, International (IPUMS). These include: Paraguay: 1972, 1982, 1992, 2002; Argentina: 1970, 1980, 1991, 2001; and Brazil: 1980, 1991, 2000 (Minnesota Population Center 2018).[11] These datasets provide us the modern outcome variables for studying the long-term impact of the war, including marriage and fertility patterns, educational attainment, and female employment.[12]

[11]The Brazilian data from 1970 does not include information on municipality so we can't categorize observations as being within 100km of the border.

[12]Employment and labor force participation are very similar in these countries and this period and we use the phrases interchangeably. Only 3% of the adult population in our data are in the labor force but not

On the cultural side, to measure modern gender norms in Paraguay, we use the Latin American Public Opinion Project (LAPOP) data which gives access to the AmericasBarometer surveys (Latin American Public Opinion Project (LAPOP) 2020). The survey includes two questions which reflect gender-norms with respect to female labor force participation. In 2012, the survey asked: "Some say that when there is not enough work, men should have a greater right to jobs than women. To what extent do you agree or disagree?" Answers are on a scale from 1 (strongly disagree) to 7 (strongly agree) where we categorize answers of 5-7 as a preference for males in the labor force. In 2018, the survey asked: "How strongly do you agree or disagree with the following statement? When a mother works outside the home, the children suffer." Answers are on a scale of from 1 (strongly agree) to 4 (strongly disagree) where we categorize answers of 1-2 as a preference for males in the labor force. After excluding Asunción and the Chaco, we are left with over 600 observations in 2012 and 1300 in 2018 spanning 51 municipalities.[13] This data is a repeated cross section as they do not survey the same individuals in each year. Summary statistics of all variables used in the modern analysis can be found in Appendix Table D.2.

4.2 Measures of conflict

To examine spatial variation in the intensity of conflict, we digitized information on the location of battles as well as the starting and ending points of marches described by Jaeggli & Bordon (2010). We geo-located the points at the centroids of modern municipalities.

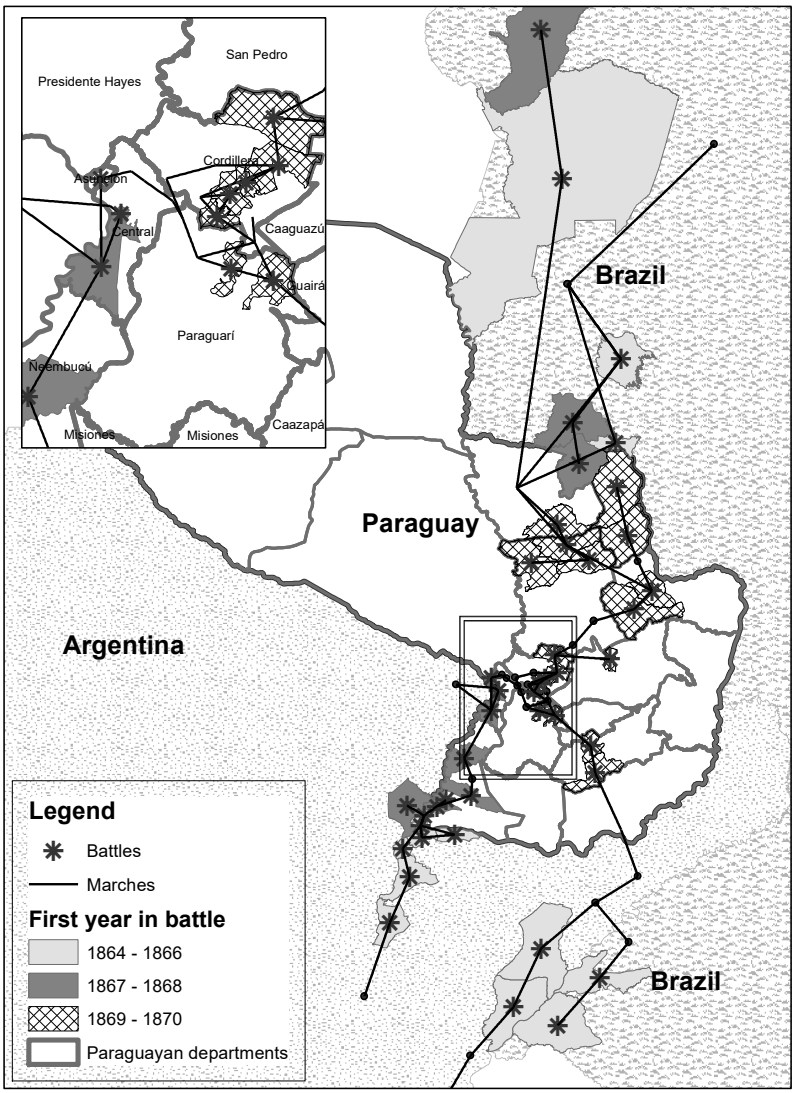
Figure 1 shows the spatial distribution of battles and marches using these data. Asterisks represent battles and lines represent marches. Many, but not all, of these marches ended or began with battles. Municipalities are shaded according to the first year that a municipality had a battle within it. The conflict began outside of the boundaries of Paraguay (instigated by Paraguayans marching into Brazil and Argentina), passed through the more populous central regions of Paraguay, and ended in the north of Paraguay. In our empirical work, we use distance to the nearest battle point, as well as distance to the nearest march line, as measures of the intensity of the war.[14] March lines are of particular importance, since soldiers were often enlisted along the way, as troops marched from one region to another (Warren 1978). For more information on the number of soldiers and recruitment of soldiers,

employed. Results are similar if we use labor force participation as our outcome.

[13]Unfortunately, this dataset does not ask any questions related to gender norms and educational attainment or out-of-wedlock childbearing. Also, while the same survey was conducted in Argentina and Brazil, there are only 42 observations from municipalities within 100 km of Paraguay, and hence we do not use the LAPOP data for cross-border analysis.

[14]Distance to US Civil War march lines have also been used to estimate the impact of that war (Feigenbaum et al. 2021).

Figure 1: Timeline and spatial extent of war



see Appendix B.1.

5 Empirical strategies

To investigate the impact of skewed sex ratios on outcomes of interest, we exploit two sources of variation. First, we use a cross-border discontinuity between Paraguay and neighboring municipalities in Argentina and Brazil. Second, we examine the variation within Paraguay in response to the intensity of the conflict. We use both of these strategies to examine immediate, medium-term, and long-term impacts of the conflict.

The cross-border and within-Paraguay analyses have different advantages and disadvantages. The benefit of the cross-border analysis is that it studies the impact of an extremely large difference in sex ratios. As we will show later, while the sex ratio in Paraguay just after the war was 3.5 women for every man, the same ratio in bordering areas of Argentina was 1.25 women for every man. The disadvantage is that many institutions change when crossing an international border, and so this analysis is subject to the usual caveats. We address this critique by limiting our non-Paraguayan observations to those within 100 km of the border. These bordering municipalities share many cultural features with Paraguayan society, since they historically housed significant numbers of Guaraní, the dominant indigenous group in Paraguay. Some of these were disputed territories that were lost by Paraguay after the war, where marked national differences may not have had as much time to consolidate. We also drop these disputed territories in robustness checks.

The benefit of the within-Paraguay analysis is that language, government, and other institutions are held constant. The disadvantage is that we sacrifice some external validity as we compare places with different degrees of extreme sex ratios – even in the least skewed Paraguayan locales there were two women for every man. For all analyses, we drop Asunción (the capital of Paraguay).[15] Furthermore, we remove the Paraguayan Chaco (constituted by three departments west of the Paraguay River) both because it was a disputed territory until the 1930s and because it is, and always was, a very sparsely populated inhospitable semi-arid region. Symmetrically, we exclude the Argentinean Chaco (constituted by three provinces west of the Paraguay River which becomes the Paraná River further south).

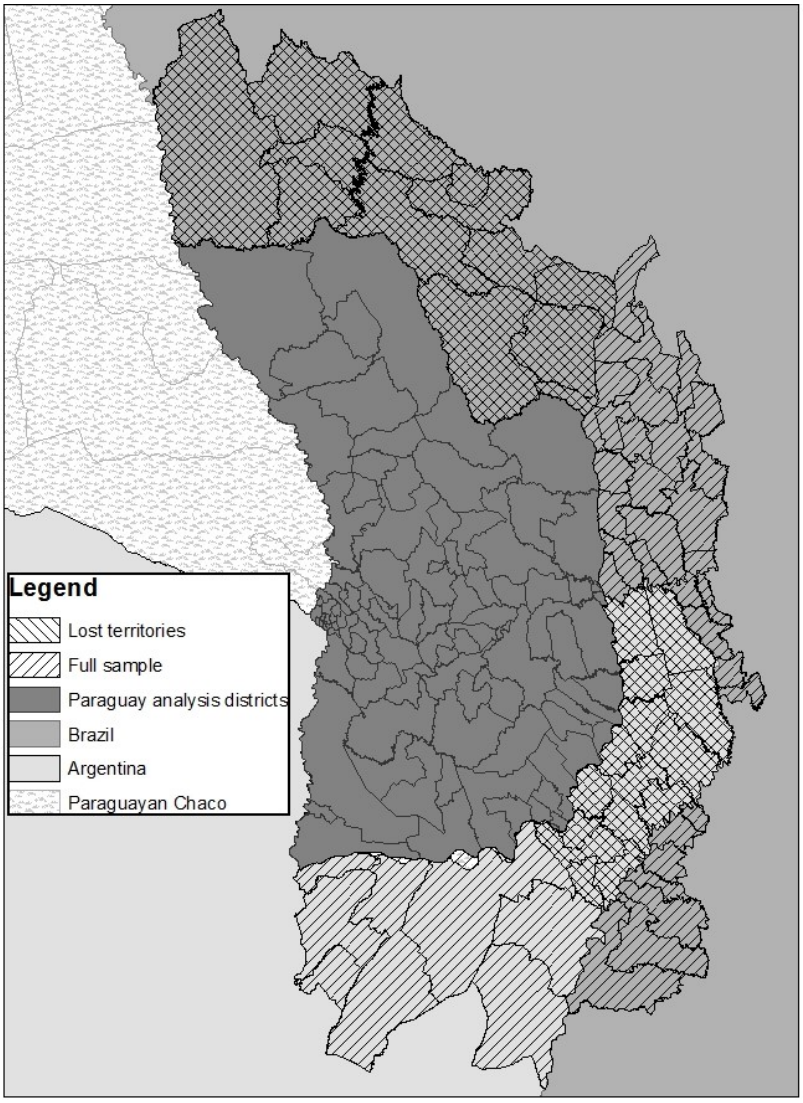
Our first strategy for estimating the impact of the conflict is to select municipalities from Argentina and Brazil that have some land within 100 km of the Paraguayan border.[16] The selection includes municipalities from the provinces of Corrientes and Misiones in Argentina,

[15]The Argentinean and Brazilian capitals are too far from the border with Paraguay to be included in our sample.

[16]The precise name for what we call "municipality" is "district" in Paraguay, "department" in Argentina, and "municipality" in Brazil.

and the states of Mato Grosso do Sul, Rio Grande do Sul, Paraná, and Santa Catarina in Brazil.[17] We call this the 'broad sample.' While the war did pass through Corrientes, Misiones, Mato Grosso do Sul, and Rio Grande do Sul, and they experienced some impacts from the war, the sex ratios in these departments were much less affected than neighboring areas in Paraguay.

Figure 2: Municipalities in cross-border analysis



For measuring the long-term impacts, we additionally show results with a more restricted sample which excludes areas which were contested before the war and officially became part of Argentina (Misiones) and Brazil (Mato Grosso do Sul) after the war. This restricted

[17] We only have information from municipalities in Corrientes province in Argentina for studying short-term impacts.

sample limits the comparison municipalities to the municipalities in Corrientes, Paraná, Santa Catarina, and Rio Grande do Sul that are within 100 km of the Paraguayan border. Figure 2 shows the map of the broad and restricted samples visually.

5.1 Estimating equations

We use two main estimating equations for our cross-border analysis. For the short and medium-run analysis, the outcome y is equal to one if the baptism is identified as out-of-wedlock for individual i, baptized in year t, in municipality m. Controls include a Paraguay dummy, P, and baptism year bin dummies B representing being baptized in 1864–1870, 1871–1880, 1881–1890, and 1891–1900 with the excluded category being a baptism before the war (1840-1863). Our preferred specification includes municipality fixed effects (δ_m):

$$y_{imt} = \alpha + \sum_t \gamma_t B_{it} + \sum_t \theta_t P_m B_{it} + \delta_m + \epsilon_{imt}. \tag{1}$$

To address spatial correlation in this regression, and in all the others discussed in this paper, we calculate two types of standard errors. We show robust standard errors clustered at the municipal level, and standard errors adjusted with spatial weights (Conley 1999) using a cutoff of 30 kilometers.[18]

All of our estimation strategies are variants on a differences-in-differences approach. Unfortunately we cannot test for parallel pre-trends in the usual way due to lack of data before the war, so we only present data of cohorts retrospectively. Our regressions either include municipality fixed effects or a relatively large set of controls for geographic characteristics and pre-existing conditions.

For the long-run cross-border analysis we use census data from Paraguay, Argentina, and Brazil for the 1970s, 80s, 90s, and 2000s. We estimate the following linear model,

$$y_{ict} = \alpha + \beta P_c + \gamma F_{ict} + \theta P_c F_{ict} + \mathbf{X}_{ict}\rho + \nu_t + \epsilon_{it}, \tag{2}$$

where y_{ict} is the outcome for individual i in country c in time period t, F is female, and $\mathbf{X}$ are control variables. Regressions use IPUMS sampling weights. Notice that we are looking at the differential effect of the war on females compared to men. Focusing on differences across sex helps isolate the effect of skewed sex ratios from the effect of the conflict more generally. Control variables include age of the respondent, a binary indicator for residing in a rural area, municipality population density, the natural log of distance to Asunción, the natural log of the municipality area, and average maize productivity.

