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Abstract

Skewed sex ratios often result from conflict, disease, and migration, yet their long term impact remains less understood. 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, high rates of out-of-wedlock births and a generally male chauvinist culture. We collate historical and modern data to test this conventional wisdom in the short and the long run. We examine both cross-border and within-country variation in child-rearing, education and labor force participation in Paraguay over a 150 year period. We find that more skewed post-war sex ratios are associated with higher out-of-wedlock births, more female-headed households, and better female educational outcomes, even after the first returned to normal. Cross-country comparisons suggest that Paraguayan women are less likely to be employed than those in neighboring districts in Argentina and Brazil, but that within Paraguay, they are more likely to be employed where the sex ratio shock was more severe. The impacts of the war persist into the present, and are seemingly unaffected by variation in economic openness, uncertainty, or traditional norms.

JEL Classification: D74, I25, J16, J21, N16

Keywords: conflict, Gender, Illegitimacy, Female Labor Force Participation, Education, History, Persistence, Paraguay, Latin America

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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 the refugee crisis. 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 current situations, as well as illuminate the causes behind existing variation in women’s status across different countries (Giuliano 2018).

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). 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, until now the data has not been available to apply a more systematic quantitative assessment of the war’s legacy. We examine the impacts of these conflict-driven skewed sex ratios over a 150-year period. We begin by documenting the extent of sex ratio skewness caused by the conflict. We then look at the immediate effects of these distorted sex ratios on out-of-wedlock births, education, and labor force participation. Next we explore the footprint of this dynamic today. Finally, we study factors that may have broken the persistence trend (as in Giuliano & Nunn (2017) and Voigtländer & Voth (2012)).

To answer these questions, we compile historical and modern data. 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). We apply two identification strategies. First, we compare outcomes of interest in Paraguay to outcomes in bordering regions of Argentina and Brazil. Second, we construct digitized maps of the conflict and calculate distance to conflicts 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.

We find that in the short run, the sex ratios among cohorts born before the war—and thus affected by the conflict—were high, i.e., around four women per man. As a consequence, post-war Paraguay had higher out-of-wedlock birth rates than comparison municipalities

in Argentina and Brazil. Moreover, within Paraguay, a greater proximity to conflicts was associated with more skewed sex ratios, higher school attendance for girls, and greater shares of out-of-wedlock births.

While sex ratios returned relatively quickly to around unity, outcomes in more war-affected areas continued to differ over a century later. Compared to bordering municipalities in Argentina and Brazil, Paraguay has more female-headed households, more unmarried women living with a child as well as higher literacy and primary education completion rates for women. Within Paraguay, closeness to historical Triple Alliance War locations is associated with more female-headed households, more unmarried women living with a child, and more women with primary education. These impacts are consistent with the lore in Paraguay and the qualitative literature.¹ The scarcity of potential husbands changed women’s marriage market outcomes and altered women’s educational outcomes.

We attempt to uncover heterogeneity behind this persistence by examining variation in impacts across proxies for openness (foreign immigration), uncertainty (low agricultural potential), and cultural traditions (a dominance of the Guaraní language). This last source of heterogeneity is of particular interest, since historians of the conflict 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, 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 any of these factors lead to more persistent outcomes.

The contributions of this paper 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. A notable exception is Boggiano (2019) who finds that the Triple Alliance War increased intimate partner violence today.² In turn, we examine the impact on female-headed households, out-of-wedlock births, female labor force participation, and female educational outcomes in the short, medium and long run.

Second, we contribute to the broader literature studying the impacts of sex ratio imbal-

¹This 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)

²Some important differences between our paper and Boggiano (2019) are: 1) She uses military camps as her measure of exposure to war while we use march lines and battle points, 2) she finds that the effect is not due to skewed sex ratios (relative male scarcity) but instead due to loss of male life more generally (absolute male scarcity), 3) her analysis focuses within Paraguay, while we conduct both within-Paraguay and cross-border analyses.

ances caused by conflicts.³ Ramos-Toro (2019) studies conflicts across the globe and finds that they lead to long-term gender inequality, and not to sustained increases in female labor force participation. Abramitzky et al. (2011) focus on WWI in France and find that the lack of men led to fewer marriages by women, especially those from lower social classes, more out-of-wedlock births, lower divorce rates, and smaller between-spouse age gaps. Using the same historical context, Knowles & Vandenbroucke (2019) find instead an increase in female marriage probabilities. Gay (2019) and Boehnke & Gay (2019) show that the warfare shocks resulted in both short- and long-term increases in female labor force participation through a mechanism of intergenerational 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, Brainerd (2017) estimates that in Russia, male shortages resulted in lower rates of marriage and fertility, and more out-of-wedlock births. And Fernández et al. (2004) shows long term increases in female labor force participation in Germany due to WWII. More recently, Rogall & Zarate (2020) show that the Rwandan genocide led to female empowerment.

There are a number of papers that look at extremely male-biased sex ratios. Aguilar-Gomez & Benshaul-Tolonen (2018) measure a ratio of 12 men for every woman during the Gold Rush in the United States, and in Australia Grosjean & Khattar (2019) estimate a ratio of three men for every woman. 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. Those effects persist through the present day. Male-bias resulting from the Gold Rush created short run increases in the likelihood of women marrying, and particularly in getting married to older men with higher-prestige occupations. These effects were apparent through the 1940s. Brodeur & Haddad (2018) find the Gold Rush also led to more LGBT communities in the modern era.⁴

Our work differs from these other papers in both the magnitude of the female-biased sex ratios and the fact that we can look at both short and medium term impacts as well as persistence over centuries. In Paraguay in the immediate aftermath of the war, the sex ratio (men per woman) was around 0.3. The literature cited above that focuses on post-WWI and post-WWII era studies relatively minor variations in sex ratios: 0.7 and 0.9 for WWI and WWII, respectively. Our results are consistent with the literature in terms of out-of-wedlock childbearing, but less consistent in terms of labor force participation. This may be

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

⁴The loss of men due to the war in Paraguay were 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.

the result of Paraguay's lower degree of economic development. Fewer studies look at effects on educational outcomes, both historically and in modern times.

2 The Triple Alliance War and its aftermath

The Paraguayan War, which pitted Paraguay against Brazil, Argentina, and Uruguay, lasted from 1864 to 1870 and was the bloodiest interstate war until WWI (Bethell 1996). Estimates of the death toll in Paraguay vary from 8.7% (Reber 1988)⁵ to 87% (Washburn 1871), with a consensus figure of nearly 70% (Whigham & Potthast 1999). We also contribute to this debate, documenting 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 *Colorado* 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 extended the conflict, which ended only with 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, the general consensus is that the war resulted in massive population loss and generated a substantial sex imbalance. A postwar census conducted by the victor 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) puts it at three to one. Even a three to one ratio is unprecedented. This imbalance, while severe, did not endure. The 1886 census measured a female to male ratio of 1.39 to one, and the 1899 census measured a ratio of 1.16 to one (Carrasco 1905).

