



UNIVERSIDAD DE SAN ANDRÉS

DEPARTAMENTO DE ECONOMÍA

MAESTRÍA EN ECONOMÍA

**Short and long term impact of the Paraguayan
War on female labour participation**

Author

Bárbara BOGGIANO

D.N.I. 34.454.797

Mentor

Facundo ALBORNOZ CRESPO

BUENOS AIRES, NOVEMBER 2019

**Impacto de la Guerra del Paraguay en la participación femenina en el mercado
laboural en el corto y largo plazo.**

Abstract

Este trabajo investiga los efectos de corto y largo plazo de la *Guerra del Paraguay (1864-1870)* en la participación femenina en el mercado laboral. Este conflicto costó las vidas de 60% de la población Paraguaya, afectando de manera desproporcionada a la población masculina activa en el este de Paraguay. Dicha pérdida de vidas, en particular de hombres activos, tuvo un efecto demográfico inmediato, un desbalance en la proporción entre los sexos, que definió a Paraguay como el '*país de las mujeres*'. Usando novedosos datos de archivo, los resultados de este trabajo muestran que las municipalidades más afectadas por la guerra exhiben niveles más altos de participación femenina en el mercado laboral en el corto y en el largo plazo. La estrategia de identificación reside en comparar municipalidades cercanas a los campos militares establecidos en 1864 con municipalidades más lejanas.

Palabras clave: coeficiente de género, efectos de largo plazo, participación femenina en el mercado laboral, campos militares.

Short and long term impact of the Paraguayan War on female labour participation

Abstract

This paper investigates the short and long-term effects of the *Paraguayan War (1864-1870)* on female labour participation. This conflict cost the lives of 60% of Paraguay's population, disproportionately affecting the active male population in the eastern part of modern Paraguay. The loss of males' life had an immediate demographic consequence, gender imbalance, which defined Paraguay as the '*country of women*'. Using unique archival data, the results indicate that municipalities that were more affected by the war exhibit higher levels of female labour participation in the short and long run. Identifying variation comes from comparing municipalities closer to the military camps established in 1864 to municipalities farther away.

Keywords: sex ratios, long term effects, female labour participation, military camps.

JEL Classification: J16, N36, O15, Z10.

1 Introduction

The economic, social and political role of women has been undergoing rapid change in recent decades and differs widely across the world. Paraguayan women faced more challenges in trying to attain social equality compared to their counterparts in other countries in the region.¹ The challenges include areas such as female labour market participation, fertility and reproductive control, literacy rates (both absolute and relative to males) and property rights.

In this paper, I show that a war has an impact on female labour participation and that this effect persists in the very long run. I link current variation in female labour participation to a large demographic shock that accompanied one of the most important events in Paraguayan history: the *Paraguayan War*.

To quantify the impact of the war, I employ a novel identification strategy. I define *Weighted Inverse Distance* (WID) as the inverse distance from a neighbourhood to all military camps established in 1864, weighted by their respective camp size, and I use it as the main explanatory variable. The intuition behind WID is that camps are likely to recruit soldiers from closer municipalities.² Therefore, a higher WID indicates a greater effect of the war on the municipality's population. I find that areas more affected by the war exhibit more female labour participation in 1886 in one of the few professions available to females, teaching. I also find female labour participation is higher in areas that were more affected by the war in the long run.

One possible concern about my results is the exogeneity of camps' placement and sizing. To address this concern, I calculate the optimal location and sizes of camps using data from the 1846 Census. I define optimal location as the place that maximizes the number of drafted males by minimizing distance of the population to such camp given that most males were drafted by foot. Similarly, I define the optimal size as the number of males assigned to each camp given

¹The countries in the region I refer to are Argentina, Chile, Brazil and Uruguay.

²I assume that the enforcement of the compulsory draft was weaker the further away from a camp the men were. I also assume that the bigger the size of the camp the more likely the soldier would have been drafted there. This is a refinement of the measure by Valencia Caicedo (2018) where size is not taken into account. This assumption is a consequence of the documented fact that most men that arrived to the camp were drafted by foot, since Paraguayan horses were '*not good*' (Thompson, 1869) and that there was only one train line running starting north Asunción to Cerro Leon and no train line running to any other camp before and during the war.

their proximity. I find that the optimal locations and sizes are not consistent with the ones that effectively took place, which validates the exogeneity of the location and sizing of military camps' assumption.

To assess the long-term impact of the Paraguayan War, I build a new dataset that combines data from the Paraguayan Census in 1870 (Whigham and Potthast, 1999), the Paraguayan Census in 1886, and archival information regarding female labour participation in 1886 with modern-day outcomes of female labour participation at the individual level from the Paraguayan National Survey of Demography and Sexual and Reproductive Health. Data are linked using geo-codes covering 507 neighbourhoods in Eastern Paraguay.

The Paraguayan war serves as a natural experiment to study an economic question. The objective of this paper is to explain the short and long term effects of a demographic shock on female labour participation. I analyse a different event in history that had as a consequence one of the biggest gender imbalances ever recorded (see Table 1). In the area most affected by the war historical evidence suggests the presence of 5 males per 100 females in fertile ages (Whigham and Potthast, 1999). Consistent with the effects of gender imbalances on marriage markets and intra-household bargaining power presented by Becker (1973), there is an established literature that well documents that in conditions of male scarcity, women are less likely to marry (Abramitzky et al., 2011), more likely to have children out of wedlock (Bethmann and Kvasnicka, 2013), and more likely to work (Goldin, 1991; Acemoglu et al., 2004; Goldin and Olivetti, 2013).

This paper also builds on the literature on historical persistence which aims to show how deep-rooted determinants of development have shown to influence modern outcomes through geography, demographics, legal systems, institutions, human capital investments and culture (Nunn, 2009, 2014). It particularly relates to previous work studying the aftermath of demographic shocks in female labour participation in the long run. Teso (2018) traces the long-term effects of the transatlantic slave trade on current variation in women's participation in the labour force within Sub-Saharan Africa. He argues that the demographic shock affected the

Table 1: Gender Imbalances in the Literature

	Male/Females Ratio	Mean	Std. Dev.	N
<i>Slave Trade (1730-1850)*</i>				
	Adult Population	0.80		
	Loango and Angola	0.50		
<i>Paraguay (1870)**</i>				
	All Population	0.540	0.187	34
	Fertile Population	0.338	0.190	33
<i>Post War Russia (1959)***</i>				
	Age 18–44 (Year of Birth 1915–1941)	0.796	0.168	2,025

* General estimates retrieved from Manning (1990),

** Data by municipality retrieved from Whigham and Potthast (1999),

*** Data by Single Year of Age by municipality retrieved from Brainerd (2017).

division of labour where women substituted for the missing men by taking up areas of work that were traditionally male tasks. He finds evidence that women whose ancestors were more exposed to this shock are today more likely to be in the labour force. This literature has focused on female labour participation in the short run or in the long run; in this paper, I am focusing on the short and long term effects of the Paraguayan War on female labour participation simultaneously.³

The rest of the paper is organized as follows. In Section 2, I discuss the historical background. In Sections 3, I describe the data. In Section 4, I describe the weighted inverse distance measure and present evidence of its exogeneity and relevance. In Section 5, I present the main analysis. Section 6 concludes.