[18] We implement the spatial standard errors in Stata using acreg (Colella et al. 2020).

Our second strategy examines variation within Paraguay. We exploit the distance to conflicts (march lines or battle points) to approximate the intensity of conflict and hence sex ratio skewness. We do not use the post-war sex ratios as our main explanatory variable (but as a key outcome, an important difference with respect to Boggiano (2021) who finds no effect of distance to military camps on post-war sex ratios) both due to the potential endogeneity of sex ratios and the fact that not all modern municipalities can be matched to sex ratios from historical municipalities. In contrast, we can easily measure distances to marches and battles for all modern municipalities. We calculate the distance from the centroid of a municipality to the centroid of the nearest municipality within which there was a battle or through which a march passed, using the modern municipal boundaries.

We use two main estimating equations for our within-Paraguay analysis. The first analysis uses cohort data from the 1886 Paraguayan census and takes the form:

$$y_{mt} = \alpha + \gamma B_t + \theta D_m B_t + \delta_m + \epsilon_{im}. \tag{3}$$

The outcome variable, y_{mt}, is the sex ratio for each municipality m and birth cohort t, i.e., the number of women divided by the number of men. Being born before the war is represented by dummy variable B_t. Distance to either a battle or the march line is D_m, and parameterized as either a binary variable indicating distance less than 30 km (close to the median in the data), distance in tens of kilometers, or a quadratic function of distance. We include municipal fixed effects, δ_m. The coefficient of interest, θ, is the coefficient on the interaction term which indicates the differential impact of proximity to the war on those born before the war. The assumption here is that in the absence of conflict, changes in sex ratios over time would have been similar across municipalities at varying distances from the conflict.

We also use data on students and teachers from the 1887 Paraguayan census to create student and teacher sex ratios at the municipal level, two decades after the war. Here we estimate a cross-sectional version of Equation (3), without municipal or cohort fixed effects. Control variables include the natural log of the municipality area, the natural log of distance to Asunción, an indicator for whether 1846 population information is available for that municipality, the natural log of the total population in 1846, an indicator for whether 1864 population information is available for that municipality, and the natural log of the number of households in 1864. Here identification relies on the assumption that, conditional on distance to the capital and population, differences in distance to battle and march lines are not correlated with other factors that might drive variation in teacher and student sex ratios, other than conflict-induced skewed sex ratios.

For the long-run within-Paraguay regressions we use the following estimating equation

$$y_{imt} = \alpha + \beta D_m + \gamma F_{it} + \theta D_m F_{it} + \mathbf{X}_{it}\rho + \nu_t + \epsilon_{imt} \tag{4}$$

where y_{imt} is the outcome for individual i in municipality m in time period t. Distance to conflict, D_m, is either a dummy variable for residing less than 30 km from the conflict or the linear distance to conflict. IPUMS sampling weights are used for the regressions using the IPUMS data. Control variables include age of the respondent, a binary indicator for residing in a rural area, municipality population density, the natural log of distance to Asunción, the natural log of the municipality area, and maize productivity.[19] As above, if the distance proxy for sex ratio skewness is not correlated with other factors driving modern outcomes, this estimation establishes the effect of female-skewed sex ratios on these outcomes.

6 Short and medium-term impacts

In this section we show the immediate effect of the war on sex ratios. We proceed to look at the trends in out-of-wedlock births both immediately after the war and in the decades thereafter. Next, we look at the effects of skewed sex ratios on female educational outcomes in the decades after the war.

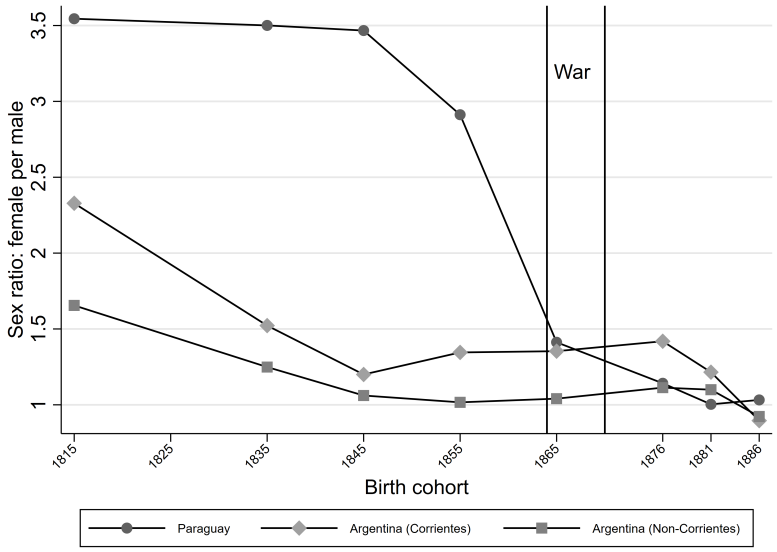
6.1 Sex ratios

6.1.1 Cross-border comparisons

There is scarce information on sex ratios prior to the end of conflict in 1870. However, the 1886 Paraguayan census and the 1895 Argentine census allow us to examine differences in sex ratios of individuals alive at that time, by their birth cohorts. For Argentina, we show the data separately for Corrientes—the sole neighboring province with data available during this time period—and for the rest of Argentina. The ratio of women to men across birth cohorts in the two countries is shown in Figure 3. The contrast is sharp. In Paraguay, those cohorts born in years prior to the war—particularly those most likely to be of fighting age during the war (born prior to 1855)—have ratios of women to men of 3.5. The ratio begins to decrease for the cohort born just before the war (1856-1865), although it is still high, consistent with the recruitment practices described. Cohorts from eras that should not be affected by the war, exhibit sex ratios at or near unity.

[19] The average maize productivity comes from the FAO GAEZ layer that estimates low input maize productivity from 1961-1990. We use maize because it is grown in the region and its yields are highly correlated with the yields of other staple crops.

Figure 3: Paraguayan and Argentinean population sex ratio by birth cohort



Data from Paraguay's 1886 census and Argentina's 1895 census. The year on the x-axis represents the end of the birth cohort. The birth cohorts are born before 1816, 1816-1835, 1836-1845, 1846-1855, 1856-1865, 1866-1876, 1877-1881, and 1882-1886.

Perhaps the best comparison comes from looking at the cohort born 1836-1845. For this group, the Paraguayan sex ratio is around 3.5, the Corrientes sex ratio is around 1.25, and the non-Corrientes Argentine sex ratio is around 1.1. Since the Argentinean data comes from the 1895 census, Argentinean individuals born before 1816 are over eighty. Because women have longer life expectancies than men, these oldest cohorts (especially those in Argentina) should skew female even without a war. The data show that the war greatly skewed the sex ratio in Paraguay, very slightly skewed it in Corrientes, and does not seem to have much effect in the rest of Argentina. For cohorts born after the war, sex ratios in all places soon approach unity.[20]

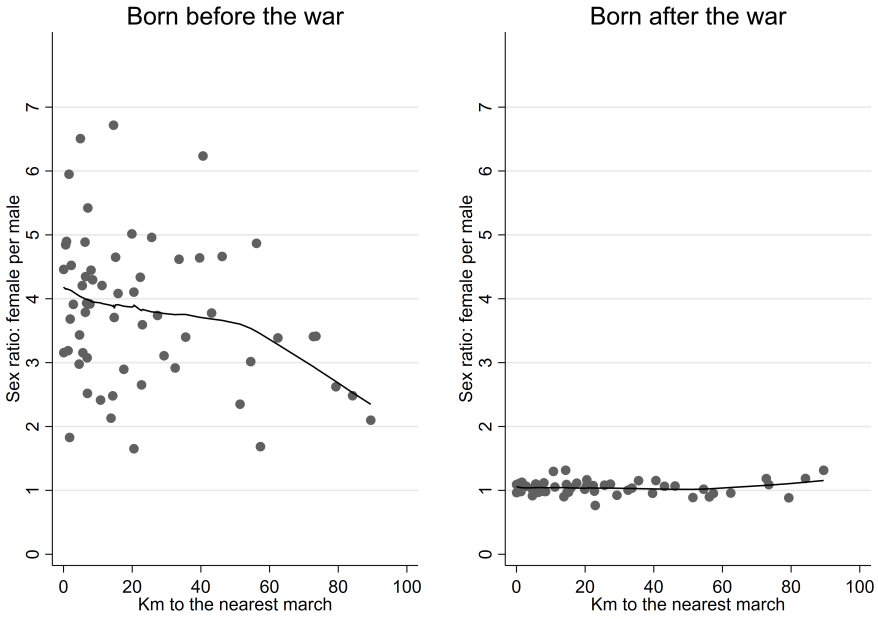
6.1.2 Within-Paraguay comparisons

Although the overall death toll during the war was high throughout Paraguay, there was variation in the location of conflict across the country. Correspondingly, there was also variation in the resulting sex ratios in the birth cohorts most affected by the conflict. Figure 4 shows a scatterplot and locally weighted regression of the sex ratios of each municipality

[20]Results from the 1873 Paraguayan census (not shown) confirm the general downward trend in Paraguayan sex ratios for cohorts born in the pre-war era.

in 1886 and the distance to the nearest march line, for birth cohorts born before and after the war. The figure shows that for those born before the conflict the sex ratio decreases with distance. Some of the ratios are extremely high, reaching almost seven females per male. For those born after the conflict, the relationship between sex ratios and distance to war is almost flat. This supports the assertion that there were differences in the intensity of conflict which affected sex ratios within Paraguay and also that these differentially skewed sex ratios were a temporary phenomenon. It bears mentioning, however, that there is a much larger difference between the average sex ratios across the two birth cohorts than across municipalities in either era; this can be seen by the difference in the y-axis values between the two subfigures.

Figure 4: Relationship between distance to march line and sex ratio, 1886



Data from Paraguay's 1886 census. The curves are from locally weighted regressions of sex ratio on distance to the nearest march line at the municipality level. The bandwidth is set at 0.8. The sample drops Asunción, the Paraguayan Chaco, and small municipalities where the population among people born either before the war or after the war was less than 200 people. Born before the war means born before 1856, and born after the war means born after 1865.

Table 1 shows estimates of Equation (3) using the 1886 Paraguayan census data. The large positive coefficients on "born before the war" show that sex ratios within cohorts born before the war are significantly higher than those of cohorts born after the war. Moreover, greater proximity to battles or marches resulted in more skewed sex ratios. So, for example,

using the results in Column (3), a person born before the war in a municipality close to the march path will have approximately three additional men for every woman in their cohort compared to someone born after the war in the same municipality. On the other hand, the cross-cohort difference in a municipality further from the march line will be only 2.5. The significant negative coefficient on the continuous measure of distance interacted with being born before the war implies that sex ratios among those born before the war are higher in municipalities closer to the conflict, consistent with the results from the binary measure.

Table 1: Within Paraguay: Short-term effects on sex ratios

	Outcome: sex ratio (female/male)					
	(1)	(2)	(3)	(4)	(5)	(6)
Born before the war	3.095***	2.923***	2.457***	3.348***	2.917***	2.352***
	(0.196)	(0.250)	(0.284)	(0.216)	(0.305)	(0.233)
	[0.233]	[0.271]	[0.373]	[0.261]	[0.284]	[0.241]
Born before × dist. to march line	-0.144***	0.058				
	(0.050)	(0.186)				
	[0.053]	[0.177]				
Born before × sq. dist. to march line		-0.027				
		(0.021)				
		[0.018]				
Born before × near march line (< 30 km)			0.426			
			(0.333)			
			[0.368]			
Born before × dist. to battle point				-0.170***	0.124	
				(0.042)	(0.158)	
				[0.043]	[0.124]	
Born before × sq. dist. to battle point					-0.031**	
					(0.014)	
					[0.011]	
Born before × near battle point (< 30 km)						0.697**
						(0.295)
						[0.255]
Observations	122	122	122	122	122	122
R^2	0.865	0.868	0.856	0.875	0.882	0.865
Mean of outcome variable	2.446	2.446	2.446	2.446	2.446	2.446

Data from Paraguay's 1886 census. Two birth cohorts for each of 61 municipalities. Sample excludes Asunción, the Paraguayan Chaco, and small municipalities where the 1886 population in either birth cohort was less than 200 people. Born before the war means born before 1856, and born after the war means born after 1865. People born between 1856 and 1865 are omitted from the sample. The unit for distance variables is 10 km. Includes municipal-level fixed effects. Clustered standard errors at the municipal level in parentheses (61 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

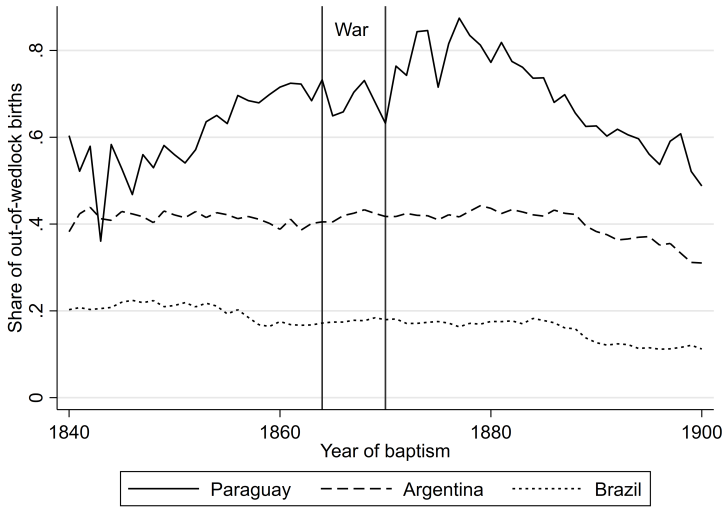
6.2 Out-of-wedlock births

Having established that the War of the Triple Alliance did indeed skew sex ratios, and that there is variation in this outcome across municipalities, we now examine out-of-wedlock birth rates in the immediate aftermath of the conflict and how these rates vary with distance to the conflict.