While the war itself took place in Paraguay, Argentina, and Brazil, the effect of the con-

⁵The 8.7% loss of Paraguayan population is an estimate scathingly criticized by Whigham & Potthast (1990) and then reevaluated as entirely possible by Whigham & Potthast (1999).

flict on sex ratios in Argentina and Brazil was comparatively small. Even in the neighboring Corrientes Province in Argentina, where some large, early battles took place, the Argentine sex ratio was closer to one and a half women for every man relative to Paraguay's ratio of well over three. This is because Paraguay's population was lower than that of the allied countries and 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, which formed a much larger share of the population and came from all over the country (Bethell 1996).⁶ This combination of factors suggests that comparisons across these borders could help to isolate the effects of skewed sex ratios from than 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 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, especially the wealthy, 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 since they were the ones who would be educating the citizens of the future. She posits that the current high percentage of women in Paraguayan universities is "the conflict's only significant and lasting positive consequence for women."⁷

However, some historians also 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 is not due to the war, but 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 1800's Rodríguez de Francia implemented various policies weakening the institution of marriage and leading to high levels of informal partnerships (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.

⁶See Appendix B.1 for more details about the number of soldiers and deaths from each country.

⁷Ganson (1990) observes that there were no improvements in political equality for women due to the war.

3 Economic perspectives on sex ratios, marriage, and labor force participation

Could the temporarily skewed sex ratios have had long-term impacts on the status of women? One possible mechanism for this would be through the marriage market. 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 relatively skewed toward women, wealthy individuals will marry while low-wealth men will father children with multiple women without marrying them and without offering their children financial support thereafter. This last scenario seems particularly relevant for Paraguay.

Extrapolating to labor force participation, an obvious impact of the scarcity of men is that it opens up room in the labor market for women. In particular, Grossbard-Shechtman (1984) shows that a drop in the sex ratio decreases the shadow wage for home production, which increases the relative return to outside employment. Returns to education for women could also rise, leading to increases in both female education and labor force participation.

Existing economic models do not necessarily predict that the impacts of temporarily skewed sex ratios would persist after the sex ratio returns to its natural level. There are a variety of views on possible sources of persistence. A number of researchers have investigated the possibility that gender roles arise from geographic conditions (Alesina et al. 2013, 2018, Boserup 1970, Carranza 2014, Giuliano 2015, Goldin & Sokoloff 1984, Pryor 1985). 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. These empirical results are consistent with the theoretical predictions of Bisin & Verdier (2000), Bisin & Verdier (2001), Boyd & Richerson (1988), and Cavalli-Sforza & Feldman (1981).

Related work points out that in more uncertain or 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 facing less uncertainty (Giuliano & Nunn 2017). 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 uncertainty, openness, and strong traditions exacerbate or attenuate our results.

4 Data description

4.1 Measures of demographic variables

Church records on baptisms in the 1800s and early 1900s across South America have been digitized and are accessible on the Internet.⁸ The baptismal records contain information 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 on the Internet as of 2016. For the econometric analysis, we restrict our sample to the eastern side 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. 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. On the other hand, not every church’s records were indexed

⁸Records 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.

for every year.

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.

Finally, 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: 1970, 1980, 1991, 2000 (Minnesota Population Center 2018). These datasets provide us the modern outcome variables for studying the long-term impact of the war.

4.2 Measures of conflict

To examine spatial variation in the intensity of the conflict, we digitized information on the location of battles as well as the starting and ending points of marches described by Jaeggli & Bordon (2010). Because it is difficult to geo-locate battlefields, these locations were linked to modern municipalities, and placed at their centroid.

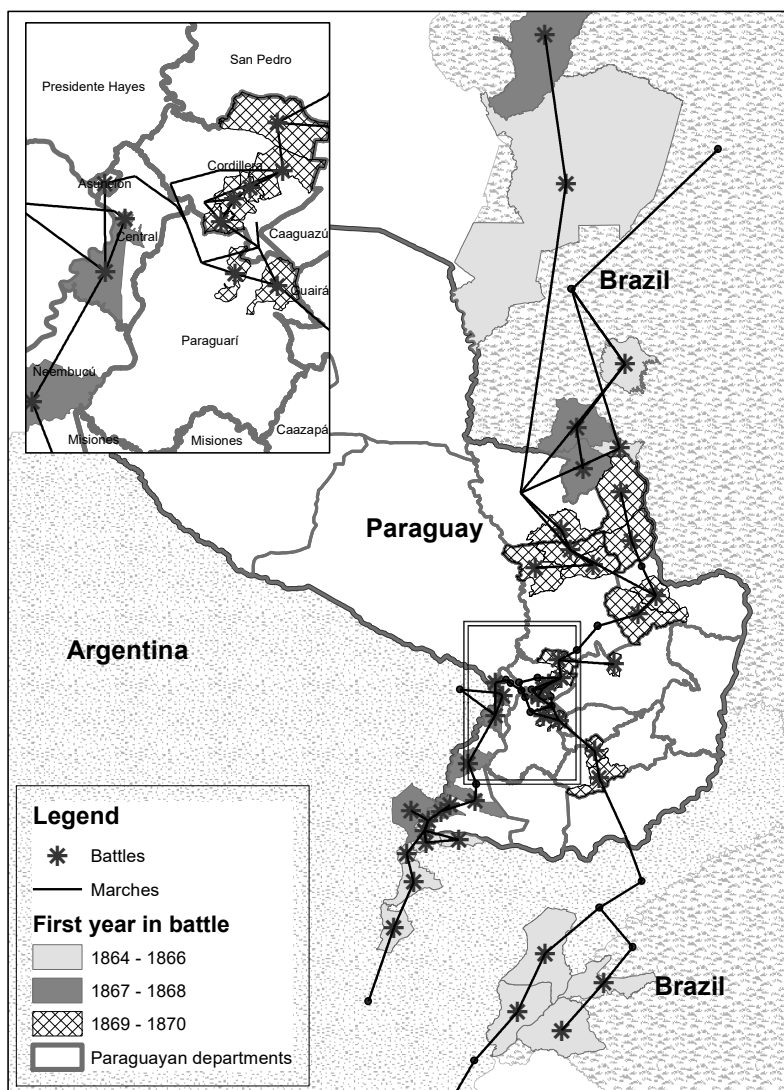
Figure 1 shows the spatial distribution of battles and marches using these data. Asterisks represent battles and lines represent marches. Many, but not all, of these marches ended or began with battles. Municipalities are shaded according to the first year that a municipality had a battle within it. 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.⁹ 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, 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

⁹Distance to US Civil War march lines have also been used to estimate the impact of that war (Feigenbaum et al. 2018).