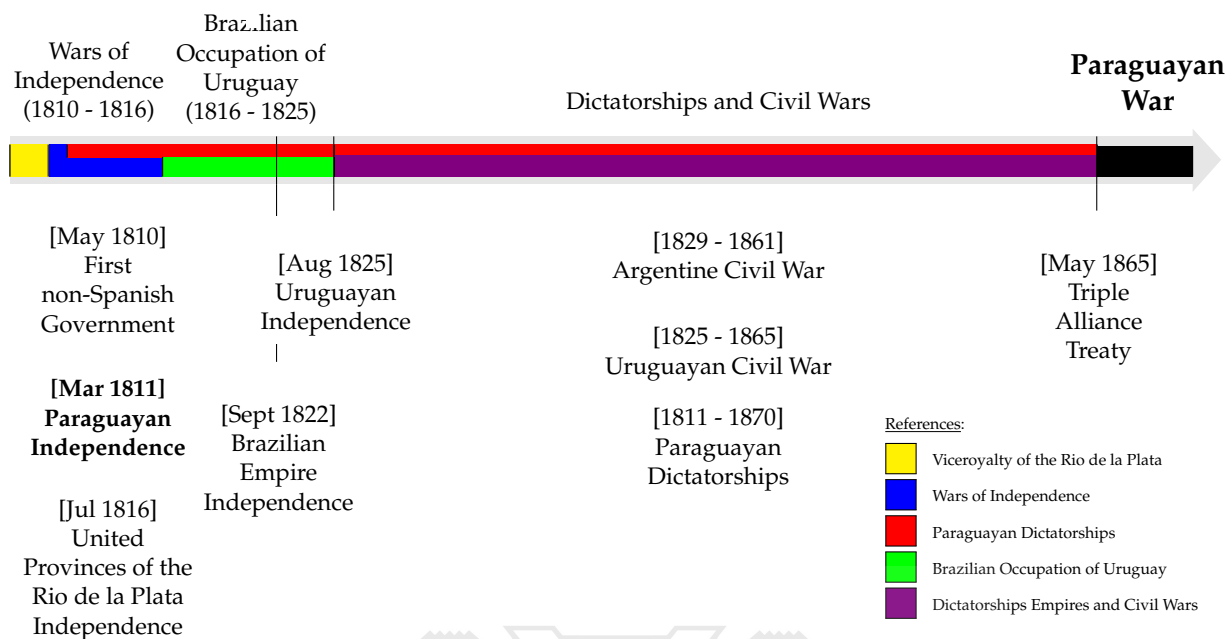
2 Historical Background

2.1 Balance of power within the Rio de la Plata Basin

Although civil wars and internal conflicts were relatively common within South America's Southern Cone in the nineteenth century, wars between South American countries have

³Another relevant papers analysing the role of historical institutions in development are Valencia Caicedo (2018) and Dell (2010).

Figure 1: Timeline of internal and external conflicts in the Rio de la Plata Basin (1800 - 1870)



Notes:

- (1) The top part of the timeline depicts the historical periods that lead to the Paraguayan War.
- (2) The bottom part of the timeline depicts specific important events that defined these historical periods.

been scarce and not comparable in terms of length, casualties, and economic losses to the Paraguayan War. In this section I describe the historical, geographic, economic and political context in which this war happened.

Paraguay, the Argentine Confederation (Argentina), the Banda Oriental (Uruguay) and Brazil, are four nations in South America, that were obliged to hold certain amount of relations because they all depended on the Rio de la Plata Basin. This interdependency, their different views on the fundamental political issues, and the overlap on claimed territories led to 60 years of conflict (1810-1870).⁴ Figure 1 summarizes the main events over these 60 years.

Prior to the Paraguayan War, Paraguay was governed by three successive dictatorships and had become the most industrialised and technologically advanced nation in South America. By 1863, under the presidency of Marshal Francisco Solano Lopez, Paraguay had developed the first iron foundry, the first railway line and the first electric telegraph line in South America.⁵ All of this infrastructure was achieved with virtually no recourse to slavery, foreign financing

⁴All territorial claims between the four nations are settled by the peace accord of the Paraguayan War where Paraguay loses almost 40% of their claim territories before the war.

⁵The foundry operated until 3 May 1868 when Brazilians demolished it (Reber, 1999).

or investments. However, by the mid 1860s, many countries in South America became more politically stable and started to integrate into the world's economy driven by the industrialization of the U.S. and Western Europe.

During this process, Paraguay became increasingly isolated. This isolation before 1865 had two main reasons. First, Paraguay was governed by a dictatorship while its neighbours were going through Civil Wars to establish a stable form of government. Second, Paraguay was landlocked and only had a single export route via the Rio de la Plata. This route was controlled from Buenos Aires and Montevideo allowing the current Argentine and Uruguayan administrations, respectively, to supervise, tax or plunder inbound and outbound shipments.

The Matto Grosso province of Brazil (north of Paraguay) suffered from a similar geographic isolation. In this context, the Paraguayan and Brazilian governments had incentives to exert influence, if and when possible, over the governments of Buenos Aires and Montevideo.

Argentina constituted itself as a unified country in 1861. This meant unified custom rights which incentivised the Argentine government to exert more control over the Rio de la Plata Basin to protect its exports to Europe.⁶ When Uruguay's internal conflict deepened in 1863, the control of the most important point of the Rio de la Plata Basin provoked the intervention of Uruguay's neighbours. In this conflict, there were two military factions: the conservative *Blancos* – who were looking after the agricultural interests of the countryside and promoted protectionism – and the liberal *Colorados* – who represented the business interests of Montevideo. The *Blanco* faction was in power and was aided by Paraguay while the *Colorado* faction was backed by Argentina and Brazil.⁷

In this context, Solano Lopez feared that Paraguay's neighbors would take complete control of the river routes by seizing the Rio de la Plata delta, fully isolating Paraguay from the Atlantic export routes. In March 1864, the Paraguayan Government preemptively started a compulsory draft of males between 15 and 50 years old. By December 1864, Solano Lopez sought to help

⁶At the time, customs revenues were the main source of funds for the Government (Villanueva, 2001).

⁷During this conflict Montevideo and its port were under siege, like many other Uruguayan cities, by the Brazilian Navy and land forces.