6.2.1 Cross-border comparisons

We begin by comparing out-of-wedlock birth rates in Paraguay to those in Argentina and Brazil. We limit the sample to baptisms occurring between 1840 and 1900, dropping municipalities that reported their first baptism after 1840 and dropping years with fewer than ten baptisms nationally, to reduce noise. Figure 5 shows the national share of out-of-wedlock births over time for each country. The war period is represented by black vertical lines. Paraguay generally had a higher proportion of out-of-wedlock births than Argentina and Brazil, even prior to the conflict, consistent with the historical literature, albeit the earlier data is noisy. Despite this, there appears to be a measurable jump in the share of out-of-wedlock births after the war, in the short to medium term.[21]

Figure 5: Out-of-wedlock birth rates across Paraguay, Argentina, and Brazil

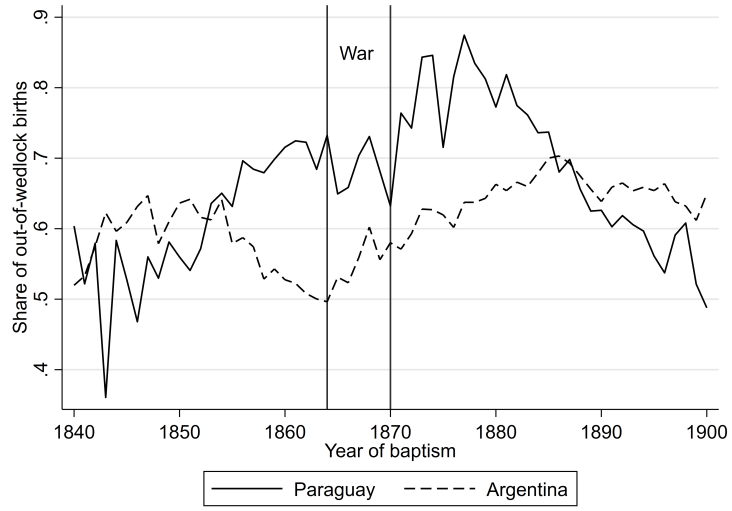


Data from baptismal church records between 1840 and 1900. Sample excludes municipalities reporting their first baptism after 1840 and excludes years with fewer than ten baptisms nationally.

[21]The jump in out-of-wedlock births begins just after the war ends. It does not happen during the war because there were fewer births and baptisms during the war, because male deaths happened throughout the war, not just at the beginning, and because birth patterns take at least 9 months to react.

Because Argentina and Brazil are large and diverse countries, we also show a comparable figure limiting the non-Paraguayan data to municipalities within 100 km of the Paraguayan border. We only have data on Argentine municipalities in Corrientes during this time period. Figure 6 suggests that Paraguay and Corrientes looked roughly similar until the mid 1850s (though again the earlier data is noisy), at which point Paraguay diverged, with the war apparently accentuating an increasing trend.

Figure 6: Out-of-wedlock birth rates across Paraguay and Corrientes, Argentina



Data from baptismal church records between 1840 and 1900. Sample includes all of Paraguay and Argentine municipalities within 100 km of the border. Sample excludes municipalities reporting their first baptism after 1840 and excludes years with fewer than ten baptisms nationally.

We also run the regression described in Equation (1) using outcomes at the individual (baptism) level. Table 2 shows the results from this estimation. In general, out-of-wedlock births increased after the war, relative to the time periods before or during the war. These increases were significantly larger in Paraguay until around 1881 and then taper off, until Paraguay's rate of out-of-wedlock births finally converges with Argentina's, showing short to medium run effects. For example, the coefficient on the Paraguay dummy in Column (1) indicates that, even before the war, out-of-wedlock births were 7.2 percentage points (pp) more likely in Paraguay than neighboring areas of Argentina. Just after the war this difference between Paraguay and Argentina increased by 15.2 pp for a difference of 22.4 pp. Though the differences are substantial, they also disappear after several decades.

Table 2: Cross-border: Short- and medium-term effects on out-of-wedlock births

	Outcome: out-of-wedlock birth indicator	
	(1)	(2)
Baptized in 1864-1870 (during the war)	-0.025	-0.008
	(0.020)	(0.022)
	[0.019]	[0.021]
Baptized in 1871-1880 (after the war)	0.039**	0.060***
	(0.018)	(0.018)
	[0.017]	[0.017]
Baptized in 1881-1890 (after the war)	0.067***	0.093***
	(0.022)	(0.015)
	[0.022]	[0.014]
Baptized in 1891-1900 (after the war)	0.074***	0.087***
	(0.019)	(0.014)
	[0.019]	[0.013]
Baptized in 1864-1870 × Paraguay	0.080**	0.068**
	(0.031)	(0.027)
	[0.027]	[0.021]
Baptized in 1871-1880 × Paraguay	0.152***	0.167***
	(0.028)	(0.020)
	[0.029]	[0.017]
Baptized in 1881-1890 × Paraguay	0.010	0.034
	(0.040)	(0.024)
	[0.039]	[0.020]
Baptized in 1891-1900 × Paraguay	-0.208***	-0.175***
	(0.041)	(0.029)
	[0.038]	[0.023]
Paraguay	0.072**	
	(0.028)	
	[0.034]	
Observations	134331	134331
R^2	0.019	0.015
Mean of outcome variable	0.624	0.624
Municipality fixed effects	No	Yes

Data from baptismal church records between 1840 and 1900 in Paraguay and in Argentinean municipalities within 100km of Paraguay. Sample excludes Asunción and the Paraguayan Chaco. The omitted time period is 1840-1863 (before the war). Clustered standard errors at the municipal level in parentheses (21 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.2.2 Within-Paraguay comparisons

We also use the baptismal church data to examine within-Paraguay impacts of the war, exploiting variation in the distance to battle points or march lines. There are very few churches with baptismal records in the data that are located "far" (greater than 30 km) from battles and marches. Of these, there are no observations from more distant parishes after 1885. For this reason, we restrict the analysis to years prior to 1885. The regression has a similar form to Equation (3), but observations are now at the individual level.

Table 3 shows that, as in the cross-country analysis, the levels of out-of-wedlock births increased after the war relative to the pre-war era. After the war, out-of-wedlock births were 18.4 pp more likely than before the war (column (4)). The post-war increases in out-of-wedlock baptisms are greater in areas closer to the war path (by 8.6 pp). This points to an interesting dynamic – the war appears to have made out-of-wedlock childbearing more uniformly acceptable by driving out-of-wedlock birth rates in the areas of the country near where the war passed to levels more similar to those in areas further from the war which had higher rates of out-of-wedlock births from the start.

6.3 Female education

6.3.1 Within-Paraguay comparisons

Next, we examine female educational outcomes in the medium term. The 1887 Paraguayan census provides the number of male and female students and teachers. From this we create the student sex ratio and the teacher sex ratio in each municipality. We do not have panel data on these outcomes, so these regressions are cross-sectional and control for municipality-level characteristics. We focus on education because the historical literature emphasizes an increase in female education as an effect of the war. The information on teacher sex ratios is also the only data we encountered measuring female labor force participation in the 1880s. We expand on these outcomes in the long-term impact analysis.

Table 4 shows similar results across both outcomes. In municipalities that were more affected by the war, there were a higher share of female students and a higher share of female teachers after the war. For example, Column (5) suggests that a municipality on the march line would have a teacher sex ratio of 0.5 females for every male (or two male teachers for every female), while a municipality 20 km from the march line would have a teacher sex ratio of 0.2 (or five males for every female). This is consistent with Potthast (2005) who argued that the skewed sex ratios caused by the war led to increased education for females. Students in 1887 were born after the war, and given that the sex ratio in this generation was close to unity, this result should not be a mechanical consequence of the lack of boys.

Table 3: Within Paraguay: Short- and medium-term effects on out-of-wedlock births

	Outcome: out-of-wedlock birth indicator			
	(1)	(2)	(3)	(4)
Baptized 1864-1870 (during the war)	0.023	0.043	0.027	0.045
	(0.029)	(0.031)	(0.026)	(0.026)
	[0.010]	[0.010]	[0.010]	[0.008]
Baptized 1871-1885 (after the war)	0.188***	0.197***	0.172***	0.184***
	(0.017)	(0.033)	(0.025)	(0.031)
	[0.022]	[0.028]	[0.028]	[0.027]
Baptized 1864-1870 × near march line	0.072*	0.050		
	(0.035)	(0.033)		
	[0.021]	[0.015]		
Baptized 1871-1885 × near march line	0.023	0.044		
	(0.029)	(0.045)		
	[0.031]	[0.041]		
Near march line (< 30 km)	-0.096**			
	(0.036)			
	[0.041]			
Baptized 1864-1870 × near battle point			0.072*	0.052*
			(0.034)	(0.029)
			[0.023]	[0.013]
Baptized 1871-1885 × near battle point			0.051	0.086**
			(0.035)	(0.031)
			[0.036]	[0.027]
Near battle point (< 30 km)			-0.105**	
			(0.035)	
			[0.039]	
Observations	26195	26195	26195	26195
R^2	0.040	0.028	0.040	0.029
Mean of outcome variable	0.715	0.715	0.715	0.715
Municipality fixed effects	No	Yes	No	Yes

Data from baptismal church records in Paraguay between 1840 and 1885. Sample excludes Asunción and the Paraguayan Chaco. The omitted time period is 1840-1863 (before the war). Clustered standard errors at the municipal level in parentheses (13 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Within Paraguay: Medium-term effects on student and teacher sex ratios

	Student ratios: female/male				Teacher ratios: female/male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to march line	-0.104				-0.182**			
	(0.065)				(0.091)			
	[0.052]				[0.070]			
Squared distance to march line	0.010				0.015			
	(0.008)				(0.011)			
	[0.007]				[0.008]			
Near march line (< 30 km)		0.030				0.191		
		(0.116)				(0.204)		
		[0.098]				[0.195]		
Distance to battle point			-0.114*				-0.207*	
			(0.060)				(0.113)	
			[0.063]				[0.104]	
Squared distance to battle point			0.010*				0.018*	
			(0.006)				(0.010)	
			[0.006]				[0.009]	
Near battle point (< 30 km)				0.053				0.146
				(0.114)				(0.220)
				[0.093]				[0.205]
Observations	62	62	62	62	61	61	61	61
R^2	0.116	0.067	0.125	0.070	0.153	0.091	0.157	0.083
Mean of outcome variable	0.406	0.406	0.406	0.406	0.490	0.490	0.490	0.490

Data from Paraguay's 1887 census. Sample excludes Asunción, the Paraguayan Chaco, and small municipalities where the 1886 population in the birth cohort before the war or after the war was less than 200 people. The unit for distance variables is 10 km. Control variables include log(distance to Asunción), log(municipality area), have 1846 population information, log(1846 population), have 1864 population information, and log(1864 population). Robust standard errors in parentheses and Conley (1999) standard errors in brackets. Asterisks are based on robust standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.4 Short- and medium-term summary

In sum, the within-Paraguay and cross-border results are in accord with one another. Municipalities (and countries) closer to (more affected by) the war had more skewed sex ratios immediately after the war. These sex ratios approached unity relatively quickly in the cohorts born after the war. Out-of-wedlock births increased immediately after the war in areas closer to the conflict, though the evidence on whether this effect lasted into the medium term is weaker. There is also evidence of medium-term increases in female educational outcomes. We next explore whether these effects persisted in the long run.

7 Long-term impacts

The previous section showed that very soon after the war the sex ratio rebounded from the reported postwar ratios of between three and seven women to one man (Potthast-Jutkeit 1991, Washburn 1871), down to 1.5 in 1886 and 1.16 in 1899 (Carrasco 1905). The 1950 census reported 1.04 women for every man, with similar ratios through 2002 (as shown in Figure D.1). Any persistence is therefore not driven by long term skewed sex ratios. In this section, we study whether the temporarily skewed sex ratios of postwar Paraguay have had long-term impacts on modern outcomes in Paraguayan society.

Following our conceptual discussion, we are interested in six modern outcome variables: female-headed household, being unmarried living with one's own child, being literate, having completed primary education, being employed, and gender norms. The first one of these is a household-level variable while the others are individual-level variables. Literacy questions are not asked in later census years in Paraguay, so those regressions contain fewer observations. We limit individual-level analysis to individuals between 18 and 65 years for all outcomes except for unmarried living with a child. Unmarried living with a child means that the individual is neither married nor in a consensual union and has at least one of their own children living in the same household. In order to better capture the idea of raising a child alone, we limit the regressions using this outcome variable to individuals aged 18 to 45. We use this as a proxy variable for the out-of-wedlock child outcome we have in the historical data, although it is important to note that it is not equivalent. Being employed means the individual works either for others or for him or herself, in either a paid or unpaid position, and either with or without legal contract. Gender norms are measured using a Likert scale measuring opinions regarding female labor force participation.

7.1 Cross-border comparisons

We first compare modern outcomes in Paraguay with outcomes in neighboring comparison municipalities in Argentina and Brazil using Equation (2). In our preferred specification, we pool all four years of data and include census-year fixed effects. Panel A of Table 5 runs the regression using the broad sample which includes as the control group Argentinean and Brazilian municipalities within 100 km of the Paraguayan border. Panel B shows the results using the restricted sample which excludes the Argentinean and Brazilian municipalities which were contested before the war and officially became part of Argentina and Brazil after the war.