Figure 1: Timeline and spatial extent of war



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. Locations are defined using three geographical levels, from a higher level to a lower level: country, department, and municipality.¹⁰

For all analyses, we drop Asunción (the capital of Paraguay) due to its special characteristics.¹¹ Furthermore, we remove the Paraguayan Chaco (this is three departments - Presidente Hayes, Alto Paraguay, and Boquerón - 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 region, constituted by the Provinces of Chaco, Formosa, and Santa Fe 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. These municipalities tend to share many cultural features with Paraguayan society, since they historically housed significant numbers of Guaraní, the dominant ethnicity in Paraguay. The selection includes municipalities from the departments of Corrientes and Misiones in Argentina, and Mato Grosso do Sul, Rio Grande do Sul, Paraná and Santa Catarina in Brazil.¹² While the war did pass through Corrientes, and it experienced some impacts from the war, as was described above, the sex ratio in this department was much less affected than neighboring areas in Paraguay. We call this the ‘broad sample.’

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

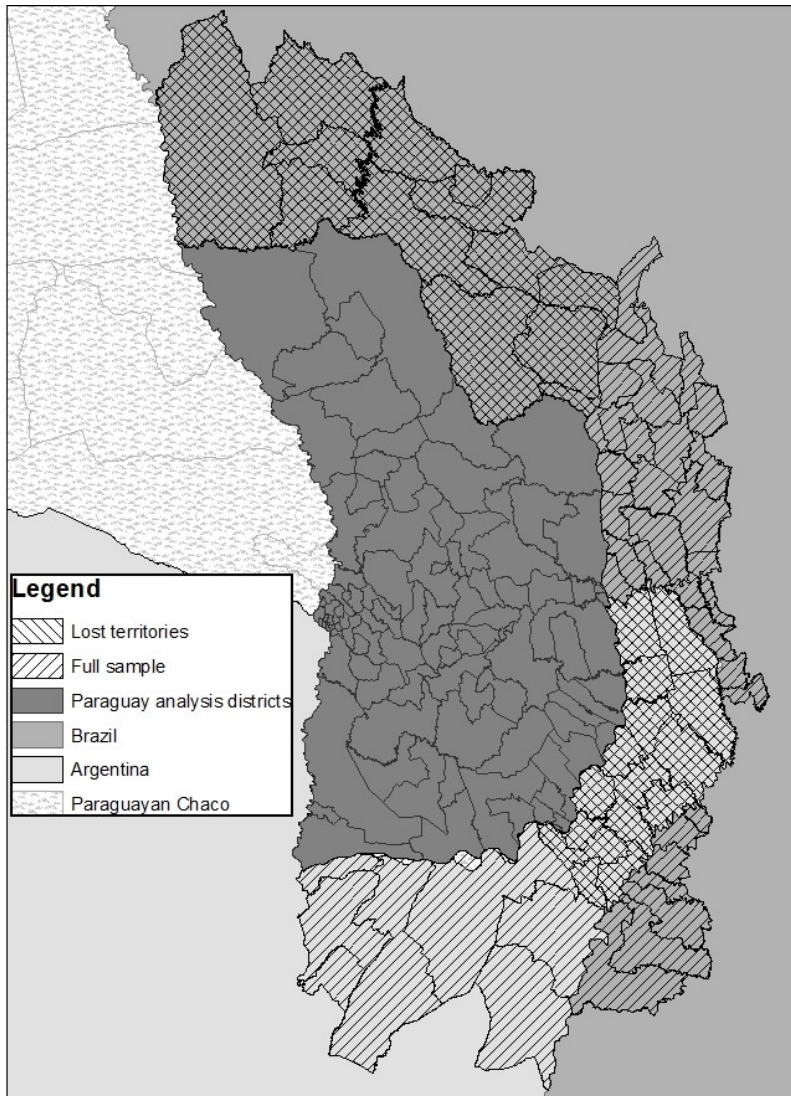
We use two main estimating equations for our cross-border analysis. For the short-run analysis, the outcome y is equal to one if the baptism is identified as out-of-wedlock for individual i , baptized in year t , in municipality m . Controls include a Paraguay dummy, P , and baptism year bin dummies 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–

¹⁰The precise name for what we call “department” is “department” in Paraguay, “province” in Argentina, and “state” in Brazil. The precise name for what we call “municipality” is “district” in Paraguay, “department” in Argentina, and “municipality” in Brazil.

¹¹The Argentinean and Brazilian capitals are too far from the border with Paraguay to be included in our sample.

¹²We only have information from municipalities in the department of Corrientes in Argentina for studying short-term impacts.

Figure 2: Municipalities in cross-border analysis



1861). Our preferred specification includes municipality fixed effects (δ_m).

$$y_{imt} = \alpha + \sum_t \gamma_t B_{it} + \sum_t \theta_t P_m B_{it} + \delta_m + \epsilon_{imt}, \quad (1)$$

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.¹³

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,

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

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. The coefficient on the interaction term represents the difference in differences, i.e., the difference between women and men in Paraguay minus the difference between women and men in neighboring Argentinean and Brazilian municipalities. 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, average maize productivity, latitude, and longitude.

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) both due to the potential endogeneity of sex ratios and the fact that not all modern municipalities can be matched to historical municipality sex ratios. In contrast, we can easily measure distances 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:

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

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

¹³We implement the spatial standard errors in Stata using `acreg` (Colella et al. 2019).

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 (Near) indicating distance less than 30 km (close to the median in the data), a linear distance, 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. Here we estimate a cross-sectional version of Equation (3), without municipal fixed effects or cohorts. 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 total households in 1864. Here identification relies on the assumption that conditional on distance to the capital and population density, 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

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

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. 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, average productivity,¹⁴ latitude, and longitude. As above, if the distance proxy for sex ratio bias is not correlated with other factors driving modern outcomes, this estimation establishes the effect of female-skewed sex ratios on these outcomes.

¹⁴The average maize productivity comes from the FAO GAEZ layer that shows 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.

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

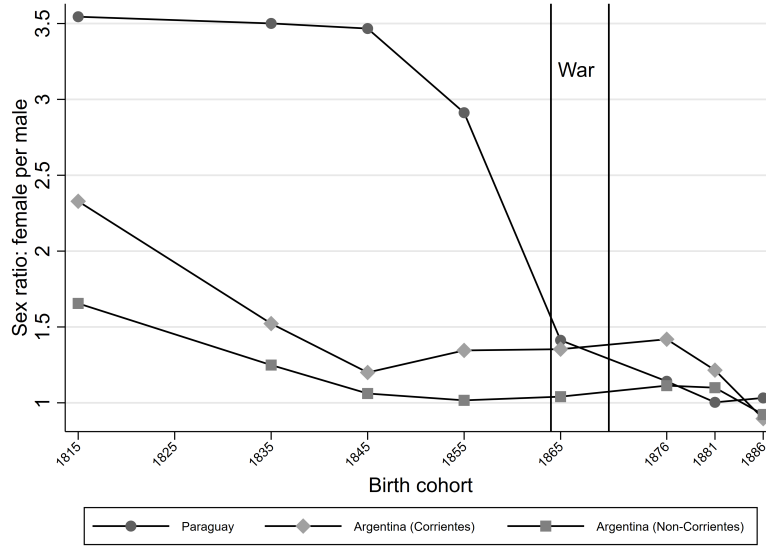
6.1.1 Cross-border comparisons

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 changes in 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. Cohorts from eras that should not be affected by the war, exhibit sex ratios at or near unity.