Uruguay and invaded Brazil's Mato Grosso province upriver. Three thousand Paraguayan soldiers took over gold mines and armories in an attempt to convince Brazilian Emperor Pedro II to abandon Uruguay. The emperor refused, and the Paraguayan army marched south. On the way to Uruguay, Paraguayan troops crossed Argentine territory, giving the country a reason to become actively involved in the conflict. Despite Solano Lopez's efforts, the Uruguayan government was ousted, and the new leaders joined Brazil and Argentina in a Triple Alliance to move against Paraguay.

2.2 Paraguayan War and its consequences

Paraguay began active preparations for war in the beginning of 1864. Prior to these preparations, the army was composed of 28,000 males, and had only one General, Solano Lopez himself. In March, Solano Lopez established the military Camp at Cerro Leon where 30,000 men between the ages of 15 and 50 were recruited as soldiers. Similarly, from March to August 1864, recruits were drafted into camps at Encarnacion (17,000), Humaita (10,000), Asuncion (4,000) and Concepcion (3,000). According to Thompson (1869), 6,000 men died during the recruiting period. The total number of males in the Paraguayan military forces was hence 80,000 at the beginning of the war.

Mortalities, injuries, and desertion reduced the pool of able bodied men. By November of 1865, 40,000 men had already died – both from diseases and in battle outside Paraguay's territory – and 10,000 surrendered.⁸ Ever since the recruiting period started, diarrhea and dysentery had done great damage to the ranks.⁹ Meanwhile, there were also epidemics of measles and smallpox, which killed off thousands, leaving some of the surviving troops in an extremely weak condition.

After more than four years of war and with Solano López on the run, Asuncion was sacked by the Brazilian army on January 1st 1870. On February 20th 1870, Brazilian officials arrived to

⁸Most of the 10,000 soldiers surrendered in the siege of Uruguayana (Brazil) in 1865 during the campaign to aid the *Blancos* in Uruguay. General Estigarribia's force had 8,000 men. After the siege 5,545 surrendered and the rest died of hunger and sickness.

⁹According to Thompson (1869), these diseases were mainly caused by the change of diet soldiers underwent, and were prevalent and fatal all through the war.

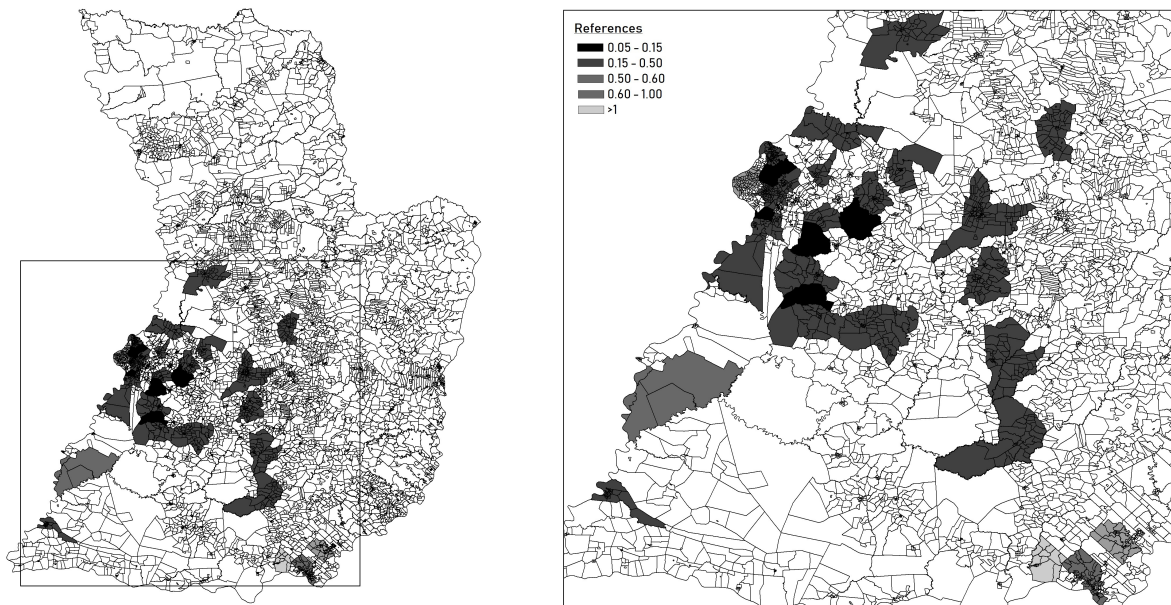


Figure 2: Male/female sex ratio on the fertile population immediately after the war (1870)

Asuncion and began consultations with local politicians to define a Provisional Government. Most of these politicians were exiles during the government of Solano Lopez and belonged to the *Legion Paraguaya* which fought next to the Allied Forces against Solano Lopez. This government was meant to sign a peace accord and recognize the border claimed by Brazil between the two nations. In this peace accord, Paraguay lost almost 40% of their claimed territories before the war. The government was installed on August 15, but was just a front for continued Allied occupation which lasted until 1876.

Solano Lopez was at last driven to the northern frontier of Paraguay, arriving at Cerro Corá in February 1870. By then, his force was only a handful of men, the rest either perished along the way, deserted or were killed because they tried to. Upon hearing about officers abandoning him, Solano Lopez called a last war council with the remaining officers to decide the course of action. The council decided to stay and end the war once and for all by fighting to the death. On March 1st, Solano Lopez was wounded and died later that day. His death marked the end of the Paraguayan War.

After the death of Lopez, the Provisional Government issued a proclamation on March 6, 1870 in which it promised to support political liberties and to protect commerce. Whigham and

Potthast (1999) argue that the Provisional Government recognized the desperate circumstances of postwar Paraguay and wanted an accurate idea of how many resources – human and otherwise – the country still had at its disposal. In this context, the Provisional Government ordered a Census in 1870 (Whigham and Potthast, 1999). The government therefore ordered the *jueces de paz* (similar to a town justice) of all towns and villages in the interior to report the number of inhabitants under their jurisdiction. Their findings were grouped by gender and by a division into age groups consisting of *ancianos* (elderly), *jovenes* (young), and *niños* (children). According to Whigham and Potthast (1999), the definition of these categories seems to have varied from place to place, but for most elderly referred to an individual over 50 years of age, a child to be under 12, and a young person to be between 12 and 50.