The cross-border regressions reveal significant differences in the status of women in Paraguay compared to neighboring areas of Argentina and Brazil. The results are similar across the broad and restricted samples.[22] Paraguayan household heads are 3.6 percentage points more likely to be female in the broad sample (Column (1)), relative to a mean of 17 percent. Paraguayan men are less likely to raise a child without a partner than Argentinean and Brazilian men (Column (2)), but Paraguayan women are significantly more likely to do so. In the broad sample, the coefficient on the interaction term is 2.3 percentage points – over a third of the mean of the outcome variable.

For the educational outcomes (Columns (3) and (4)), we find that women are less educated than men in general, but Paraguayan women have relatively less education than women across the border. This contradicts the idea that the skewed sex ratios after the war led to increases in female education, at the cross-country level. (The cross-country results for educational outcomes are in contrast to the within-Paraguay results shown in the next section.)

For labor force participation, Paraguayan men are more likely to participate in the labor force compared to their neighbors in Argentina and Brazil while Paraguayan women are significantly *less* likely to participate. This is in contrast to studies finding long term increases in female labor force participation due to the World Wars in Europe and will be in contrast to our within-Paraguay results in the next section. One explanation for this result may be that females who work on their own farms don't consider and report themselves as being employed. Another possibility is that women who are raising children alone, of which there are more in Paraguay, are less likely to be regularly employed. These issues are more relevant in a developing country context, and also more relevant in Paraguay compared to its neighbors.

[22]We have also run regressions using a different restricted sample control group - just those contested municipalities which became part of Argentina and Brazil after the war. As would be suggested by the minor differences between panels A and B of Table 5, the results using this alternate control group are quite similar.

We show estimates for each census year separately using the restricted sample in Appendix Table D.3. For primary education and employment, the results are quite consistent across all census years. There are some differences across census years for the other outcome variables though there do not appear to be meaningful patterns. Results look different for female headed households in 1972, unmarried living with child in 2002, and literacy in 1982.

Table 5: Cross-border: Long-term effects on modern outcomes

	Demography		Education		Employment
	Female Head	Unmarried w/ Child	Literacy	Primary Edu	Employed
	(1)	(2)	(3)	(4)	(5)
Panel A: Broad Sample					
Paraguay	0.036***	-0.038***	0.030**	0.011	0.053**
	(0.009)	(0.009)	(0.014)	(0.030)	(0.021)
	[0.009]	[0.009]	[0.014]	[0.033]	[0.031]
Female		0.078***	-0.030***	-0.018***	-0.472***
		(0.003)	(0.004)	(0.004)	(0.018)
		[0.004]	[0.005]	[0.005]	[0.019]
Paraguay × Female		0.023***	-0.055***	-0.031***	-0.152***
		(0.005)	(0.005)	(0.005)	(0.029)
		[0.006]	[0.007]	[0.006]	[0.052]
Observations	410475	805618	665816	1054669	1054669
Mean of outcome variable	0.174	0.063	0.861	0.468	0.598
Paraguay + Paraguay × Female		-0.016*	-0.024	-0.020	-0.099***
		(0.008)	(0.016)	(0.031)	(0.017)
Panel B: Restricted Sample					
Paraguay	0.039***	-0.024***	0.031**	0.060**	0.044*
	(0.008)	(0.008)	(0.012)	(0.029)	(0.025)
	[0.009]	[0.008]	[0.013]	[0.030]	[0.035]
Female		0.074***	-0.036***	-0.020***	-0.474***
		(0.004)	(0.006)	(0.004)	(0.023)
		[0.004]	[0.006]	[0.004]	[0.023]
Paraguay × Female		0.027***	-0.048***	-0.029***	-0.150***
		(0.006)	(0.007)	(0.005)	(0.032)
		[0.007]	[0.008]	[0.005]	[0.053]
Observations	323796	648025	459515	848368	848368
Mean of outcome variable	0.178	0.057	0.858	0.462	0.599
Paraguay + Paraguay × Female		0.003	-0.016	0.030	-0.106***
		(0.008)	(0.015)	(0.030)	(0.017)

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco) and neighboring municipalities in Argentina and Brazil. The broad sample in Panel A includes municipalities in Argentina and Brazil within 100 km of the Paraguay border excluding the Argentinean Chaco. The restricted sample in Panel B additionally excludes municipalities in departments which were contested before the war and officially became part of Argentina and Brazil after the war. Column (1) is limited to household heads aged 18-65; Column (2) is limited to individuals 18-45 years old; and Columns (3)-(5) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. Fixed effects at the year level. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (122 clusters in Panel A and 98 clusters in Panel B) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7.2 Within-Paraguay comparisons

In this section, we examine whether within-Paraguay variation in modern outcomes is associated with distance from Triple Alliance battles or marches. Given the general decimation of the male population throughout the entire country caused by the war, it is plausible that the within-Paraguay effects understate the true effects. Still, this sample provides variation at the intensive margin, which avoids some of the potential issues in the cross-border sample, although it reduces the variation in the historical sex ratio.

We use Equation (4) to estimate the long-run effects within Paraguay. We use a dummy for residing less than 30 km from the march path in our preferred specification, found in Panel A of Table 6. As a robustness check, we repeat the estimation using a binary indicator for residing close to a battle point as well as linear distance to marches and battles. Those additional results are presented in Appendix Table D.4.

The coefficient on the interaction between female and living near a march line represents the double difference between women and men living close to and farther from the conflict. Column (1) of Panel A shows that household heads residing in municipalities closer to a march line are 2.8 pp (or 14%) more likely to be female than those residing farther away. Column (2) shows that women living closer to the march line are significantly more likely to be unmarried and living with their child. This parallels the short-term historical finding of more out-of-wedlock children closer to the conflict and recalls the historical *concubinato* institution for Paraguay.

Regarding education, while women are less likely than men to have completed primary education (Column (4)), this disadvantage is smaller closer to the march lines. This mirrors the within-Paraguay variation in school enrollment in the aftermath of the war. Admittedly, the effect is more muted for self-reported literacy (Column (3)), which has largely converged in modern times. These effects might also accrue differently, depending on the demographic structure of the household.

Women within Paraguay living close to historical battles or march lines are more likely to be employed than those living farther away. The results within Paraguay are consistent with the traditional narrative that conflict empowered women to work. Noticeably, women have significantly lower labor force participation than men in Paraguay; in fact the coefficient on female (69 pp) in column (5) is larger than the mean of the outcome variable (0.59). This is consistent with the idea that Paraguayan women who work on the family farm do not consider themselves to be working when responding to the census. The earlier cross-country results which show Paraguayan women less likely to be employed may reflect Paraguay's higher concentration of women working on their own farms. The within-country result likely reflects the true impact of the skewed sex ratios, given that it controls for national labor-

market characteristics. However, it may be attenuated because there are few unaffected regions.

An alternative explanation for the high levels of out-of-wedlock childbearing is that much of what historians and journalists have attributed to war impacts were actually driven by particular characteristics of the Guaraní. In the pre-colonial era, single mothers and females working in agriculture were more common in Guaraní culture (Potthast-Jutkeit 1991). Panel B of Table 6 tests this hypothesis by replacing the "proximity to march" variable with a binary indicator for whether less than 44.2% of the municipality (the median in the sample) speak only Guaraní at home (as opposed to only Spanish or a mix of the two) in 1962.[23]

The empirical results are not consistent with this theory—municipalities with fewer pure Guaraní speakers do not have significantly different rates of female-headed households, single motherhood, or primary education. The areas with less Guaraní (households speak more languages other than Guaraní) have higher female literacy rates and higher female labor force participation, which is the opposite of what the characteristics of Guaraní culture would have predicted. Overall, we conclude that effects are due to the war and skewed sex ratios rather than due to Guaraní culture.[24]

Appendix Table D.5 shows results by each census year for the near march line specifications. As with the cross-country estimations, there are some small deviations across census cohorts. The most consistent results are for female headed households, unmarried living with child, and employment. The results for the educational outcomes seem to be driven by the later more recent years.

[23]This is the first available measure for this variable.

[24]In the next section we explore heterogeneous impacts adding the triple interaction between Guaraní-speaking and distance and also find few consistent patterns.

Table 6: Within Paraguay: Long-term effects on modern outcomes

	Demography		Education		Employment
	Female Head	Unmarried w/ Child	Literacy	Primary Edu	Employed
	(1)	(2)	(3)	(4)	(5)
Panel A					
Near March Line (< 30 km)	0.028***	-0.003*	0.005	0.030***	-0.043**
	(0.010)	(0.001)	(0.010)	(0.011)	(0.018)
	[0.010]	[0.002]	[0.011]	[0.011]	[0.032]
Female		0.086***	-0.087***	-0.055***	-0.693***
		(0.005)	(0.004)	(0.004)	(0.035)
		[0.005]	[0.004]	[0.005]	[0.035]
Near March Line × Female		0.023***	0.003	0.010**	0.105**
		(0.005)	(0.005)	(0.004)	(0.042)
		[0.006]	[0.006]	[0.005]	[0.065]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588
Near + Near × Female		0.020***	0.008	0.040***	0.062**
		(0.005)	(0.011)	(0.012)	(0.025)
Panel B					
Municipality Mostly Speak More Than Guaraní	0.014	-0.004	0.001	0.011	-0.062***
	(0.009)	(0.003)	(0.009)	(0.012)	(0.018)
	[0.008]	[0.003]	[0.009]	[0.012]	[0.027]
Female		0.099***	-0.090***	-0.050***	-0.699***
		(0.006)	(0.004)	(0.004)	(0.026)
		[0.008]	[0.005]	[0.004]	[0.026]
Female × Speak More Than Guaraní		0.005	0.013*	0.004	0.158***
		(0.007)	(0.006)	(0.004)	(0.038)
		[0.007]	[0.008]	[0.005]	[0.058]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588
More than Guaraní + More than Guaraní × Female		0.001	0.014	0.015	0.096***
		(0.006)	(0.012)	(0.013)	(0.022)

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco). Column (1) is limited to household heads aged 18-65; Column (2) is limited to individuals 18-45 years old; and Columns (3)-(5) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. "Municipality Mostly Speak More Than Guaraní" indicates that the share of the municipality speaking only Guaraní at home in 1962 is below the median of that share among all municipalities. Fixed effects at the year level. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (58 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7.3 Mechanisms and mediators within Paraguay

Next we explore the mechanism behind this persistence, and potential mediators of it. We posit that altered gender norms may be transmitted across generations. To this end, we first look at effects on norm-related outcomes from the LAPOP data in modern times. Next, we assess whether openness to immigrants and the Spanish (or Guaraní) language mediates the effects we observed in the IPUMS data.

Table 7: Within Paraguay: Long-term effects on modern gender norm outcomes

	Single Outcome		Combined Outcome
	(1)	(2)	(3)
	Rights to job	Child suffer	Work outcomes
Near march line (< 30 km)	-0.181**	-0.014	-0.073
	(0.083)	(0.038)	(0.045)
	[0.083]	[0.037]	[0.047]
Female	-0.104	-0.002	-0.038
	(0.099)	(0.038)	(0.047)
	[0.071]	[0.041]	[0.039]
Near march line × Female	0.008	0.027	0.023
	(0.110)	(0.049)	(0.053)
	[0.089]	[0.045]	[0.047]
Children suffer question indicator			0.140***
			(0.028)
			[0.046]
Observations	637	1304	1941
Mean of outcome variable	0.411	0.545	0.501
Near + Near × Female	-0.173**	0.012	-0.050
	(0.078)	(0.037)	(0.037)

Data from LAPOP data in Paraguay (excluding Asunción and the Paraguayan Chaco). Dependant variables are indicators for (1) agree that when there is not enough work, men should have a greater right to jobs than women; (2) agree that when a mother works outside the home, children suffer; and (3) pooled regression that includes both outcomes. Control variables include age, rural, log(municipality area), log(distance to Asunción), and average maize productivity. Additional control in Column (3) is the question indicator. Clustered standard errors at the municipal level in parentheses (49 clusters in Columns (1) and (2) and 51 clusters in Column (3)) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In Table 7 we look at the long-term effect of living near the historical march line on the two survey questions measuring gender norms with respect to labor force participation. We find that individuals who live near the march line are less likely to agree that men have a

greater right to access jobs than women. This more equal gender norm with respect to female labor force participation is more strongly held by both men and women. Gender-related labor force participation norms could pass from parents to their children as in Fernández et al. (2004).

Two notes about these results are in order. The first is that in Table 7, we see a significant impact of living near the march line on everyone, with no significant difference between the effect on men versus women. On the other hand, for actual labor force participation as shown in Table 6, we see a differential effect of being near the march on women. This is sensible, as one could imagine that both men's and women's perceptions of women's right to work could be equally affected, and this would differentially affect only women's labor force participation. Second, we show results for the two labor force related gender norms questions from the LAPOP data even though only one is significantly correlated with exposure to the war. The gender norm affected seems to be connected with a belief in women's right to work rather than the effect their employment will have on children, speaking to our previous results.

The literature suggests that gender norms might be less persistent in environments that are more open and modern. This is because beliefs based on past experiences might have less predictive power in more open areas. The literature also suggests that norms might be stronger among families that are more steeped in indigenous traditions.