In Corrientes, Argentina, sex ratios for older cohorts are around 2.25, much lower than those in Paraguay. For the rest of Argentina they are even lower, at around 1.6. 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 older cohorts should skew female even without a war. 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, Argentina sex ratio is about 1.1. 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 by the time of the censuses.¹⁵

¹⁵Results from the 1873 Paraguayan census (not shown) confirm the general downward trend in Paraguayan sex ratios for cohorts born in the pre-war era.

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



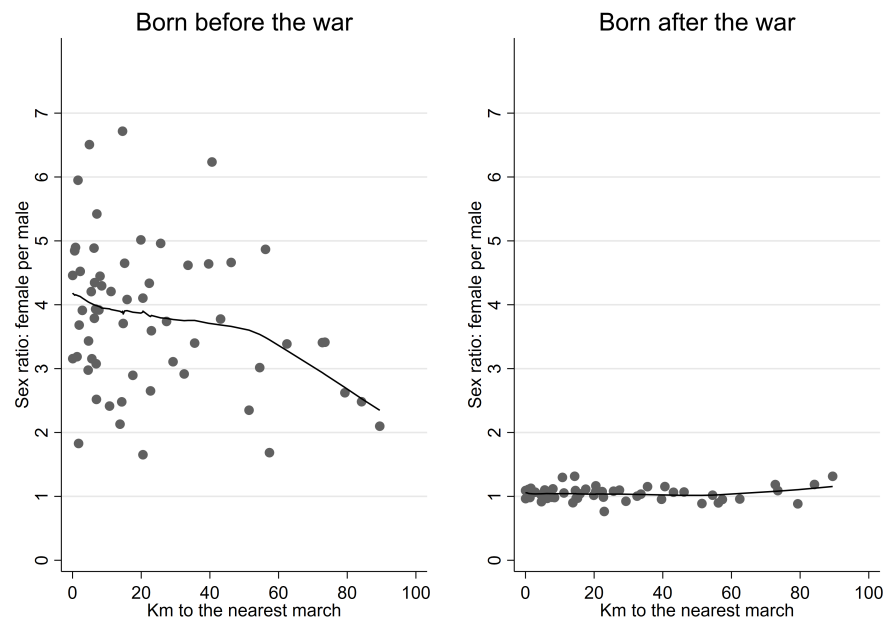
Data from Paraguay’s 1886 census and Argentina’s 1895 census. The year on the x -axis represents the end of the birth cohort. The birth cohorts are born before 1816, 1816-1835, 1836-1845, 1846-1855, 1856-1865, 1866-1876, 1877-1881, and 1882-1886.

6.1.2 Within-Paraguay comparisons

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

Table 1 shows simple regressions using the 1886 Paraguayan census data used to construct Figure 3. The regression has the form of Equation (3). The large positive coefficients on

Figure 4: Relationship between the distances to march lines and sex ratios, 1886



Data from Paraguay's 1886 census. The curve in this scatterplot is from a locally weighted regression of sex ratios on distances 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.

“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. 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. This is consistent with the positive interaction term on the binary measure of being near the war (less than 30 km) interacted with being born before the war. Standard errors are clustered at the municipality level and also estimated using Conley (1999) spatially correlated standard errors with a cutoff of 30 km, for robustness. The statistical significance does not differ substantially between the two.

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*** (0.196) [0.233]	2.923*** (0.250) [0.271]	2.457*** (0.284) [0.373]	3.348*** (0.216) [0.261]	2.917*** (0.305) [0.284]	2.352*** (0.233) [0.241]
Born before × Dist. to march line	-0.144*** (0.050) [0.053]	0.058 (0.186) [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*** (0.042) [0.043]	0.124 (0.158) [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. 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 and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

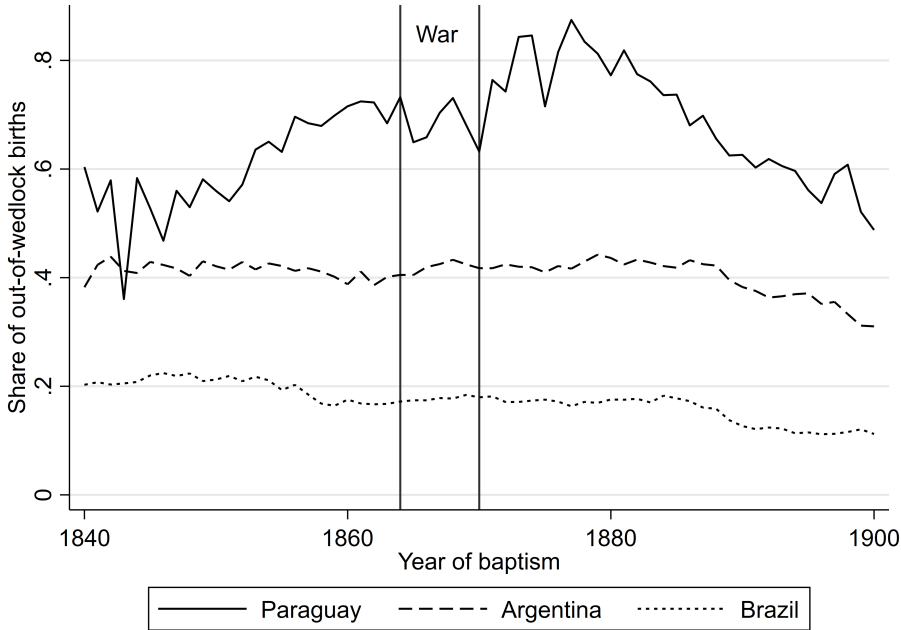
6.2 Out-of-wedlock births

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. Figure 5 shows the national share of out-of-wedlock births across the years of baptism 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. While there is a measurable jump in the share of out-of-wedlock births after the war, the figure gives the impression that the war exacerbated an existing trend rather than creating a new one.

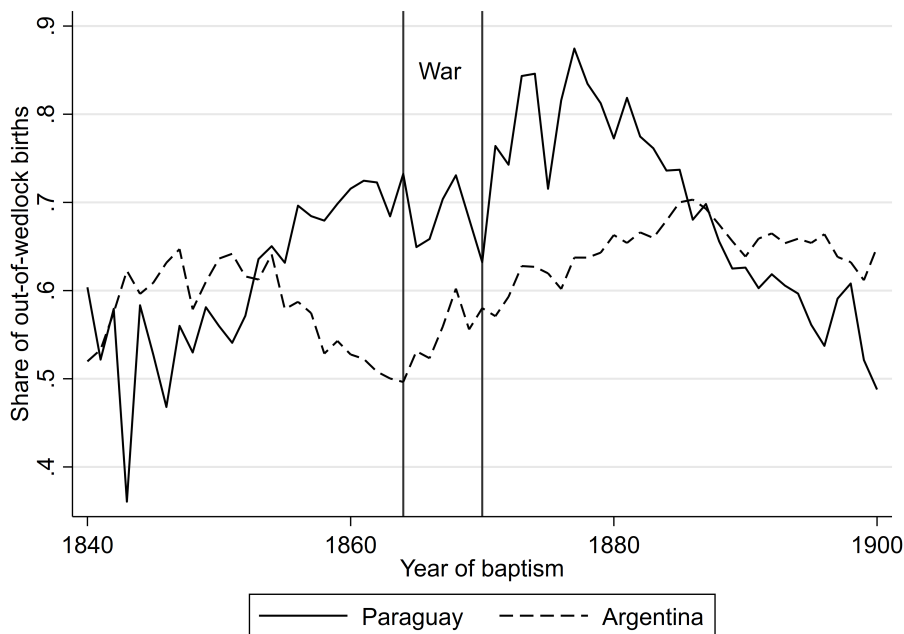
Figure 5: Out-of-wedlock birth rates across Paraguay, Argentina, and Brazil



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.