The reconstruction process of Paraguay after the war included the approval of the Constitution (1870), Civil Code (1876 and 1897) and the Marriage Code (1873 and 1897) among others. According to Capdevila (2010), these laws excluded females from all forms of power putting them under the tutelage of their father or husband in all matters referred to assets (both management or inheritance). The Marriage Code declared females as unfit. As a consequence, females were not able to make decisions or manage their assets and they were not able to perform as witnesses in public affairs. In addition, these laws forced women to ask for permission to practice a profession and to manage the expenses of the household. In this context, Paraguayan females were expected to be only dedicated to the subsistence of the Paraguayan nation (agricultural and home production) while the few remaining males were dedicated to rebuild the institutional structure of a country devastated by the war (Warren and Warren, 1978).¹⁰ These laws represented a step back on females' rights in Paraguay. Relative lack of rights of females with respect to males were common in the region but not the norm in Paraguay. Prior to the war Paraguayan women were the heads of their households, meaning they held a position of power and authority.¹¹

¹⁰The one exemption being female teachers.

¹¹They received such positions by being widows, among other contexts. This step back also reflects on how long it took for Paraguayan females to gain full rights compared to females from other countries in the region (Uruguay in 1946, Brazil in 1962, Argentina in 1968, and Paraguay in 1992)., see Giordano (2013).

Table 2: Paraguayan Population (1867 - 1870) and Distances to Military Camps

Variables	Obs	Mean	Std. Dev.	Min	Max
<i>Male/Female Ratio*</i>					
All Population	34	0.540	0.187	0.202	1.12
Fertile Population	33	0.338	0.190	0.052	2.00
<i>Distances (WID)**</i>					
Cont. Data	13,516	0.0165	0.0285	0.0024	0.3911
Hist. Data	88	0.0137	0.014	0.004	0.109

Sources:

*Whigham and Potthast (1999),

**Own elaboration with data from the Cartography Department of the DGEEC.

3 Data

To study the short and long-term impact of the Paraguayan War on female labour participation, I match individual-level data from the Paraguayan National Survey of Demography and Sexual and Reproductive Health with historical data.

Historical Data I use three sources of historical data. The first source is the Census of 1870 as documented by Whigham and Potthast (1999). From this Census I observe the total population stratified by gender and age groups in 34 out of 92 municipalities.¹² The second source of information is the Census of 1846 (Williams, 1976). This Census includes the total population classified by age and freedom status groups in 69 out of the 92 municipalities. The third source of historical data is data on teachers per school by gender for 88 of the 92 municipalities in 1886 and the 1886 Census from the *Anuario Estadístico de las República del Paraguay* (1887) (Statistical Yearbook of the Paraguayan Republic).

Given the Census of 1870, I can calculate the male/female sex ratio in each of the 34 municipalities immediately after the war as shown in Table 3.¹³ In Figure 2, I show the spatial distribution of the municipalities in the 1870 Census and their respective male/female sex ratios.

¹²See Appendix for a map of the 95 municipalities where 4 correspond to neighbourhoods within Asuncion.

¹³For the Caapucu municipality I only observe the total female population without the distinction by age group which doesn't allow me to calculate the gender imbalance for the fertile population. Then, I proxy this by using all males over all females instead.

Table 3: Sociodemographics of the Sample Population

Variables	<i>n</i>	%	N
<i>Age</i>			
15-19	2798	20.70%	13516
20-24	2721	20.13%	13516
25-29	2443	18.07%	13516
30-34	2111	15.61%	13516
35-39	1881	13.91%	13516
40-44	1562	11.55%	13516
<i>Educational attainment</i>			
None	189	1.39%	13516
Primary	6336	46.87%	13516
High School	4668	34.53%	13516
College or more	2323	17.18%	13516
<i>Marital Status</i>			
Consensual Union	3945	29.18%	13516
Married	4504	33.32%	13516
Widowed	83	0.61%	13516
Separated	624	4.61%	13516
Divorced	30	0.22%	13516
Single	4330	32.03%	13516

Source: Own elaboration with data from ENDSSR-2004 and ENDSSR-2008.

Contemporaneous Data This paper uses data on female labour participation from a collection of surveys conducted by the Paraguayan Center for Population Studies (CEPEP), with technical assistance from the U.S. Centers for Disease Control and Prevention, in 2004 and 2008 with a total of 13,777 women between 15 and 44 years old residing in eastern Paraguay.^{14,15} The 2004 and the 2008 Paraguayan National Survey of Demography and Sexual and Reproductive Health (Encuesta Nacional de Demografía y Salud Sexual y Reproductiva 2004 y 2008; ENDSSR-2004 and ENDSSR-2008) employed a multi-stage cluster sample based on the 2002 census tracts: a total of 352 and 384 (respectively) census tracts were randomly selected; a number of households, proportional to the size of the population, were randomly selected from each cluster, and one woman aged 15-44 years was randomly selected from each household for the interview. The individual response rate was 97.4% (2004) and 95.1%(2008), and the final, nationally representative sample consists of 7321 and 6540 women respectively. Data were col-

¹⁴The Paraguayan National Survey of Demography and Sexual and Reproductive Health is survey with national coverage but I excluded the observations that were not placed in eastern Paraguay due to the focus of this paper.

¹⁵This paper also uses female labour participation data from the CEPEP surveys.

lected with a standardized questionnaire in face-to-face household interviews conducted from August through September 2003 and June through October 2008.

The cartographic data which allows to match the individual-level data with historical data has been provided by the Cartography Department of the *Dirección General de Estadística, Encuestas y Censos* (Department of Statistics, Surveys and Censuses). From the 2002 census I am able to identify the location at the neighbourhood level of 10878 out of 13516 individuals that reported to have ever been in a marital or consensual union and responded to the ENDSSR-2004 and ENDSSR-2008 while for the rest I am able to locate them within their corresponding municipality. By identifying their geographical location I am able to link them with the WID measure and historical data to see whether the war has a long lasting effect on female labour participation.

4 Weighted Inverse Distance Measure –Exogeneity & Relevance–

In this section, I describe the main explanatory variable of the analysis, *weighted inverse distance* (WID).

Municipalities that are located closer to a military camp were more affected by the war since males in those municipalities – closer to military camps – men were more likely to be drafted. I then identify the relationship between the war, the resulting changes in Paraguayan male/female sex ratios, and current female labour participation by using the distance of municipalities to military camps during the war, accounting for camps size, as a proxy of the effect of the war. In particular, this measure weighs the inverse distance to all military camps by the size of the respective camps.

$$WID_{jk} = \sum_{c=1}^5 \frac{1}{DistToCamp_{cjk}} * SizeOfCamp_c$$

where c are the 5 military camps, j is the contemporaneous neighbourhood where the females