To test these ideas, we estimate the long-term within-Paraguay regressions adding sources of heterogeneity as measured by historical openness to immigration, and language modernization in the municipality. We include the double interactions of these measures with both distance to the march line and with female, and the triple interaction of the variable measuring heterogeneity with distance and female.[25]

To proxy for economic openness, we use levels of international immigration into Paraguay in 1886. After the war, Paraguay's government encouraged immigration in an attempt to repopulate the country. This attempt was not very successful (Kleinpenning 2009). Paraguay experienced relatively little international immigration, as detailed in Appendix B.3. A municipality is considered economically open if the number of foreigners divided by the total population in 1886 according to the Paraguayan census is above the median value of 1.6%.

To proxy for modernization, we use levels of Spanish-speaking in 1962. In the colonial era, Paraguay had one of the highest miscegenation rates between the Spaniards and the indigenous populations. Even today, 95% of Paraguayans are considered mestizos (Potthast-

[25]For the household-level regressions in which the outcome is household head sex and we do not control for whether the individual is female, we include the sources of heterogeneity in the municipality and the double interaction of these measures with distance to the march line.

Jutkeit 1997). According to the 1982 census data, 44% of the population spoke only Guaraní, decreasing slightly to 28% in 2002. This implies a large share of the Paraguayan population continues to hold fast to their roots. A municipality is regarded as non-traditional if the share of individuals in the municipality that spoke languages other than Guaraní (i.e., Spanish) at home in 1962 was greater than the median of 44.2%. This is the same measure explored in the previous sub-section.

These results are shown in Appendix Tables D.6 and D.7. We do not observe any evidence that economic openness (proxied by high 19th century immigration) or a more modern environment (proxied by a low share of Guaraní speakers) influence the impact of conflict on women.[26] Although there are some occasional statistically significant results in these tables, they are generally weak and tell no consistent story. This may simply be because Paraguay does not contain sufficient spatial variation in both the proxy for sex ratio bias and the potential sources of heterogeneity. It may also be that the long term effects are not diminished by these commonly hypothesized sources of heterogeneity in a developing country context. In either case, we are left with no evidence that openness to immigrants or the Spanish language have any moderating influence on the long run impacts of skewed sex ratios in Paraguay. The gender norm results appear stronger.

7.4 Long-term summary

The within-Paraguay results comparing Paraguayans living closer to and further from a historical march line, and the cross-border results comparing Paraguayans with Argentineans and Brazilians living near the border with Paraguay are generally consistent with one another with respect to marriage and fertility outcomes. Females who live in areas that were more exposed to historical skewed sex ratios caused by the Triple Alliance War are more likely to be raising a child without a spouse or partner and household heads are more likely to be female. In more affected areas within Paraguay, females are more likely to be educated and employed. In such areas, individuals of both sexes are more likely to believe in the value of equal labor markets. This shows that the reverberations of the conflict are still present today. This persistence is not moderated by the factors commonly hypothesized to condition the transmission of cultural norms.

[26] We obtained similar non-results with a measure of agricultural productivity, as a proxy for economic uncertainty, not shown.

8 Conclusion

In this paper, we investigate the immediate, medium, and long run impacts of the extreme sex ratio shock induced by the War of the Triple Alliance (1864-1870). We analyze previously unexplored historical data and sources of conflict variation. In particular, we compare outcomes in Paraguay to those in bordering municipalities of Argentina and Brazil, as well as exploring within-Paraguay variation based on newly digitized information on the location of battles and marches during the war.

First, our data show clear evidence of significant and extremely large, albeit temporary, changes in sex ratios. These sex ratios are more severely skewed towards females than the sex ratios after other events previously studied in the literature. Paraguay, Brazil, and Argentina were all affected by conflict on their soil, but only Paraguay experienced such an extreme variation in sex ratios. Furthermore, the impacts of the war on sex ratios within Paraguay varied with distance to battles and marches. The sex ratio shock, while large, was short lived, with ratios approaching unity shortly after the conflict.

In the immediate aftermath of the war, there were higher rates of out-of-wedlock births in Paraguay compared to neighboring municipalities in Argentina, and also in Paraguayan municipalities closer to the conflict compared to those farther away. Furthermore, female to male student (and teacher) ratios were higher in Paraguayan municipalities closer to the conflict, in the medium term. This reflects the historical narrative that women were expected to be educated in order to help educate the next generation of men.

Over one hundred years later, these behaviors persist, and there is evidence that other norms may have been affected by the shock as well. Paraguay contains more female-headed households and more unmarried women living with their child than neighboring areas of Argentina and Brazil, and the same is true comparing areas within Paraguay close to the war relative to areas farther away from it. Similarly, the within-Paraguay analysis suggest that the skewed sex ratios led to higher literacy rates and higher primary education completion rates. Although we have scant information on employment during the immediate aftermath of the war with which to compare, we find that in the longer term Paraguayan women are less likely to be employed than those in neighboring countries, but that women more affected by the conflict within Paraguay are more likely to be employed. The within-Paraguay results are likely to more accurately reflect the intensive impacts of the sex ratio shock, since they are estimated within the same agriculture-based labor market.

The short and long-term impacts of the conflict are consistent across time, and also with the anecdotal evidence and historical literature. What do these results mean for us today? First, they give us a deeper understanding of the roots of Paraguay's unusual standing in

the region. To the extent that they are generalizable, they can inform our thinking about the present crises in the Middle East, the general migration trends of Latin America, and the multiple conflicts worldwide, situations where sex ratios are biased towards females. Our findings suggest that these events are likely to fundamentally alter gender roles. While the effects of these shifting norms on welfare are ambiguous, it is clear that they can last for generations. In more affected areas of Paraguay, women had to take on more responsibility in the household, raising children on their own and heading households, getting more educated, and entering the labor force in greater numbers, providing some silver lining for in the very long run. Cognizance of the existence of these underlying dynamics may help inform the design of policies aimed to maximize the benefits and minimize the costs of these shifts, especially in the developing world.

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A Historical timeline

This timeline is largely based on Williams (1979), but also informed by Whigham (2002), Whigham & Potthast (1999), and the other papers cited in the summary of historical literature.

Year	Event
1811	José Rodríguez de Francia (El Supremo) becomes first dictator following independence from Spain.
1840	Francia dies. Paraguay is ruled by military junta, but effectively by Carlos Antonio López. Literacy rate is 10% and there is little Catholic presence.
1841	C.A. López rules jointly with Mariano Roque Alonso.
1844	C.A. López assumes dictatorial powers and slowly begins modernization.
1840s	Villa Rica is linked to the capital and with Caaguazú by a functional road. San Joaquín is linked to other interior towns, and Jesús connected to Acaraí. Indian segregation is ended, cotton production begins. Outposts are populated in the Chaco. A police force is created in cities. Trade is opened.
1845	Standard salaries are set for rural primary school teachers. A decree is written defining status of foreign merchants in Pilar—an indication of increased trade activity. Francisco Solano López (the son of C.A. López) leads troops for the first time in a botched exercise in Corrientes. This is a period of marked increase in the presence of foreigners in Paraguay, who assist in medicine, education, infrastructure, and business development.
1846	Census undertaken by the priests in each of the nation's 86 partidos. Total population: 238,862 Paraguayans plus 20,000 "migratory" Indians. About 42% of the population lives within 50 miles of Asunción.
1847	Educational institutions in the capital begin producing graduates who can be ordained as clergy.
1850s	C.A. López undertakes many construction projects, earning the nickname of The Great Builder. Medical clinics are established by British doctors who train a corps of Paraguayan paramedics.
1852	Juan Manuel de Rosas (Argentina) is deposed. Rivers in Paraguay are opened by diplomatic treaty with Brazil, Uruguay, and Argentina. Within a year, Britain, France, Sardinia, and the U.S. recognize Paraguay's independence.

Continued table...

Year	Event
1853	Francisco Solano Lopéz begins diplomatic and educational tour of Europe.
1855	British company Blyth and Co. begins to play a major role in fixing an iron foundry, channeling rivers, and making weaponry and ships. The shipyard is finished and functioning smoothly in 1860.
1830s to 1850s	Across the border: Brazil and Argentina are greatly fragmented during this period through continuous civil wars, which works to Paraguay's advantage. By 1860, they are each relatively united and more powerful countries.
1862	Carlos Antonio López dies. Foreigners are granted over half of all business licenses in the capital; they run schools, reinvigorate culture, and generally constitute a middle class. Industrialization is a classic military-industrial complex. Francisco Solano López takes power. Opposition is jailed or killed, and many go into exile.
1863	Francisco Solano López decides that an independent Uruguay is necessary for regional power balance; this is one of the root causes of the war. Uruguay is torn apart by rural (Blanco)/urban (Colorado) political divides exacerbated by the interventions of Brazil and Argentina.
1864	The telegraph arrives in Paraguay and links Humaitá with Asunción and Villa Rica.
Fall 1864	Brazil invades Uruguay. Paraguay refuses alliance with Brazil, instead capturing and holding a Brazilian ship in Asunción. The total population of Paraguay is smaller than Brazil's National Guard.
March, 1865	Paraguay declares war on Brazil. Paraguayan troops enter Mato Grosso (Brazil) and capture its center (almost the only successful venture for Paraguay in the conflict); they then head into Corrientes (Argentina) and begin their disastrous fall.
April, 1865	Brazil, Argentina, and Uruguay sign the Treaty of the Triple Alliance. Paraguay's southern offensive is its last, and the defensive war begins with an army of new recruits from tiny pueblos.

Continued table...

Year	Event
1866	Paraguay is on the defensive, usually with casualty rates double those of the "Allies." However, Allied forces dawdle south of Humaitá, and during this time are heavily hit by cholera. From late 1866 onward, women are in charge of farming.
1867	By now, at least 60,000 young men are dead. Domestic production of yerba falls from 1,681,000 pounds in 1863 to no active harvesting in February 1867. Cotton and food production continue, and women are employed in farming and producing army uniforms.Between 1866 and 1867, cotton and foodstuff production decreases from 6,805,695 liños and 215,000 fruit trees to 4,192,520 liños and 135,757 fruit trees.
Aug, 1868	Humaitá surrenders.
1868-1869	Francisco Solano López begins retreat, dragging civilians with him and spreading cholera. The Allies occupy Asunción and then Piribebuy, followed by battles in Ytororó, Avaí, Itá-Ybaté, and Pikysyry. López kills hundreds out of fear of a conspiracy, including two of his own brothers, two of his brothers-in-law, the bishop, and at least 500 foreigners.
1869	Francisco Solano López is finally killed in Cerro Corá, 75 miles northeast of Concepción, along with his eldest son and the vice-president, ending the war.

B Historical literature

In this Appendix we review the relevant historical literature. We start with a description of the war itself in terms of the number of people involved and how recruitment was carried out. We follow that with a detailed discussion of sexual mores in Paraguay. We conclude with a description of foreign immigration into Paraguay after the war.

B.1 Human involvement in the war

Of the participants in the war, Paraguay was the most affected demographically. More Paraguayans died than Argentineans and Brazilians put together. While there were higher numbers of Brazilian soldiers, this was not true as a percent of the population.

The following numbers for the three countries are cited in terms of soldiers.

> In the course of the war, Paraguay mobilised at least 70-80,000 men (though probably less than the 100,000 sometimes suggested)... Once the Paraguayan forces had been expelled from Argentine territory (and had no serious possibility of returning), Argentina reduced its commitment to the Allied war effort so that by the end of the war there were only some 4,000 Argentine troops on Paraguayan soil. Uruguay never had more than a symbolic presence in the theatre of operations. Brazil, on the other hand, increasingly assumed responsibility for the bulk of the fighting... In the course of the war Brazil is estimated to have mobilised up to 130-150,000 men (though probably not the 200,000 indicated by some historians). (Bethell 1996, p. 6)

And, the following numbers for the three countries are cited in terms of deaths:

> And although population loss has been grossly exaggerated –even put as high as 50 per cent of Paraguay's (usually inflated) pre-war population, i.e. 200,000 or 300,000 or even half a million dead – more modest recent estimates of 15-20 percent (or even lower) of a much smaller estimated pre-war population, i.e. 50-80,000 deaths, in battle as well as from disease (measles, small pox, yellow fever and cholera), are enormously high percentages by the standards of any modern war... Argentina suffered estimated (possibly exaggerated) losses of 18,000 in battle plus 5,000 in internal disturbances triggered by the war and 12,000 in cholera epidemics... Brazil, which had made the major contribution to the war effort to which victory was due, suffered human losses totalling at least 25-50,000 in combat, and more from disease (though probably less than the total of 100,000 sometimes claimed). (Bethell 1996, p. 9)

> Brazil bore the largest burden for the Allies and so could expect to play the most important role in postwar settlements. The Empire's sacrifice in manpower was certainly well over 100,000 dead and probably another 65,000 wounded. An incredibly low estimate gives the total Brazilian combat dead, wounded, and missing as 23,917... R. C. Kirk, American minister to Argentina, estimated the Brazilian losses as 168,000, Argentine as 20,000, and Uruguayan as 3,000... Recovery was slow in coming. Paraguay needed time "for the grass to grow over its 400,000 graves. It desires time for its thousands of orphan boys to attain the strength of manhood." (Warren 1978, p. 30-31)

And this excerpt discusses how Paraguayans living near battles and marches were recruited to join the troops.

> López forced as many Paraguayans as possible to take refuge behind his nebulous lines at Caacupe, Piribebuy, and Villa Rica until the latter was overrun by Brazilians. Small patrols constantly went out to round up stragglers, and often these patrols committed horrible atrocities... The fleeing dictator sent squads of executioners, clad in red ponchos, to cut the throats of all who refused his order to abandon their homes. Thus scores of villages were deserted in this brutal scorched-earth policy. (Warren 1978, p. 21)

B.2 Sexual mores in Paraguay

Some of the historical literature describes how, even before the war, the Guaraní culture was characterized by women of loose sexual mores who provided strong leadership in households. Other authors emphasize that these features were a result of the extremely skewed sex ratios after the war. A final group posits that mores were different in Paraguay before the war and then this difference was exacerbated by the war itself. Below we copy quotes from the three sides of the debate.