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, at which point Paraguay diverged, with the war apparently exacerbating a pre-existing trend.

Figure 6: Out-of-wedlock birth rates across Paraguay and nearby 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.

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 (0.020) [0.019]	-0.008 (0.022) [0.021]
Baptized in 1871-1880 (after the war)	0.039** (0.018) [0.017]	0.060*** (0.018) [0.017]
Baptized in 1881-1890 (after the war)	0.067*** (0.022) [0.022]	0.093*** (0.015) [0.014]
Baptized in 1891-1900 (after the war)	0.074*** (0.019) [0.019]	0.087*** (0.014) [0.013]
Baptized in 1864-1870 × Paraguay	0.080** (0.031) [0.027]	0.068** (0.027) [0.021]
Baptized in 1871-1880 × Paraguay	0.152*** (0.028) [0.029]	0.167*** (0.020) [0.017]
Baptized in 1881-1890 × Paraguay	0.010 (0.040) [0.039]	0.034 (0.024) [0.020]
Baptized in 1891-1900 × Paraguay	-0.208*** (0.041) [0.038]	-0.175*** (0.029) [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 1840-1864 (before the war). Clustered standard errors at the municipal level in parentheses and Conley 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. Before the war, out-of-wedlock baptisms were less common in areas closer to where the war was to later pass. The post-war increases in out-of-wedlock baptisms are greater in areas closer to the war path. This points to an interesting dynamic – the war appears to have served to make illegitimacy more uniformly acceptable by driving illegitimacy rates in the central areas of the country to levels more similar to those in peripheral areas which always had high rates of out-of-wedlock births.

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 (0.029) [0.010]	0.043 (0.031) [0.010]	0.027 (0.026) [0.010]	0.045 (0.026) [0.008]
Baptized 1871-1885 (after the war)	0.188*** (0.017) [0.022]	0.197*** (0.033) [0.028]	0.172*** (0.025) [0.028]	0.184*** (0.031) [0.027]
Baptized 1864-1870 \times near march line	0.072* (0.035) [0.021]	0.050 (0.033) [0.015]		
Baptized 1871-1885 \times near march line	0.023 (0.029) [0.031]	0.044 (0.045) [0.041]		
Near march line (< 30 km)	-0.096** (0.036) [0.041]			
Baptized 1864-1870 \times near battle point			0.072* (0.034) [0.023]	0.052* (0.029) [0.013]
Baptized 1871-1885 \times near battle point			0.051 (0.035) [0.036]	0.086** (0.031) [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 1840-1864 (before the war). Clustered standard errors at the municipal level in parentheses and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.3 Female education

6.3.1 Within-Paraguay comparisons

Next, we examine the impact on female educational outcomes. 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 in 1887. We do not have panel data on these outcomes, so these regressions are cross-sectional at the municipality level, and control for municipality-level characteristics.

Table 4 shows the results. The patterns are similar across both outcome variables. Higher distance to the nearest conflict or march line is weakly correlated with lower student and teacher sex ratios. In other words, in municipalities that were more affected by the war, there were a higher share of female students and a higher share of female teachers. 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 all born after the war, and given that the sex ratios of the younger generation were close to unity, this result should not be a mechanical consequence of the lack of men. Given the weak statistical significance, we take these results as suggestive, and also note two factors that may drive this weakness: the small number of observations and measurement error in our proxies for the skewness of the sex ratio.

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 (0.064) [0.052]				-0.182** (0.090) [0.070]			
Squared distance to march line	0.010 (0.008) [0.007]				0.015 (0.011) [0.008]			
Near march line (< 30 km)		0.030 (0.115) [0.097]				0.192 (0.204) [0.195]		
Distance to battle point			-0.114* (0.060) [0.063]				-0.207* (0.113) [0.104]	
Squared distance to battle point			0.010* (0.006) [0.006]				0.018* (0.010) [0.009]	
Near battle point (< 30 km)				0.053 (0.114) [0.093]				0.148 (0.221) [0.206]
Observations	62	62	62	62	61	61	61	61
R^2	0.115	0.066	0.124	0.068	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 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 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 some evidence of medium-term increases in female educational outcomes.

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 1.05 women for every man, with similar but slightly decreasing ratios through 2002. 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 five modern outcome variables: female-headed household, unmarried living with a child, being literate, having completed primary education, and being employed. The first one of these is a household-level variable while the others are individual-level variables. Literacy questions are not asked in all census years, 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 either alone or with an unmarried partner, 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.

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). We pool all four years of IPUMS 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 (excluding the Chaco). Panel B shows the results using the restricted sample which excludes departments which were contested before the war and officially became part of Argentina and Brazil after the war.¹⁶

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. Column (1) indicates that Paraguayan household heads are 9.7 percentage points more likely to be female in the broad sample, relative to a mean of 17 percent. Column (2) illustrates that Paraguayan men are not more likely to raise a child without a spouse than Argentinean and Brazilian men, but that Paraguayan women are significantly more likely to do so. In the broad sample, the coefficient on the interaction term is 2.2 percentage points – over a third of the mean of the outcome variable.

For the educational outcomes in Columns (3) and (4), Paraguayan men are more likely to have completed primary education than Argentinean and Brazilian men in neighboring municipalities. This effect is less strong for Paraguayan women (as seen by the negative coefficient on the interaction term). The net effect (as seen by the test of the sum of the coefficient on Paraguay and Paraguay times female) is that women in Paraguay are more likely to have completed primary school than women in neighboring municipalities in Argentina and Brazil. The magnitude of the primary education effect is particularly large – in the broad sample, the impact is 28 percentage points, over half of the mean level of primary schooling.

For labor force participation, however, the results differ for Paraguayan men and women. While Paraguayan men are similarly likely to participate in the labor force compared to their neighbors in Argentina and Brazil, 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. One explanation for this difference is the higher levels of unemployment in Paraguay in general, and the issue that women raising children without a partner may find it harder to get and retain employment¹⁷. This paper provides new evidence of the impact of conflict-skewed sex ratios in a developing country setting.

¹⁶This is discussed in more detail in Section 5.