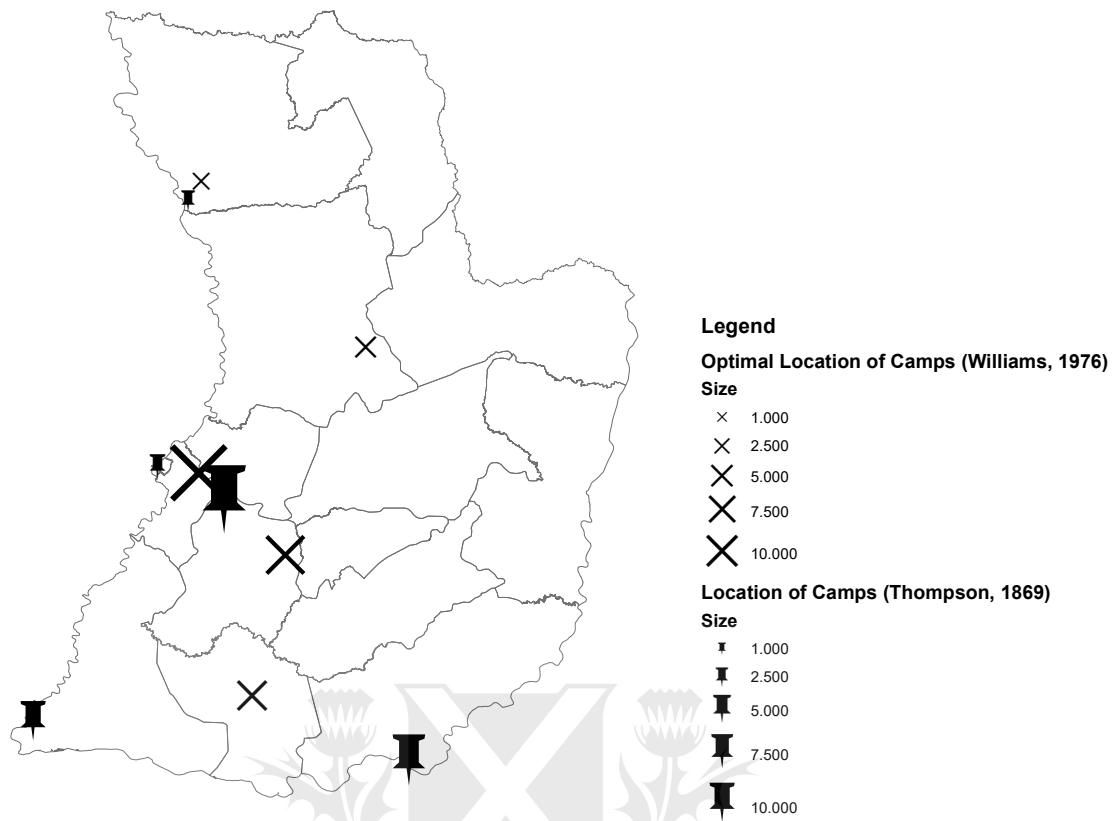


Figure 3: Optimal Location of Military Camps (1864).

are located and k is the municipality (both historical and contemporaneous).¹⁶

I use data on the location and size of the military camps from Thompson (1869). Distance to a camp is calculated using cartographical data provided by the Cartography Department of the *Dirección General de Estadística, Encuestas y Censos* (Department of Statistics, Surveys and Censuses).

To examine whether the WID measure is exogenous, I analyse whether the camps where optimally located and sized with respect to the population in 1864. Since there is no 1864 Census, I project 1864s drafted population using the last available one. I use the population data from the Census of 1846 and allocate it to their respective geographical locations. Specifically, I generate as many points per municipality in the map as the population number in the respective municipality in 1846. Then, I find the size and location of camps which minimizes the average distance between each person and the closest camp. To do so, I run a k-medians

¹⁶See Appendix for the list and map of the municipalities.

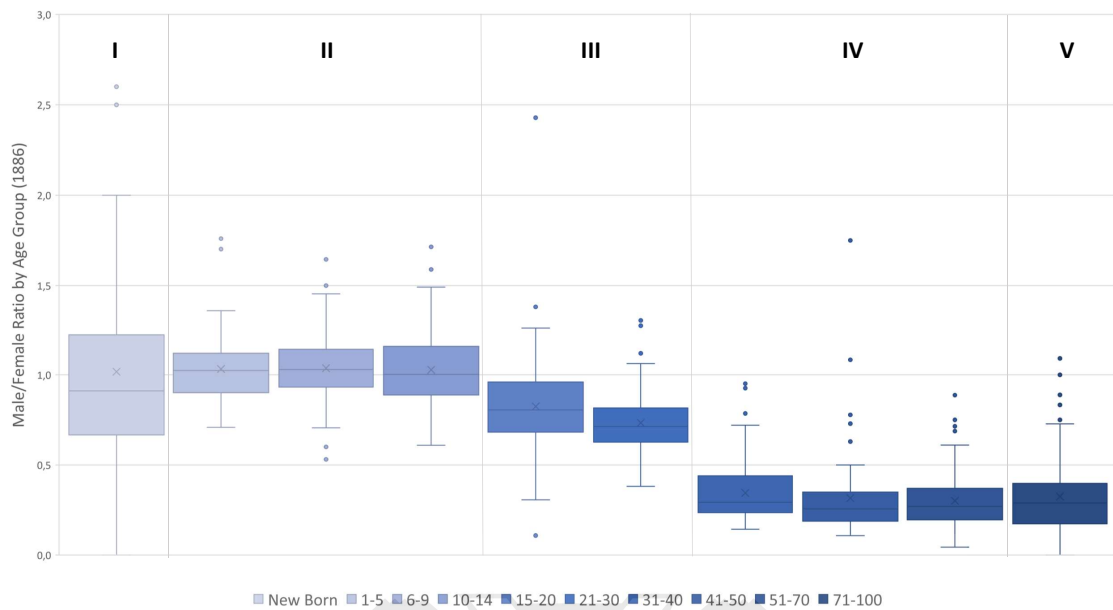


Figure 4: Gender Imbalance by Age Group (1886)

Notes:

(1) Age groups are depicted with different shades. New borns being the lightest group and the elderly (adults above 71 years old) being the darkest.

(2) The numbering at top depicts the relationship between the different age groups and the war. People that belonged to groups I and II were born after the war. People that belonged to group III were born during the war but were not old enough to be drafted conditional on being male. People that belonged to group IV were compulsory drafted conditional on being male. People that belonged to group V were born before the war and were too old to be drafted.

clustering algorithm with 5 clusters corresponding to the 5 camps.¹⁷ I ran this algorithm 15,000 times.¹⁸

The algorithm gives me the optimal location of the camps. I calculate the size of each camp by counting the points that belong to each cluster. Then, I weigh the size of the camp by the total population drafted in 1864 – 64,000 males.

In Figure 3, I present the optimal locations and sizes of camps based on the Census of 1846 collected by Williams (1976). There is little overlap between the optimal location and size of camps and the actual locations reported by Thompson (1869). Both camps along the southern border of Paraguay were misplaced and of the wrong size given the population in the area. The

¹⁷I fix the number of camps to the actual number of camps that were in place in 1864 since including the optimization the number of camps in this analysis implies a cost function of the settlement and running costs of a military camp for which I don't have any data.