In support of the view that Guaraní culture is responsible for today's gender norms:

> In Guaraní indigenous societies, caciques (chiefs) could have more than one wife. Divorce was also especially easy for women. When an Indian woman no longer cared for her husband or because he abused her, she would simply say "Go wherever you want," and the couple would separate...
>
> Whatever the reason, the fact that more than one-third of all households in rural areas were headed by women is quite significant, since it demonstrates that many women were in positions of responsibility and authority before the war...

> Parish marriage records also show that illegitimate birth was not a social barrier to marriage, since those of "legitimate" birth did not always marry those of like birth. Rural marriage patterns could not be fully reconstructed because priests did not record the brides' and grooms' ages. According to a contemporary, it was customary for most couples to live in free unions. The incidence of marriage was low because a church wedding may have represented a considerable expense which most rural couples could not afford. Under Dr. Francia (1811-1840), the state also established marriage bans which prohibited all Europeans from marrying "white Paraguayans" (blancas Paraguayas) and as serving as godparent as part of the backlash against the Spanish colonial elite following independence. Since most Spaniards did not desire to marry black or Indian women, Dr. Francia's marriage bans probably led to a slight increase in the number of free unions in the country during the early national period. (Ganson 1990, p. 340-342)

> Women's agricultural roles date back to the pre-colonial traditions of Guaraní Indian society. In 1545 a Spanish cleric described how the Guaraní Indian women worked: "We find, Señor, in this land a very bad custom: that it is the women who sow and reap the crops." Another Spanish colonist noted that "it was the custom of the land that the women work and produce the food in the fields..." Tracing this pattern into the early national period under the administration of Dr. Francia (1811-1840), it is evident that women still provided the bulk of the agricultural labor in Paraguay. A British traveler noted that women and children were employed "without the labor of men." (Ganson 1990, p. 347)

> This paper highlights the roles of women in agricultural production but emphasizes that it did not occur completely because of the shortage of men, as is generally assumed, but was rather part of a continuing pattern in society whose roots can be traced back to Paraguay's Guaraní cultural heritage. (Ganson 1990, p. 371)

In support of the view that the skewed sex ratios after the war are responsible for today's gender norms:

> The nation survived these disasters because the women worked with remarkable endurance and often considerable skill, at whatever tasks had to be done. They still do. Women are the farmers, the shopkeepers, the factory workers, the school teachers, and in many instances they are the mainstays of the family. As one North American who had lived several years in Asunción observed, "To all intents

and purposes a matriarchy prevails in Paraguay. Women's position vis-à-vis men is one of respect and tenderness mixed with a complacent conviction that women should do the work and shoulder all family responsibilities. Women exert a tremendous influence on the men. Women of higher-income families do not, as the poorer women, "do all the work," but they exercise great influence. (Cannon 1946, p. 2)

Paraguay came to be known as "the land of the women," not only because of the numerical superiority of the female population, but also because women did most if not all of the work and at least in the eyes of many male visitors did everything they could in order to keep a man. The stereotype of the lazy Paraguayan man and the industrious but morally loose woman persists to the present day.

> Only the women worked to feed their children or surviving elders. Then as boys grew to be men, the preponderance of female over male led to actual if undeclared competition for the few males available. Women were happy enough to work to keep a man, even if he chose only to swing in his hammock all day... So the Paraguayan rural male grew out of the habit of working... It is not surprising, then, still to find strong evidence of a matriarchal society in Paraguay –the result of history, not of the survival of primitive customs. (Raine 1956, pp. 16-17)

... Phenomena such as Paraguayan "machismo" and the present family structure which is characterized by the abundance of female-headed households, illegitimate births, and consensual unions are still attributed mainly to the breakdown of family and society after the "Great War." (Potthast-Jutkeit 1991, p. 216)

After the war it was accepted that women also needed adequate education, especially because they were the ones who would educate future citizens. All the newspapers published articles about the need for better education for women. In some cases this argument was based on the recognition that females also had the right to develop their intellectual faculties, but in most cases it was because people had become aware that "to combat the immense evils invading us and destroying our peace, there is only one remedy... educating women." (Translated by the authors from Potthast-Jutkeit (1996, p. 335).)

The patriarchal model of the family surely remained intact, but the shortage of men gave women the opportunity to participate more actively in economic

life. But above all, women had to take charge of educational work in the public sphere, that is, teaching in the public schools. This, in turn, required better trained women, which opened the doors to higher education for women. In the long run, this had vast consequences for upper class females, and, later also, for the emerging middle class. The high percentage of women in universities today is a characteristic feature of the –otherwise backward –Paraguayan society. (Translated by the authors from Potthast-Jutkeit (1996, p. 43).)

The only conclusion that men could draw from this was that it was absolutely necessary for the well-being of the nation to improve female education at all social levels. Before the war even many upper-class women were illiterate, but those who could read and write actively promoted women's education after the war. This was perhaps the conflict's only significant and lasting positive consequence for women, and it helped change attitudes in the following generations. Today the gender gap in illiteracy rates is comparatively small in Paraguay, 7.8 percent for women versus 5.6 percent for men; in contrast, in Bolivia these rates stand at 20.6 and 7.9 percent respectively. (Potthast 2005, p. 60)

He is seldom thrifty, and he will, it is said, often gamble away in an hour what it has taken him a week to earn. His wife and daughter, on the other hand, are energetic and industrious, trudging daily many miles to market to sell the produce they carry on their heads or on the back of a single donkey. (A quote about Paraguayan men from the British consul to Paraguay in 1896 as cited by Kleinpenning (2009, p. 102).)

Cirovic pointed to another unfavourable fact: the nomadic nature of many men, who left wife and children after some years, as a result of which there were many incomplete households, headed by women. (A quote about the early 1900s from Kleinpenning (2009, p. 123).)

For the sake of truth and justice, I should clarify that the Paraguayan woman, even if she might enjoy luxury like all women, is a hundred times more hard-working, diligent, economical, and persistent than the Paraguayan man. Intellectually and morally she is his superior. Her capacity for self-sacrifice, her loyalty, and her devotion to her spouse and children are exemplary, equal to those of the women of any other country. (González 2013, p. 166)

Another feature, which does demonstrate [the Paraguayan male's] nobility, is that he recognizes his illegitimate children and his debts. He will neither support

the former nor settle the latter, but he will not deny either... What I have said above refers both to single and married men; the latter are few, as men tend to abandon their farm and their family and go elsewhere in search of adventure. Once they leave, most of them are oblivious to the needs of their families. They earn money and spend it without consideration that their parents, wives, and children might be in great need. And if they do pay an occasional return visit, they arrive empty-handed as if they were penniless. (Bogarín 2013, p. 176)

In Paraguay it is quite commonplace for paternity to be irresponsible, denied, and of little consequence for the man involved. There may be many legacies in our history as a people that have contributed to the lamentable practice among men that leaves women as the sole carers of their children (such as the abusive mestizaje practised by the Spanish colonizers or the near extermination of our men during the Triple Alliance War). But without seeking to go into the possible causes, what is clear is that in Paraguay it is normal for men not only to not worry about their offspring, but in fact to consider them as a "trophy of war" that they need not even have to look after. Many politicians, presidents, and even church leaders have displayed a tendency to think and act in this way. Examples abound and, in Paraguay at least, they are well known. Just recently a priest said in Guaraní, by way of an excuse for his own previously denied paternity, "Oikóntema voi aga" ("These things just happen"), summing up in a few words the traditional (but hopefully not majority) attitude on this issue. (Soto 2013, p. 358)

Perhaps the most terrible and lamentable effect of the war of 64-70 was destruction of the Paraguayan home. More than material destruction, more than territorial spoliation, it caused Paraguay's misfortune by its consequences, the disappearance of that strong and healthy cell that the family was before that great disaster. The country was left without the home. Homeless and sorrowing women were the ones who rebuilt the race... and they continue being its support after more than fifty years... The formation of families is almost an exception, the percentage of natural children[27] is alarming... because the natural child in our country is a creature abandoned to the weak protection of the woman. Almost never can it count on paternal protection. (A quote from Justo Pastor Benítez cited by Warren (1985, p. 274).)

[27]Natural children are children born out-of-wedlock.

The British minister, on a visit from Buenos Aires in 1881, made a short trip into the interior where he found that "the women do all the work –the war having destroyed most of the male population – This excess of women is naturally very pleasant for the lords of creation. It is singular, though, that as a rule generally faithful to their men, a large proportion of the women prefer not marrying – as that entails working for a husband as well as children." (Warren 1985, p. 275)

In Paraguay for historical reasons "matriarchy" was established. The Chaco War and the War of the 70s [The War of the Triple Alliance], buried too many men and made women assume a leading role, perhaps out of equilibrium, but necessary... The Paraguayan woman, from "Las Residentas" [women in the War of the Triple Alliance] to our times fulfilled a thousand roles to satisfy historical events. The hard-working Paraguayan woman produced children to see our nation reborn as the Phoenix. Mother, wife, father, worker without fatigue, nurse and lover. Destiny was perhaps brutally demanding of our women. Now, in the present... if we ask a street child:... "and where is your dad?" the child will answer you with a hint... of sadness and anger on his lips: "I do not have a dad." And then he looks far away as if to say "don't ask me anymore." He knows he is not a test tube child. He knows that he is not the fruit of an in-vitro insemination. He painfully knows that his father is traveling on the road, maybe he plays on the same soccer fields or cools himself in the same streams... A whole generation of men without fathers, where the hate/love love/hate psychological struggle transcends individuality to become the bleeding reality of our nation... Paraguayan women must become aware that those historical conditions no longer exist. We must instill responsible parenthood from the cradle. We cannot continue irresponsibly sowing sperm like we sow [agricultural] seeds in the rows of our future.... Perhaps in this way, the valuable Paraguayan women stop thinking, "this is just the way things are" and "men do things differently" repeating this curse forever and ever, throwing into the street sibling children with the same mother but different and unknown father who will repeat history. (Translated by the authors from Sanabria (1998, p. 49-50).)

Machismo is to blame for irresponsible fatherhood, a phenomenon that has so far not received preferential attention by any state policy. The high number of children born out-of-wedlock is a complex phenomenon, no doubt.... The more women a man possesses, the greater their prestige as a male. There is nothing better than looking to the popular refrain to summarize this attitude: The

> Paraguayan must have one pair of pants and two women. (Translated by the authors from Vera (2010, p. 171-173).)

Finally, in support of the view that mores were different before the war, and this difference was additionally exacerbated by the war itself.

> Moral laxity could be expected during the postwar period when Allied troops occupied the country. However, one should understand that nothing like a Puritan morality ever had prevailed in Paraguay. The numbers of "natural" children were always high, and little if any stigma attached to such origins. The extraordinary surplus of women was in itself sufficient explanation for looseness in family ties. Perhaps a French writer was correct: "But the women saved Paraguay, since they bore nameless children, and that liberty of morals that they instinctively practiced in place of marriage... assured the continuance of the race. (Warren 1978, p. 153-154)

> Sexual relations in Paraguay have always been open: in 1545 a Spanish priest called the country "Muhammad's paradise" after witnessing his compatriots sleeping with numerous native women, behaviour he associated with Muslims. In the mid-1800s most Paraguayan households were led by señoras, often depicted chomping cigars, carrying food on their heads and sporting white cotton dresses. They paired off with a rotating cast of itinerant men. But even that tradition did not prepare society for the post-war free-for-all. "Men without modesty," wrote one newspaper, "may be found even in the corridors of the Church and the cemetery, atrociously scandalising even during the day to satiate their brutal passions." No one knows whether the intercourse in "plazas, streets and meeting places" was rape, prostitution or a result of the privileges men enjoyed because of the distorted sex ratio. (Economist 2012)

B.3 Foreign immigration to Paraguay

After the war, the Paraguayan government attempted to make up for the lack of males by encouraging international immigration. This endeavor was not very successful.