¹⁷Indeed, regressions comparing unmarried individuals with children to those without show much larger negative impacts of being a woman in Paraguay than in the other countries.

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

	Demography		Education		Employment
	Female Head (1)	Unmarried w/ Child (2)	Literacy (3)	Primary Edu (4)	Employed (5)
<i>Panel A: Broad Sample</i>					
Paraguay	0.097* (0.058) [0.026]	0.055 (0.034) [0.014]	0.058 (0.071) [0.030]	0.307** (0.143) [0.067]	-0.072 (0.060) [0.040]
Female		0.078*** (0.004) [0.004]	-0.030*** (0.005) [0.005]	-0.018*** (0.006) [0.005]	-0.472*** (0.019) [0.019]
Paraguay × Female		0.022*** (0.007) [0.006]	-0.054*** (0.006) [0.006]	-0.030*** (0.007) [0.005]	-0.152*** (0.053) [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		0.077** (0.034)	0.004 (0.071)	0.277* (0.140)	-0.223*** (0.059)
<i>Panel B: Restricted Sample</i>					
Paraguay	0.024 (0.056) [0.025]	0.031 (0.025) [0.021]	0.043 (0.067) [0.034]	0.277** (0.104) [0.112]	-0.023 (0.052) [0.054]
Female		0.074*** (0.005) [0.004]	-0.036*** (0.006) [0.006]	-0.021*** (0.004) [0.004]	-0.473*** (0.024) [0.024]
Paraguay × Female		0.027*** (0.008) [0.007]	-0.047*** (0.007) [0.008]	-0.028*** (0.005) [0.005]	-0.151*** (0.055) [0.054]
Observations	323796	648025	459515	848368	848368
Mean of outcome variable	0.178	0.057	0.858	0.462	0.599
Paraguay + Paraguay × Female		0.058** (0.023)	-0.005 (0.067)	0.249** (0.104)	-0.173*** (0.059)

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), average maize productivity, latitude, and longitude. Fixed effects at the year level. Clustered standard errors at the harmonized municipal level in parentheses and Conley 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 devastation and 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. The effects measured in the previous section using the cross-border analysis did not suffer from this issue.

We use Equation (4) to estimate the long-run effects within Paraguay. We control 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.1.

The coefficient on the interaction term represents the difference between women and men living close to the conflict compared to the difference between women and men living farther away. Column (1) of Panel A in Table 6 shows that household heads residing in municipalities closer to a march line are 1.4 percentage points (or 7%) 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.

Regarding education, while women are less likely than men to have completed primary education, this disadvantage is smaller closer to the march lines. This mirrors the within-Paraguay variation in school enrollment immediately after the war. While women have lower labor force participation than men, this difference is attenuated closer to the march line.

An alternative explanation for the high levels of out-of-wedlock child rearing is that much of what historians and journalists have attributed to war impacts, were actually driven by particular characteristics of the Guaraní for whom single mothers and females working in agriculture were more common in the pre-colonial era (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.

The 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. They do have higher female literacy rates (as in Valencia Caicedo (2019)) and higher female labor force participation. Overall, we conclude that effects are due to the war and skewed sex ratios rather than due to Guaraní culture.¹⁸

¹⁸In the next section we explore heterogeneous impacts adding the triple interaction between Guaraní-speaking and distance and also find few consistent patterns.

Women within Paraguay living close to historical battles or march lines are more likely to be employed than those living farther away. This contrasts with the cross-border comparison, which shows Paraguayan women being less likely to be employed than those in neighboring municipalities of Argentina and Brazil. The results within Paraguay are consistent with the narrative that the conflict empowered women, while the cross border results suggest the opposite. One explanation for this is that the comparison across borders picks up differences between a place with an extremely skewed sex ratio (Paraguay) compared to those with sex ratios that are not skewed (Brazil and Argentina), while the within-Paraguay comparison recovers the effects of marginal changes in sex ratios across places which all have quite skewed sex ratios. As mentioned above, the cross-country result may also reflect Paraguay's relatively less developed labor market. 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 no truly unaffected regions.

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

	Demography		Education		Employment
	Female Head (1)	Unmarried w/ Child (2)	Literacy (3)	Primary Edu (4)	Employed (5)
<i>Panel A</i>					
Near march line (< 30 km)	0.014* (0.007) [0.010]	-0.006*** (0.002) [0.002]	-0.004 (0.010) [0.011]	0.019* (0.011) [0.012]	-0.038* (0.019) [0.032]
Female		0.086*** (0.005) [0.005]	-0.087*** (0.004) [0.004]	-0.055*** (0.004) [0.005]	-0.693*** (0.035) [0.035]
Near march line × Female		0.023*** (0.005) [0.006]	0.003 (0.005) [0.006]	0.010** (0.004) [0.005]	0.105** (0.042) [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		0.016*** (0.004)	-0.001 (0.011)	0.029** (0.012)	0.068*** (0.024)
<i>Panel B</i>					
Municipality mostly speak more than Guaraní	0.011 (0.007) [0.008]	-0.007* (0.003) [0.003]	-0.009 (0.009) [0.009]	0.000 (0.010) [0.012]	-0.057*** (0.017) [0.027]
Female		0.099*** (0.006) [0.008]	-0.090*** (0.004) [0.005]	-0.050*** (0.004) [0.004]	-0.699*** (0.026) [0.026]
Female × Speak more than Guaraní		0.004 (0.007) [0.007]	0.013* (0.006) [0.007]	0.004 (0.005) [0.005]	0.158*** (0.038) [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		-0.002 (0.005)	0.003 (0.011)	0.004 (0.010)	0.101*** (0.023)

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), average maize productivity, latitude, and longitude. “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 and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7.3 Within-Paraguay heterogeneity

The literature suggests that norms around gender might be less persistent in environments that are more economically open or more economically uncertain. This is because beliefs based on past experiences might have less predictive power in open and uncertain places. The literature also suggests that norms might be stronger among families that cling more tightly to tradition.

To test these ideas, we estimate the long-term within-Paraguay regressions adding sources of heterogeneity as measured by openness, uncertainty, and 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. For the household-level regressions in which the outcome is household head sex, we include the sources of heterogeneity in the municipality and the double interaction of these measures with distance to the march line.

To proxy for economic openness, we use levels of international immigration into Paraguay in 1886. 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-Jutkeit 1997). 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%.

We use estimated agricultural productivity for maize to proxy for economic uncertainty. The Global Agro-Ecological Zones (GAEZ) gives data on agro-climatically attainable yields suited for low-input, rain-fed technology. A municipality is considered economically uncertain if its estimated production value is below the median for maize. While a more appropriate measure of uncertainty might be the standard deviation of yields, this information is not available.

Finally, 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 subsection.

These results are shown in Appendix Tables D.2, D.3, and D.4. We do not observe any evidence that economic openness (proxied by high 19th century immigration), greater economic uncertainty (proxied by low agricultural productivity), or a more modern environment (proxied by a low share of Guaraní speakers) influences the impact of conflict. Although there

are some occasional statistically significant results in these tables, they are generally weak and not consistent across interaction terms. 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 these long term effects are truly not diminished by these commonly hypothesized sources of heterogeneity. In either case, we are left with no evidence that economic openness, uncertainty, or traditional norms have any moderating influence on the long run impacts of skewed sex ratios in Paraguay.