¹⁸This algorithm only assures the finding of local minima. In terms of distances, this algorithm uses the sum of absolute differences. Each centroid is the component-wise median of the points in that cluster.

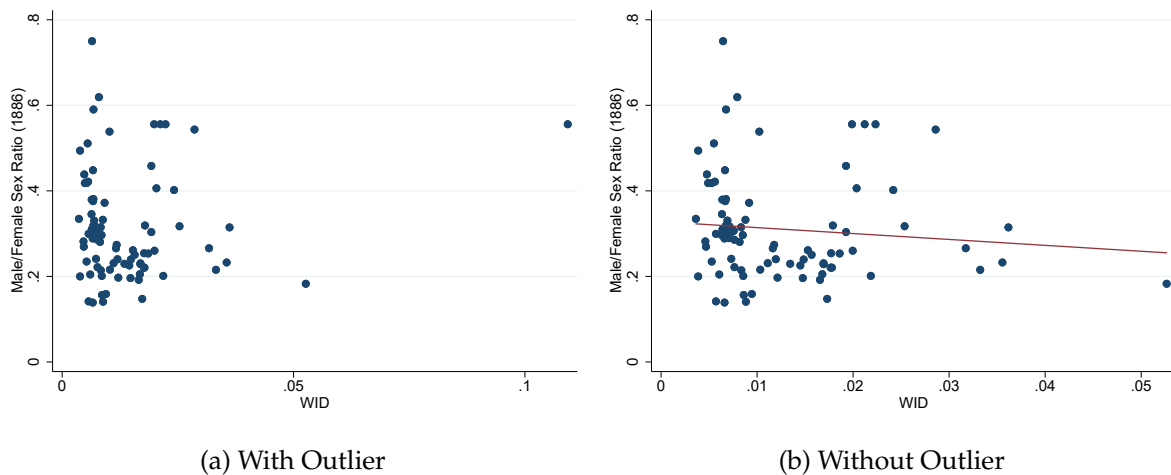


Figure 5: Gender Imbalance and WID (1886)

population of the eastern area of the country was not properly covered by any of the camps. Likewise, given the population density in the center of the country, there should have been more camps in the area.

This confirms that the location and sizes of camps imposed by Solano Lopez were not optimal. This, therefore, corroborates the assumption that camps were exogenous.

Another possible concern regarding the use of the weighted inverse distance to military camps measure is that the military camp of Humaita – located in the Humaita fort – was at the junction of the two main combat fronts during the war, the Southern border of Paraguay and the Paraguayan river. To address this point, I perform the same analysis presented in Section 5 but with the distance to Humaita which can be found in Appendix A2. From this analysis, I can corroborate that the effects I find in section 5 are not through the combat fronts but through the likelihood of males being drafted which validates the use of my measure.¹⁹

Since the 1870 Census is only available for 33 observations, I perform the relevance analysis with data from the 1886 Census. With this census I am able to distinguish people according to

¹⁹The only results that are robust to the inclusion of individual level controls are the effect of the inverse distance to the military camp at Humaita on females being regularly employed and self employed. In the case of the results associated with females being employed, that is not a result I find when using the WID. However, this result is in line with Becker's predictions. In the case of the results associated with self employment, they have the opposite sign to the results I present in Table 6. Moreover, they are not in line with the idea of females replacing males by taking risks and being self employed. To the contrary, the closer females are to former combat front lines the less likely are to be self-employed.

their age and participation in the war. I classify their participation in the following categories: (I) new borns, (II) people that were born after the war (ages 1 to 14), (III) people that were born prior or during the war but were too young to be drafted (ages 15-30), (IV) people that were born before the war and were compulsory drafted (ages 31-70), and (V) people that were born before the war and were too old to be drafted. In Figure 5, I present data on gender imbalances by age group using the previously presented classification.

In this figure, I show that the gender imbalance increases significantly on average for group IV. However, I want to analyse the impact of the war on the gender imbalance post-war. In Figure 5, I present the relationship between the male/female sex ratio in 1886 and WID. In Panel (a), the presence of an outlier becomes apparent. By removing the outlier in panel (b), I show the negative relationship between WID and the gender imbalance after the war which suggests that WID is a relevant proxy.

5 Main Analysis

In this paper, I perform two analyses already present in the literature – never joint in cases of female biased sex ratios – of the effects of demographic shocks. The first analysis – in line with Goldin (1991), Acemoglu et al. (2004), Goldin and Olivetti (2013) – quantifies the short term effects of a demographic shock proxied by WID on female labour participation. To do so, I use teachers' data since it was one of the only available professions to females after the war. The second analysis quantifies the long term impact of a demographic shock proxied by WID on female labour participation and the type of participation similar to Teso (2018).

5.1 Short Term Effects of the War on Female Labour Participation

After the war, Paraguayan females were declared unfit (Capdevila, 2010). Females needed to ask for permission to their fathers or husbands to be able to practice a profession. In this context, females were mainly relegated to the subsistence of the household (agricultural and home production). The few available professions for females outside the household were, ac-

According to the *Anuario Estadístico de las Republica del Paraguay (1887)* (Statistical Yearbook of the Paraguayan Republic), the following: laundress, seamstress, 'plachadoras' (females who irons clothes), teachers and midwives. Notably, the only available profession to females and males after the war were teachers. In 1886, 146 females were teachers in Paraguay compared to 300 of their male counterparts.

To analyse whether females replaced males as a consequence of the male scarcity generated by the war, I use data from *Anuario Estadístico de las Republica del Paraguay (1887)* (Statistical Yearbook of the Paraguayan Republic). I calculate the number of teachers per child attending school for both genders and I regress

$$FTPC_k = \beta_1 WID_k + \epsilon_k \quad (1)$$

$$MTPC_k - FTPC_k = \beta_1 WID_k + \epsilon_k \quad (2)$$

where *FTPC* and *MTPC* are the number of female and male teachers per child attending school, respectively. I also control for children out of school to proxy for how developed the school system is at each district in 1887.

Results In Table 4, I present the OLS estimates of equations (1) and (2). All coefficients are significant and unaltered by the inclusion of the children out of school control. This implies that the higher the impact of the war, the higher the number of females per child attending school. Furthermore, the results presented in columns (3) and (4) suggest that females replace males as teachers in areas where the impact of the war was more prominent. These results go in line with results present in the literature and, in particular, with the predictions of Becker (1973).