> The only way to reduce the underpopulation [after the war] in a relatively short time, while simultaneously accelerating economic growth, was through immigration... The plans to encourage immigration therefore immediately became an integral part of the economic recovery policy... Because writers, politicians and

expert observers were convinced that agriculture should not only be expanded, but modernised and intensified, and that industry and trade would also greatly benefit from the arrival of wealthy, better educated and enterprising people, the main objective was not to encourage the immigration of Latin Americans. The Oficina had a definite preference for Europeans and, particularly, for Western Europeans... Despite all this, however, Paraguay has never become an important immigration country. Moreover, by no means all the colonies in which foreigners settled were successful. The results in the 1870s were frankly disappointing. (Kleinpenning 2009, p. 143-145)

One of the main reasons why Paraguay has never become an important country for immigration despite the incentives offered, has been the direct competition from Argentina, Uruguay and southern Brazil. Once they arrived in those countries, it was much more attractive to most migrants to settle there than to undertake a further difficult journey to the interior of South America in order to settle in an isolated inland state, especially during the years when the government lacked the funds to carry out its policy of providing transport for immigrants from the River Plate. Many emigrants who had Paraguay in mind as their ultimate destination therefore remained in the La Plata region. Argentina and Uruguay also granted immigrants various facilities and wages were higher there. There are even repeated instances after 1870 of representatives of official bodies and private colonisers trying to persuade newly arrived immigrants in Buenos Aires to settle in Argentina (e.g. in the colonies in Entre Ríos) by painting an unfavourable picture of the prospects for making a living in Paraguay. In other words, Argentina, Brazil and Uruguay drained off the current of immigration from Europe before it could reach the interior republic... The attempts to 'poach' immigrants from Paraguay were made easier because Paraguay was an unknown, poor and little developed country with few attractions... Paraguay was, however, not only an inland state, but also had poor internal communications because of the lack of investment in roads, railways etc. These were not the only drawbacks. Clearing the forest lands was an arduous task; the warm and often humid climate of Paraguay was much less attractive to Europeans than that of Argentina and Uruguay... To put it another way, in Argentina, the colonist found better facilities for the transport of his crops and a surer market for them. He found a sounder monetary system and the assurance of more stable political conditions. His children had access to better schools than existed in the rural districts of Paraguay, and the people among whom he had to live spoke a European language instead of the

> Guaraní of the Paraguayan masses. In fact, he found generally more advanced conditions of life than he would encounter in Paraguay. (Kleinpenning 2009, p. 171-173)
>
> Despite the generally felt need and despite all the concrete and, sometimes, even very generous measures, the final results were nevertheless meagre... The tens of thousands of industrious European colonists who would transform the Paraguayan countryside in a short rime unfortunately stayed away. (Kleinpenning 2009, p. 363)
>
> Paraguay desperately needed people after the war, people to resettle her abandoned lands, to revitalize the processing of raw materials, to provide for the nation's internal needs, and to produce surpluses for the Uruguayan and Argentine markets. A prime need was for healthy young men and women, principally agriculturalists, to exploit the fertile lands, huge forests, and extensive yerbales. The attempt to promote immigration was an integral part of plans to increase agricultural production, which might provide needed exports to trade for tools, machinery, drugs, cloth, and innumerable products that Paraguay could not produce... A few hundred immigrants made their way to Paraguay in the postwar decade, but many of them gave up the struggle against overwhelming difficulties. (Warren 1978, p. 143)

And, on the difficulties immigrants have in assimilating due to the Guaraní language.

> Guaraní, modified by four and a half centuries of intimate contact with Spanish, was almost universally spoken by Paraguayans. A very difficult language for a foreigner to learn, this expressive Indian tongue surely exerted a tremendous influence on thought patterns while serving as a barrier against foreign penetration into Paraguayan society, especially in rural areas where many people spoke only Guaraní. This language was considered to have been the agent for diffusion of the common culture, "the depository of the old and new traditions and great sorrows of the country... When Paraguayans are abroad, they feel a common brotherhood only when speaking in Guaraní." (Warren 1985, p. 273)

C Comparison between church records and census data

This Appendix compares the data extracted from Ancestry.com (hereafter referred to as the church records) and the historical Paraguayan census data. The church records provide

information on baptisms over many years both before and after the war, but cover few municipalities. On the other hand, the census data represent all municipalities but are available only for one post-war year. We investigate the correlation between those two data sources for two variables: the total number of births, and the share of out-of-wedlock births.

C.1 Total births

We use the church records on baptisms in Paraguay from 1840 to 1900. All church records contain the date of baptism, and 62.6% of them also contain the date of birth. We focus on the year of baptism to avoid missing observations. The time between birth and baptism is fairly short, with an average difference of 1.1 years (standard deviation of 2.5 years). The census provides birth information for 1886 and baptism information for 1887.

Two incompatibilities are worth noting before comparing the church records with the census data. First, the number of people born and the number of people baptized in a given year are not necessarily the same. Second, the location of a person's birth and the location of a person's baptism are not necessarily the same. Individuals who live in a smaller municipality without a priest may get baptized at a church in a nearby municipality. To mitigate this second issue, our comparison focuses on the aggregate country level.

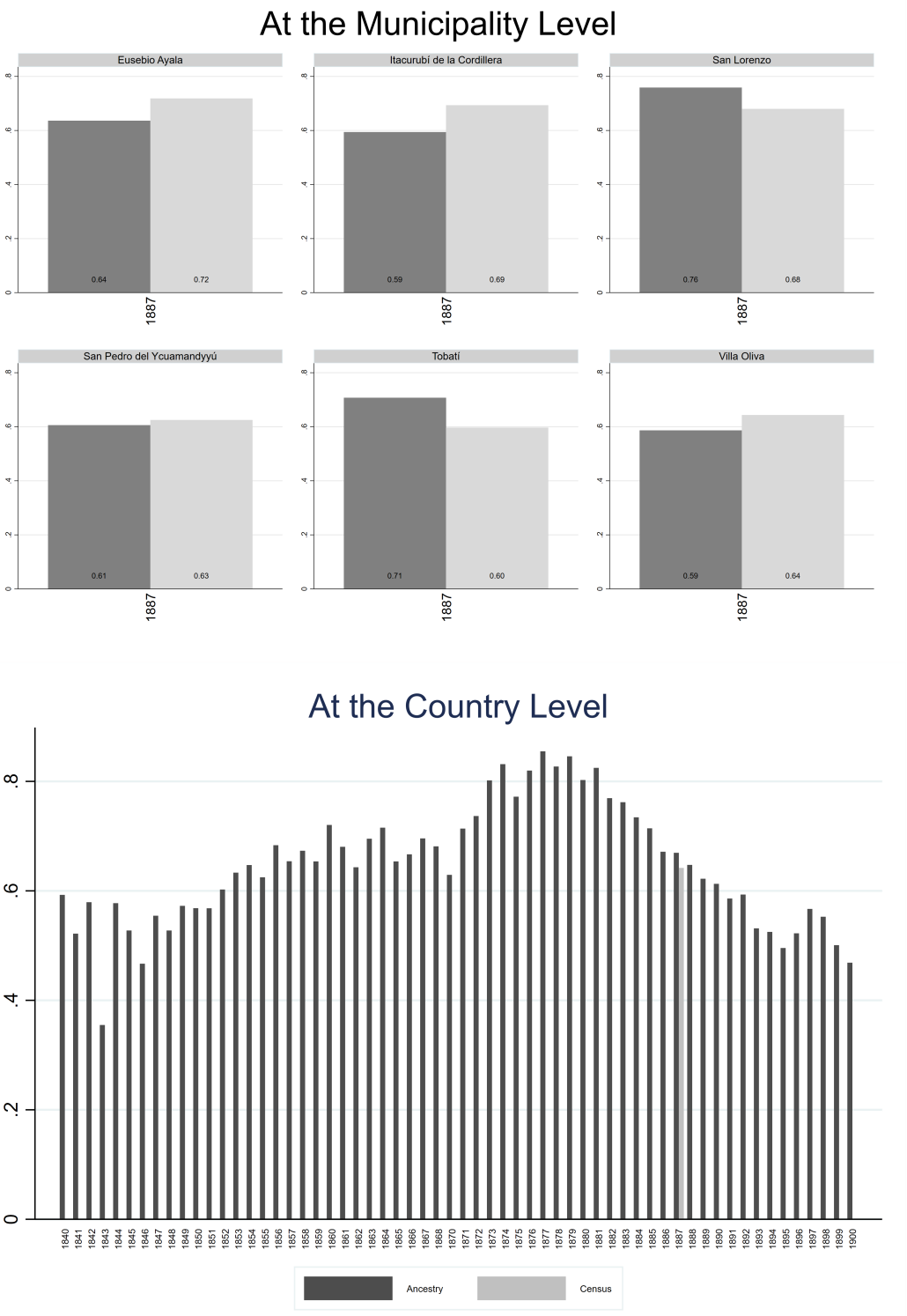
We only have data from both the online database and the Paraguayan Census for 1886. The census data covers the whole country (116 municipalities) while we only have baptismal records from 14 municipalities. However, with these 14 municipalities are likely the most populous ones, as the number of baptisms recorded in our dataset is nearly 50% of the total recorded in the entire country.

C.2 Out-of-wedlock baptisms

Based on Paraguay's 1887 census, we know that several municipalities shared a common church in 1887. Thus, to compare the more disaggregated census data with the more aggregated church data, we merge census records from the municipalities of Itacurubí de la Cordillera and Valenzuela to approximate baptisms in the former, and from Villa Oliva, Villeta, and Villa Franca to approximate baptisms in Villa Oliva.

The comparisons are shown in Figure C.1. For 1887, the year in which we have data from both church records and the census, the share of out-of-wedlock baptisms at the municipality level is similar between the two data sources. The correlation between the two is 0.69. At the country level, the shares are quite similar across the two sources. This suggests that, while we may be missing church records from many churches, conditional on having the records we are not differentially missing different types of births.

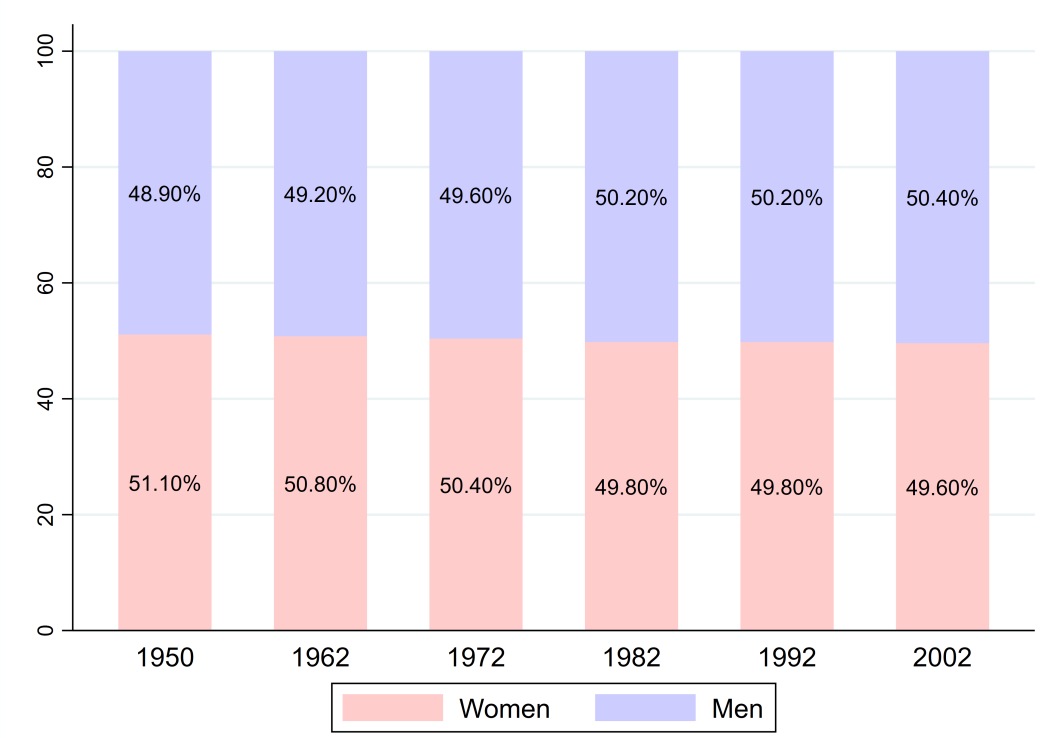
Figure C.1: Share of out-of-wedlock baptisms in Paraguayan church records and births in Paraguayan census data



Data from baptismal church records and Paraguayan census. Sample excludes years with fewer than ten baptisms nationally.

D Additional figures and tables

Figure D.1: Gender Ratios in Modern Paraguay: 1950-2002



Data from Paraguayan national censuses, decadal starting in 1950.

Table D.1: Summary statistics: Short- and medium-term variables

	Mean (1)	SD (2)	N (3)
Municipality level - Outcomes :			
Sex ratio of the cohort born before the war (1886)	3.849	1.229	65
Sex ratio of the cohort born after the war (1886)	1.043	0.100	65
Student ratios: female/male (1887)	0.406	0.335	66
Teacher ratios: female/male (1887)	0.490	0.521	65
Municipality level - Covariates :			
Distance to march line (10 km)	2.381	2.453	62
Near march line (< 30 km)	0.710	0.458	62
Distance to battle point (10 km)	3.514	2.760	62
Near battle point (< 30 km)	0.581	0.497	62
Log (municipality area)	6.330	1.345	62
Log (distance to Asunción)	2.484	0.676	62
Have 1846 population information	0.788	0.412	66
Log (1846 population)	6.366	3.386	66
Have 1864 population information	0.924	0.267	66
Log (1864 population)	5.918	1.797	66
Individual level - Outcomes :			
Out-of-wedlock birth in Paraguay	0.715	0.451	26,195
Out-of-wedlock birth in Argentinean municipalities	0.605	0.489	97,844

Data from Paraguay's 1886 and 1887 census, and baptismal church records in Paraguay and in Argentinean municipalities within 100km of Paraguay.

Table D.2: Summary statistics: Long-term variables

	Paraguay			Broad Sample			Restricted Sample		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcomes :									
Female headed household	0.196	0.397	218,397	0.160	0.366	194,834	0.159	0.366	106,509
Unmarried living with child	0.056	0.231	448,335	0.077	0.266	362,180	0.065	0.247	201,815
Literacy	0.823	0.382	192,731	0.875	0.331	479,807	0.876	0.329	269,782
Primary education	0.490	0.500	581,584	0.472	0.499	479,807	0.441	0.497	269,782
Employed	0.588	0.492	581,584	0.598	0.490	479,807	0.604	0.489	269,782
Covariates :									
Age	35.18	12.75	581,584	35.84	12.83	479,807	36.05	12.93	269,782
Rural	0.545	0.498	581,584	0.377	0.485	473,086	0.365	0.482	266,784
Population density	502.8	988.7	581,584	65.05	113.2	479,807	94.05	141.5	269,782
Log (distance to Asunción)	4.465	1.222	581,584	6.149	0.462	479,807	5.980	0.162	269,782
Log (municipality area)	6.496	1.786	581,584	8.091	1.403	479,807	7.628	0.892	269,782
Average maize productivity	3.679	0.538	581,584	3.667	0.792	479,807	3.880	0.788	269,782
Female	0.494	0.500	581,584	0.495	0.500	479,807	0.504	0.500	269,782
Near march line ($<$ 30 km)	0.648	0.478	581,584						
Municipality mostly speak more than Guaraní	0.472	0.499	581,584						

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco) and neighboring municipalities in Argentina and Brazil. The broad sample refers to municipalities in Argentina and Brazil within 100 km of the Paraguay border excluding the Argentinean Chaco. The restricted sample refers to the broad sample excluding municipalities in departments which were contested before the war and officially became part of Argentina and Brazil after the war.