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. 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, have higher education outcomes, and are more likely to be employed. More affected areas also have more female household heads, showing that the reverberations of the conflict are still present today. The results regarding differential labor force participation within Paraguay are consistent with a story where skewed sex ratios drive women into the labor market. This persistence is not moderated by any of the factors commonly hypothesized to condition the transmission of cultural norms.

8 Conclusion

In this paper, we investigate the immediate and long run impacts of the extreme sex ratio shock induced by the War of the Triple Alliance. We analyze previously unexplored historical data and sources of variation. In particular, we examine outcomes comparing Paraguay to 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 than those previously analyzed in the literature. Paraguay, Brazil, and Argentina were all affected by conflict on their soil, but only Paraguay experienced 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 Brazil, and also in Paraguayan municipalities closer to the conflict compared to those further away. Furthermore, female to male student ratios were slightly higher in Paraguayan municipalities closer to the conflict.

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, both cross-border and within-Paraguay analyses suggest that the skewed sex ratios led to higher literacy rates and higher primary education completion rates. Although we do not have information on employment in the immediate aftermath of the war with which to compare, we find that Paraguayan women are less likely to be employed than those in neighboring countries, but that those more affected by the conflict within Paraguay are relatively more likely to be. 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 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 and the general migration trends of Latin America, 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 Paraguay, women had to take on more responsibility in the household, raising children on their own and heading households, perhaps hindering potential labor benefits. On the other hand, their educational outcomes improved. 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.

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A Historical timeline

This timeline is largely based on Williams (1979), but also informed by Whigham (2002), citetwp:larr, 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 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, assisting 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 López 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 – 1850s	Side note: 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 comes to the conclusion 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.

Continued table...

Year	Event
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.
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 Argentines 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 children¹⁹ 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).)

¹⁹Natural 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.

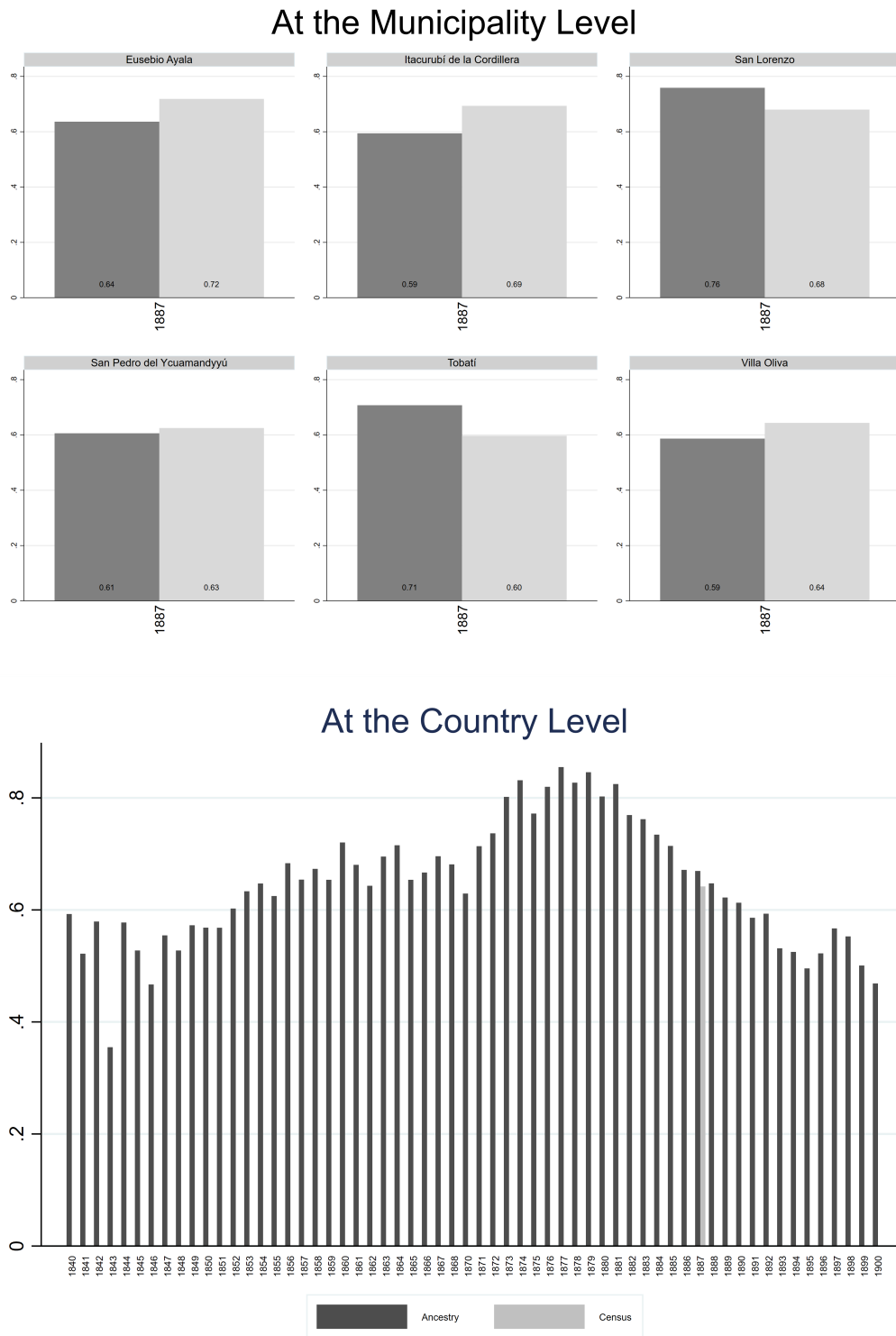
We only have data from both the online database and the Paraguayan Census for 1886. The census data covers the whole country (116 municipalities) while we only have baptismal records from 14 municipalities. However, with these 14 municipalities are likely the most populous ones, as the number of baptisms 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 using modern data