5.2 Long term effects of the war on Female Labour Participation

To quantify the long term effects of the war on female labour participation, I use the contemporaneous data provided by CEPEP. This sample is composed of 13516 females from which

Table 4: WID and Female Teachers Per Child at School in 1887 (OLS)

	(1) FTPC	(2) FTPC	(3) MTPC-FTPC	(4) MTPC-FTPC
WID	0.121*** (0.0335)	0.111*** (0.0352)	-0.269*** (0.0827)	-0.238*** (0.0842)
<i>N</i>	87	87	87	87
Adjusted <i>R</i> ²	0.059	0.124	0.057	0.195
Controlling for OSR	No	Yes	No	Yes

Standard errors in parentheses
 * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes:
 (1) WID stands for Weighted Inverse Distance
 (2) FTPC stands for Female Teacher per Child at School
 (3) MTPC stands for Male Teacher per Child at School
 (4) OSR stands for Out of School Rates

5813 report to participate in work activities. In CEPEP’s surveys females are asked if they work and in case of an affirmative response, they are asked if they do so outside the house. This is an important distinction in the context of high levels of labour informality. To address these distinctions I regress

$$P(FLP_{ijk} = 1 | WID_k, X_{ijk}) = \mathbb{1}(\beta_1 WID_k + X'_{ijk}\Delta \geq \epsilon_{ijk}) \quad (3)$$

$$P(FLPOHH_{ijk} = 1 | WID_k, X_{ijk}) = \mathbb{1}(\beta_1 WID_k + X'_{ijk}\Delta \geq \epsilon_{ijk}) \quad (4)$$

where *FLP* is a dummy variable that takes value 1 if the female interviewed answers affirmatively to be working and *FLPOHH* is a dummy variable that takes value 1 if the female interviewed answers affirmatively to be working outside the house conditional on being working. WID_{jk} is the WID measure for neighbourhood j , in municipality k , X_{ijk} a set of covariates at the individual level, and ϵ_{ijk} is the individual error term clustered at the neighbourhood level.²⁰

I assume that observations are independent across groups (clusters) but allow for them to be correlated within groups, $E(\epsilon_{ijk} \epsilon_{gjk}) \neq 0$. This relaxes the usual requirement that observations should be independent at the individual level.

In Table 5, I present the logit results for equations (3) and (4) and their respective marginal

²⁰Even for the observations I can’t geographically locate at the neighbourhood level within a municipality, a neighbourhood identifier is available. I cluster the observations by using this neighbourhood identifier and I use the average of the WID measures for all neighbourhoods in said municipality.

Table 5: WID and female labour participation (Logit with clusters)

	(1) FLP	(2) FLPOHH	(3) FLP	(4) FLPOHH
WID	8.538*** (1.548)	10.89*** (2.547)	3.598*** (0.564)	6.363*** (1.910)
Marginal Effects	2.093*** (0.380)	2.119*** (0.486)	0.877*** (0.137)	1.165*** (0.345)
<i>N</i>	13516	5813	13516	5813
Ind. level controls	No	No	Yes	Yes
pseudo R^2	.0086	.0108	.1104	.0946
Nr of clusters	507	494	507	494
Dep. var. mean	0.430	0.730	0.430	0.730
Dep. var. st. dev.	0.495	0.444	0.495	0.444

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes:

(1) WID stands for weighted inverse distance.

(2) FLP stands for female labour participation.

(3) FLPOHH stands for female labour participation outside the household.

(4) Individual level controls include the number of people in the household, age, area (urban/rural), highest education level, whether the female speaks spanish and whether the female has a partner.

effects. Female labour participation coefficients are significant in all cases independently of the type and the inclusion of individual level controls. These results imply that in areas more affected by the war female labour participation is higher more than 100 years later.

Finally, I analyse which type of working conditions females are most likely to face. To do so, I explore the following outcomes: employed (which takes value 1 if females are employed with a monthly wage), daily paid (which takes value 1 if females are employed and paid by the day), self employed, and employer (which takes value 1 if the female is an employer). All these outcomes are evaluated in the sub-sample of females that are working outside the household.

In Table 6, I present the logit coefficients associated with the outcomes described and their respective marginal effects. Similarly to the specifications presented in Table 5, I controlled by individual covariates and clustered the errors by neighbourhood.

The coefficients associated with daily paid, self employment and employer status are significant. In the case of daily paid, the coefficient is negative. This implies that the higher the effect of the war in a neighbourhood the lower the likelihood that females are hired and paid

Table 6: WID and type of female labour participation (Logit with clusters)

	(1) Employed	(2) Daily Paid	(3) Self Emp.	(4) Employer	(5) Employed	(6) Daily Paid	(7) Self Emp.	(8) Employer
WID	-0.476 (1.106)	-5.577** (2.697)	1.898 (1.161)	4.080** (1.606)	-1.604 (1.110)	-4.475* (2.594)	3.200*** (1.092)	3.787* (2.147)
Marginal Effects	-0.0961 (0.223)	-0.371** (0.177)	0.274 (0.168)	0.0468*** (0.0177)	-0.311 (0.215)	-0.235* (0.135)	0.417*** (0.141)	0.0241* (0.0144)
N	4241	4241	4241	4241	4241	4241	4241	4190
Ind. level controls	No	No	No	No	Yes	Yes	Yes	Yes
pseudo R ²	5.8e-05	.0032	9.6e-04	.004	.0619	.071	.0689	.0959
Nr of clusters	468	468	468	468	468	468	468	461
Dep. var. mean	0.719	0.0726	0.175	0.0118	0.719	0.0726	0.175	0.0119
Dep. var. st. dev.	0.449	0.260	0.380	0.108	0.449	0.260	0.380	0.109

Standard errors in parentheses

Notes:

(1) WID stands for weighted inverse distance.

(2) Employed stands for females that responded affirmatively to being employed in a contract.

(3) Daily Paid stands for females that responded affirmatively to being employed by the day.

(4) Self Emp. stands for females that responded affirmatively to being self employed.

(5) Employer stands for females that responded affirmatively to employ others.