Table D.3: Cross-border: Long-term effects on modern outcomes, by census year

Census year	Pooled	1972	1982	1992	2002
A: Female headed household					
Paraguay	0.039***	-0.006	0.017*	0.046***	0.048***
	(0.008)	(0.017)	(0.010)	(0.010)	(0.011)
Observations	323796	30638	68929	98934	126405
Mean of outcome variable	0.178	0.194	0.120	0.166	0.217
B: Unmarried living with child					
Paraguay	-0.024***	-0.011**	-0.009***	-0.003	-0.036**
	(0.008)	(0.005)	(0.003)	(0.002)	(0.015)
Female	0.074***	0.071***	0.039***	0.075***	0.100***
	(0.004)	(0.008)	(0.004)	(0.004)	(0.005)
Paraguay × Female	0.027***	0.047***	0.051***	0.014**	0.009
	(0.006)	(0.010)	(0.006)	(0.006)	(0.005)
Observations	648025	61898	143187	195290	249775
Mean of outcome variable	0.057	0.065	0.037	0.048	0.074
C: Literacy					
Paraguay	0.031**	-0.057**	0.015		
	(0.012)	(0.028)	(0.011)		
Female	-0.036***	-0.037***	-0.066***		
	(0.006)	(0.014)	(0.008)		
Paraguay × Female	-0.048***	-0.071***	0.001		
	(0.007)	(0.014)	(0.009)		
Observations	459515	81970	185696		
Mean of outcome variable	0.858	0.786	0.835		
D: Primary education					
Paraguay	0.060**	-0.258***	0.044	0.064**	0.051**
	(0.029)	(0.058)	(0.037)	(0.030)	(0.023)
Female	-0.020***	-0.016**	-0.024***	-0.026***	-0.012**
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)
Paraguay × Female	-0.029***	-0.017**	-0.027***	-0.031***	-0.033***
	(0.005)	(0.008)	(0.006)	(0.006)	(0.006)
Observations	848368	81970	185696	252964	330736
Mean of outcome variable	0.462	0.236	0.303	0.467	0.612
E: Employed					
Paraguay	0.044*	0.079**	0.027	0.038*	0.057*
	(0.025)	(0.039)	(0.019)	(0.022)	(0.029)
Female	-0.474***	-0.545***	-0.674***	-0.495***	-0.304***
	(0.023)	(0.054)	(0.024)	(0.024)	(0.015)
Paraguay × Female	-0.150***	-0.208***	-0.061**	-0.201***	-0.163***
	(0.032)	(0.056)	(0.030)	(0.034)	(0.027)
Observations	848368	81970	185696	252964	330736
Mean of outcome variable	0.599	0.564	0.568	0.609	0.618

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco) and neighboring municipalities in Argentina and Brazil. The neighboring municipalities are defined as municipalities in Argentina and Brazil within 100 km of the Paraguay border, but exclude the Argentinean Chaco and municipalities in departments which were contested before the war and officially became part of Argentina and Brazil after the war. Panel (A) is limited to household heads aged 18-65; Panel (B) is limited to individuals 18-45 years old; and Panels (C)-(E) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. Fixed effects at the year level for the pooled regression. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (98 clusters). Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.4: Within Paraguay: Long-term effects on modern outcomes using different distance measures

	Demography		Education		Employment
	Female Head	Unmarried w/ Child	Literacy	Primary Edu	Employed
	(1)	(2)	(3)	(4)	(5)
Panel A					
Near Battle Point (< 30 km)	0.019*	-0.001	-0.007	0.014	-0.051***
	(0.010)	(0.002)	(0.009)	(0.010)	(0.017)
	[0.009]	[0.002]	[0.009]	[0.009]	[0.028]
Female		0.093***	-0.086***	-0.050***	-0.673***
		(0.005)	(0.004)	(0.004)	(0.025)
		[0.005]	[0.004]	[0.004]	[0.026]
Near Battle Point × Female		0.017***	0.003	0.004	0.104***
		(0.006)	(0.006)	(0.004)	(0.037)
		[0.006]	[0.007]	[0.004]	[0.059]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588
Near + Near × Female		0.016***	-0.004	0.018	0.053**
		(0.005)	(0.011)	(0.011)	(0.020)
Panel B					
Distance to March Line (10 km)	-0.004***	0.000	-0.002*	-0.003**	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
	[0.001]	[0.000]	[0.001]	[0.001]	[0.004]
Female		0.109***	-0.083***	-0.044***	-0.612***
		(0.003)	(0.004)	(0.002)	(0.032)
		[0.005]	[0.006]	[0.002]	[0.069]
Dist. to March Line × Female		-0.002***	-0.001	-0.001***	-0.004
		(0.000)	(0.001)	(0.000)	(0.007)
		[0.000]	[0.001]	[0.000]	[0.009]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588
Distance + Distance × Female		-0.002***	-0.002**	-0.004***	-0.002
		(0.000)	(0.001)	(0.001)	(0.004)
Panel C					
Distance to Battle Point (10 km)	-0.003**	0.000	0.001	0.001	0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
	[0.001]	[0.000]	[0.001]	[0.001]	[0.005]
Female		0.112***	-0.086***	-0.043***	-0.615***
		(0.003)	(0.005)	(0.002)	(0.039)
		[0.005]	[0.008]	[0.002]	[0.084]
Dist. to Battle Point × Female		-0.002***	0.000	-0.001***	-0.002
		(0.000)	(0.001)	(0.000)	(0.006)
		[0.000]	[0.001]	[0.000]	[0.009]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588
Distance + Distance × Female		-0.002***	0.001	-0.000	0.000
		(0.000)	(0.001)	(0.001)	(0.003)

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco). Column (1) is limited to household heads aged 18-65; Column (2) is limited to individuals 18-45 years old; and Columns (3)-(5) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. Fixed effects at the year level. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (58 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.5: Within Paraguay: Long-term effects on modern outcomes, by census year

Census year	Pooled	1972	1982	1992	2002
A: Female headed household					
Near March Line (< 30 km)	0.028***	0.031***	0.032***	0.032**	0.023*
	(0.010)	(0.011)	(0.009)	(0.013)	(0.013)
Observations	218397	29528	41170	64611	83088
Mean of outcome variable	0.195	0.194	0.145	0.181	0.231
B: Unmarried living with child					
Near March Line (< 30 km)	-0.003*	-0.002	-0.002	-0.003*	-0.001
	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)
Female	0.086***	0.102***	0.077***	0.073***	0.097***
	(0.005)	(0.009)	(0.010)	(0.005)	(0.002)
Near March Line × Female	0.023***	0.023**	0.021*	0.027***	0.018***
	(0.005)	(0.010)	(0.010)	(0.005)	(0.003)
Observations	448335	59773	88272	128929	171361
Mean of outcome variable	0.056	0.069	0.050	0.050	0.060
C: Literacy					
Near March Line (< 30 km)	0.005	-0.010	0.013		
	(0.010)	(0.013)	(0.009)		
Female	-0.087***	-0.112***	-0.072***		
	(0.004)	(0.005)	(0.004)		
Near March Line × Female	0.003	0.000	0.010**		
	(0.005)	(0.006)	(0.005)		
Observations	192731	78972	113759		
Mean of outcome variable	0.823	0.778	0.854		
D: Primary education					
Near March Line (< 30 km)	0.030***	0.006	0.031**	0.041**	0.033**
	(0.011)	(0.013)	(0.013)	(0.018)	(0.013)
Female	-0.055***	-0.038***	-0.044***	-0.060***	-0.061***
	(0.004)	(0.007)	(0.008)	(0.004)	(0.003)
Near March Line × Female	0.010**	-0.005	-0.008	0.007	0.025***
	(0.004)	(0.009)	(0.009)	(0.005)	(0.004)
Observations	581584	78972	113759	165636	223217
Mean of outcome variable	0.491	0.201	0.356	0.510	0.647
E: Employed					
Near March Line (< 30 km)	-0.043**	-0.033***	-0.047***	-0.049**	-0.040**
	(0.018)	(0.010)	(0.011)	(0.023)	(0.018)
Female	-0.693***	-0.820***	-0.793***	-0.768***	-0.547***
	(0.035)	(0.010)	(0.010)	(0.038)	(0.041)
Near March Line × Female	0.105**	0.092***	0.090***	0.114**	0.119***
	(0.042)	(0.023)	(0.023)	(0.046)	(0.045)
Observations	581584	78972	113759	165636	223217
Mean of outcome variable	0.588	0.562	0.559	0.586	0.614

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco). Panel (A) is limited to household heads aged 18-65; Panel (B) is limited to individuals 18-45 years old; and Panels (C)-(E) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. Fixed effects at the year level for the pooled regression. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (58 clusters). Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.6: Within Paraguay: Heterogeneous long-term effects with respect to historical immigration

	Demography		Education		Employment
	(1)	(2)	(3)	(4)	(5)
	Female Head	Unmarried w/ Child	Literacy	Primary Edu	Employed
Near March Line (< 30 km)	0.025***	-0.002	-0.006	0.027**	-0.081***
	(0.006)	(0.002)	(0.011)	(0.013)	(0.019)
	[0.005]	[0.002]	[0.012]	[0.012]	[0.032]
Female		0.092***	-0.092***	-0.053***	-0.749***
		(0.004)	(0.005)	(0.005)	(0.019)
		[0.004]	[0.005]	[0.005]	[0.019]
High Immigration (1886)	-0.009	0.002	-0.014	0.001	-0.040**
	(0.012)	(0.001)	(0.015)	(0.016)	(0.018)
	[0.012]	[0.002]	[0.015]	[0.017]	[0.018]
Female × High Immigration		-0.010	0.009	-0.003	0.096**
		(0.007)	(0.007)	(0.007)	(0.045)
		[0.005]	[0.007]	[0.007]	[0.045]
Near March Line × High Immigration	0.007	0.000	0.020	0.005	0.074**
	(0.014)	(0.002)	(0.015)	(0.019)	(0.028)
	[0.013]	[0.001]	[0.016]	[0.017]	[0.024]
Near March Line × Female		0.019***	0.008	0.008	0.188***
		(0.004)	(0.006)	(0.005)	(0.044)
		[0.004]	[0.007]	[0.006]	[0.068]
Near March Line × Female × High Immigration		0.004	-0.009	0.003	-0.161**
		(0.008)	(0.010)	(0.008)	(0.068)
		[0.007]	[0.010]	[0.008]	[0.063]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco). Column (1) is limited to household heads aged 18-65; Column (2) is limited to individuals 18-45 years old; and Columns (3)-(5) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. "High Immigration" indicates that the share of international immigrants in the municipality in 1886 is above the median. Fixed effects at the year level. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (58 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.7: Within Paraguay: Heterogeneous long-term effects with respect to Guaraní prevalence

	Demography		Education		Employment
	(1)	(2)	(3)	(4)	(5)
	Female Head	Unmarried w/ Child	Literacy	Primary Edu	Employed
Near March Line (< 30 km)	0.030***	-0.004**	0.006	0.025**	0.015
	(0.011)	(0.002)	(0.012)	(0.011)	(0.019)
	[0.011]	[0.002]	[0.012]	[0.011]	[0.020]
Female		0.086***	-0.088***	-0.057***	-0.685***
		(0.005)	(0.005)	(0.004)	(0.042)
		[0.006]	[0.004]	[0.004]	[0.042]
Municipality Mostly Speak More Than Guaraní	0.017	-0.003	0.002	-0.002	0.019
	(0.011)	(0.003)	(0.014)	(0.017)	(0.022)
	[0.013]	[0.003]	[0.014]	[0.017]	[0.024]
Female × Speak More Than Guaraní		0.001	0.003	0.008	-0.035
		(0.010)	(0.009)	(0.012)	(0.051)
		[0.011]	[0.009]	[0.013]	[0.055]
Near March Line × Speak More Than Guaraní	-0.012	0.002	-0.003	0.014	-0.102***
	(0.016)	(0.003)	(0.016)	(0.022)	(0.026)
	[0.017]	[0.003]	[0.016]	[0.021]	[0.030]
Near March Line × Female		0.027***	-0.004	0.013***	-0.030
		(0.007)	(0.006)	(0.004)	(0.048)
		[0.008]	[0.007]	[0.005]	[0.049]
Near March Line × Female × Guaraní		-0.008	0.013	-0.011	0.244***
		(0.012)	(0.011)	(0.012)	(0.061)
		[0.012]	[0.012]	[0.013]	[0.070]
Observations	218397	448335	192731	581584	581584
Mean of outcome variable	0.195	0.056	0.823	0.491	0.588

Data from IPUMS census in Paraguay (excluding Asunción and the Paraguayan Chaco). Column (1) is limited to household heads aged 18-65; Column (2) is limited to individuals 18-45 years old; and Columns (3)-(5) are limited to individuals 18-65 years old. Control variables include age, rural, population density (i.e., population/area), log(distance to Asunción), log(municipality area), and average maize productivity. "Municipality Mostly Speak More Than Guaraní" indicates that the share of the municipality speaking only Guaraní at home in 1962 is below the median. Fixed effects at the year level. Regressions use sampling weights. Clustered standard errors at the harmonized municipal level in parentheses (58 clusters) and Conley (1999) standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.