Table D.1: 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)
<i>Panel A</i>					
Near Battle Point (< 30 km)	0.005 (0.008) [0.009]	-0.005* (0.003) [0.002]	-0.017* (0.008) [0.010]	0.000 (0.009) [0.010]	-0.047** (0.018) [0.027]
Female		0.093*** (0.005) [0.005]	-0.086*** (0.004) [0.004]	-0.051*** (0.004) [0.004]	-0.673*** (0.025) [0.026]
Near Battle Point × Female		0.017*** (0.006) [0.006]	0.003 (0.006) [0.007]	0.005 (0.004) [0.004]	0.104*** (0.037) [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		0.012** (0.005)	-0.013 (0.011)	0.005 (0.009)	0.057*** (0.021)
<i>Panel B</i>					
Distance to March Line (10 km)	-0.002* (0.001) [0.001]	0.001*** (0.000) [0.000]	-0.001 (0.001) [0.001]	-0.002 (0.002) [0.001]	0.001 (0.003) [0.004]
Female		0.109*** (0.003) [0.005]	-0.083*** (0.004) [0.006]	-0.044*** (0.002) [0.002]	-0.612*** (0.032) [0.069]
Dist. to March Line × Female		-0.002*** (0.000) [0.000]	-0.001 (0.001) [0.001]	-0.001*** (0.000) [0.000]	-0.004 (0.007) [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*** (0.000)	-0.001 (0.001)	-0.003 (0.002)	-0.003 (0.004)
<i>Panel C</i>					
Distance to Battle Point (10 km)	-0.001 (0.001) [0.001]	0.001*** (0.000) [0.000]	0.002* (0.001) [0.001]	0.003* (0.001) [0.001]	0.002 (0.003) [0.005]
Female		0.112*** (0.003) [0.005]	-0.086*** (0.005) [0.008]	-0.043*** (0.002) [0.002]	-0.614*** (0.039) [0.084]
Dist. to Battle Point × Female		-0.002*** (0.000) [0.000]	0.000 (0.001) [0.001]	-0.001*** (0.000) [0.000]	-0.002 (0.006) [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*** (0.000)	0.003* (0.001)	0.002 (0.002)	-0.000 (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), average maize productivity, latitude, and longitude. Fixed effects at the year level. Clustered standard errors at the harmonized municipal level in parentheses and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Regressions use sampling weights.

Table D.2: Within Paraguay: Heterogeneous long-term effects on modern demographic outcomes

	Demography		Education		Employment
	(1) Female Head	(2) Unmarried w/ Child	(3) Literacy	(4) Primary Edu	(5) Employed
Near march line (< 30 km)	0.016** (0.007) [0.005]	-0.004** (0.002) [0.002]	-0.010 (0.011) [0.011]	0.021 (0.014) [0.012]	-0.079*** (0.019) [0.033]
Female		0.093*** (0.004) [0.004]	-0.092*** (0.005) [0.005]	-0.053*** (0.005) [0.005]	-0.749*** (0.019) [0.019]
High immigration (1886)	0.002 (0.010) [0.012]	0.004 (0.003) [0.001]	-0.018 (0.015) [0.015]	0.000 (0.018) [0.017]	-0.042** (0.020) [0.018]
Female × High immigration		-0.010 (0.007) [0.005]	0.008 (0.007) [0.007]	-0.004 (0.007) [0.007]	0.096** (0.045) [0.045]
Near march line × High immigration	-0.004 (0.011) [0.013]	-0.003 (0.003) [0.002]	0.012 (0.015) [0.016]	-0.002 (0.019) [0.018]	0.079*** (0.029) [0.026]
Near march line × Female		0.019*** (0.004) [0.004]	0.008 (0.006) [0.007]	0.008 (0.005) [0.006]	0.189*** (0.044) [0.068]
Near march line × Female × High immigration		0.004 (0.008) [0.007]	-0.009 (0.010) [0.010]	0.003 (0.008) [0.008]	-0.161** (0.068) [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), average maize productivity, latitude, and longitude. “High Immigration” indicates that the share of international immigrants in the municipality in 1886 is above the median. Fixed effects at the year level. Clustered standard errors at the harmonized municipal level in parentheses and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Regressions use sampling weights.

Table D.3: Within Paraguay: Heterogeneous long-term effects on modern demographic outcomes

	Demography		Education		Employment
	(1) Female Head	(2) Unmarried w/ Child	(3) Literacy	(4) Primary Edu	(5) Employed
Near march line (< 30 km)	0.005 (0.008) [0.007]	-0.005*** (0.002) [0.001]	-0.004 (0.009) [0.009]	0.015 (0.013) [0.014]	-0.015 (0.013) [0.014]
Female		0.093*** (0.005) [0.006]	-0.091*** (0.004) [0.004]	-0.052*** (0.005) [0.006]	-0.733*** (0.014) [0.016]
Low productivity	-0.042*** (0.014) [0.017]	-0.002 (0.005) [0.005]	-0.044* (0.022) [0.026]	-0.031 (0.024) [0.026]	-0.035* (0.018) [0.017]
Female × Low productivity		-0.016*** (0.005) [0.006]	0.013*** (0.005) [0.005]	-0.008 (0.007) [0.008]	0.103** (0.041) [0.042]
Near march line × Low productivity	0.018 (0.014) [0.018]	-0.006* (0.003) [0.003]	-0.011 (0.017) [0.022]	-0.003 (0.018) [0.024]	-0.006 (0.026) [0.036]
Near march line × Female		0.018*** (0.006) [0.006]	-0.000 (0.007) [0.007]	0.011** (0.005) [0.006]	0.061 (0.037) [0.037]
Near march line × Female × Low productivity		0.013** (0.007) [0.008]	0.000 (0.008) [0.009]	0.001 (0.007) [0.008]	0.023 (0.059) [0.078]
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), average maize productivity, latitude, and longitude. “Low Productivity” indicates that a municipality’s estimated production value for maize is below the median. Fixed effects at the year level. Clustered standard errors at the harmonized municipal level in parentheses and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Regressions use sampling weights.

Table D.4: Within Paraguay: Heterogeneous long-term effects on modern demographic outcomes

	Demography		Education		Employment
	(1) Female Head	(2) Unmarried w/ Child	(3) Literacy	(4) Primary Edu	(5) Employed
Near march line (< 30 km)	0.018** (0.009) [0.011]	-0.007** (0.003) [0.001]	-0.001 (0.011) [0.013]	0.017 (0.012) [0.012]	0.021 (0.021) [0.020]
Female		0.086*** (0.005) [0.006]	-0.088*** (0.004) [0.004]	-0.057*** (0.004) [0.004]	-0.685*** (0.042) [0.042]
Municipality mostly speak more than Guaraní	0.024** (0.011) [0.013]	-0.003 (0.004) [0.003]	-0.006 (0.014) [0.014]	-0.005 (0.017) [0.017]	0.021 (0.022) [0.023]
Female × Speak more than Guaraní		0.001 (0.010) [0.011]	0.003 (0.009) [0.009]	0.008 (0.012) [0.013]	-0.035 (0.052) [0.055]
Near march line × Speak more than Guaraní	-0.020 (0.015) [0.017]	0.000 (0.005) [0.003]	-0.004 (0.015) [0.016]	0.008 (0.021) [0.022]	-0.099*** (0.026) [0.031]
Near march line × Female		0.027*** (0.007) [0.008]	-0.004 (0.006) [0.007]	0.013*** (0.004) [0.005]	-0.030 (0.048) [0.049]
Near march line × Female × Guaraní		-0.008 (0.012) [0.012]	0.013 (0.011) [0.012]	-0.011 (0.012) [0.013]	0.244*** (0.061) [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), average maize productivity, latitude, and longitude. “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. Clustered standard errors at the harmonized municipal level in parentheses and Conley standard errors in brackets. Asterisks are based on clustered standard errors: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Regressions use sampling weights.