(6) Individual level controls include the number of people in the household, age, area (urban/rural), highest education level, whether the female speaks spanish and whether the female has a partner.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

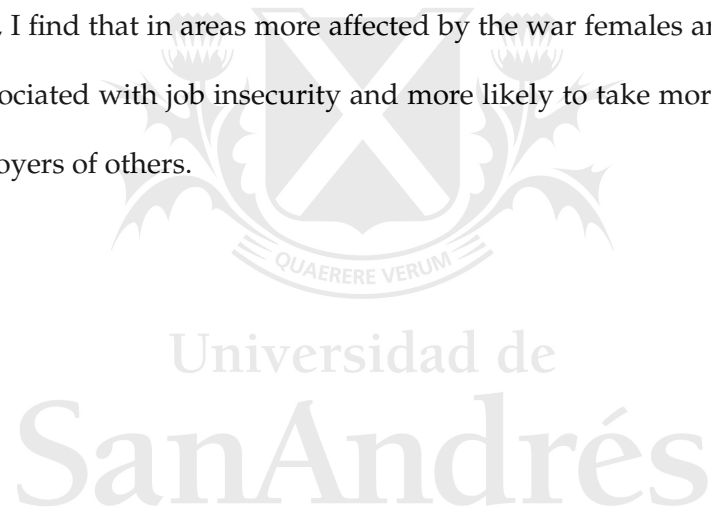
daily. Since people employed in this fashion usually suffer from high job insecurity (both from a legal perspective and as a consequence of the business cycle), this result implies that females in areas more affected by the war are less likely to work on daily paid jobs conditional on being working outside the household and, therefore, less likely to suffer from job insecurity. In the case of self employed females, the coefficient is positive and significant only when individual level controls are included. This result combined with the significant and positive coefficient of females being employers, imply that females in areas more affected by the war are more likely to be self employed and to employ others. This is usually a result found for males and suggests that females in areas that were more affected by the war are more likely to replace males in risky endeavours.

6 Conclusion

This paper shows that a historical shock that affects demographics and social norms can have persistent effects on female labour participation. Since the Paraguayan War affected

disproportionally the male population of Paraguay in 1870 a noteworthy gender imbalance emerged in the population.

The *Paraguayan war* serves as a natural experiment which I use to study an important economic question. Today, more than 100 years later, the impact of the war still resonates. In line with Becker's predictions, I find evidence of female labour participation increasing in areas more affected by the war both in the short and in the long run. In particular, I find that in areas that were more affected by the war females increased their labour participation, both in absolute and in relative terms with respect to males, in one of the only available professions to them, teachers. I also show that in areas more affected by the war female labour participation and female labour participation outside the household are higher more than 100 years later. Furthermore, I find that in areas more affected by the war females are less likely to have daily paid jobs associated with job insecurity and more likely to take more risks by being self employed or employers of others.



References

- Ran Abramitzky, Adeline Delavande, and Luis Vasconcelos. Marrying up. the role of sex ratio in assortative matching. *American Economic Journal. Applied Economics*, 3(3):124–57, 2011.
- Daron Acemoglu, David H Autor, and David Lyle. Women, war, and wages. the effect of female labor supply on the wage structure at midcentury. *Journal of political Economy*, 112(3):497–551, 2004.
- Alberto Alesina, Paola Giuliano, and Nathan Nunn. On the origins of gender roles. women and the plough. *The Quarterly Journal of Economics*, 128(2):469–530, 2013.
- Alberto Alesina, Benedetta Brioschi, and Eliana La Ferrara. Violence against women. a cross-cultural analysis for africa. Technical report, National Bureau of Economic Research, 2016.
- Robert J Barro. Human capital and growth. *American economic review*, 91(2):12–17, 2001.
- Gary S Becker. A theory of marriage. part i. *Journal of Political economy*, 81(4):813–846, 1973.
- Gary S Becker, Kevin M Murphy, and Robert Tamura. Human capital, fertility, and economic growth. *Journal of political economy*, 98(5, Part 2):S12–S37, 1990.
- Jess Benhabib and Mark M Spiegel. The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary economics*, 34(2):143–173, 1994.
- Dirk Bethmann and Michael Kvasnicka. World war ii, missing men and out of wedlock childbearing. *The Economic Journal*, 123(567):162–194, 2013.
- Barbara Boggiano. New evidence on the demographics of the paraguayan war. *Working Paper*, 2019.
- Elizabeth Brainerd. The lasting effect of sex ratio imbalance on marriage and family. evidence from world war ii in russia. *Review of Economics and Statistics*, 99(2):229–242, 2017.
- Luc Capdevila. *Una guerra total. Paraguay 1864-1870. ensayo de historia del tiempo presente*. Centro de Estudios Antropológicos de la Universidad Católica (CEADUC), 2010.
- Jerry W Cooney. Abolition in the republic of paraguay: 1840–1870. *Jahrbuch für Geschichte Lateinamerikas Anuario de Historia de America Latina*, 11(1):149–166, 1974.
- Melissa Dell. The persistent effects of peru’s mining mita. *Econometrica*, 78(6):1863–1903, 2010.

- Verónica Giordano. La sanción de la capacidad civil plena de la mujer en los países del cono sur, 1945-1990: Una propuesta de análisis del fenómeno legal. *Latin American Research Review*, pages 25–43, 2013.
- Claudia Goldin and Claudia Olivetti. Shocking labor supply. a reassessment of the role of world war ii on women's labor supply. *American Economic Review*, 103(3):257–62, 2013.
- Claudia D Goldin. The role of world war ii in the rise of women's employment. *The American Economic Review*, pages 741–756, 1991.
- Luigi Guiso, Paola Sapienza, and Luigi Zingales. Long-term persistence. *Journal of the European Economic Association*, 14(6):1401–1436, 2016.
- Kanako Ishida, Paul Stupp, Mercedes Melian, Florina Serbanescu, and Mary Goodwin. Exploring the associations between intimate partner violence and women's mental health: evidence from a population-based study in paraguay. *Social Science & Medicine*, 71(9):1653–1661, 2010.
- Anneliese Kegler de Galeano. Alcance histórico-demográfico del censo de 1846. *Revista paraguaya de sociología*, 13(35):71–121, 1976.
- Jan MG Kleinpenning. *Paraguay 1515-1870: a thematic geography of its development*, volume 1. Iberoamericana, 2003.
- L'illustration: Journal Universel. Guerre de la plata: Capitulation des paraguayés enfermés dans la ville uruguayana. - d'après un croquis de m. francisco rubio, 1866.
- Patrick Manning. The slave trade. the formal demography of a global system. *Social Science History*, 14(2):255–279, 1990.
- Nathan Nunn. The importance of history for economic development. *Annu. Rev. Econ.*, 1(1):65–92, 2009.
- Nathan Nunn. Historical development. In *Handbook of economic growth*, volume 2, pages 347–402. Elsevier, 2014.
- Vera Blinn Reber. The demographics of paraguay: A reinterpretation of the great war, 1864-70. *The Hispanic American Historical Review*, 68(2):289–319, 1988.
- Vera Blinn Reber. A case of total war: Paraguay, 1864–1870. *Journal of Iberian and Latin American Research*, 5(1):15–40, 1999.

- Edoardo Teso. The long-term effect of demographic shocks on the evolution of gender roles: Evidence from the transatlantic slave trade. *Journal of the European Economic Association*, 17(2):497–534, 2018.
- George Thompson. *The War in Paraguay. With a Historical Sketch of the Country and Its People and Notes Upon the Military Engineering of the War*. Longmans, Green, and Company, 1869.
- UN Women. The economic costs of violence against women, 2016. URL <http://www.unwomen.org/en/news/stories/2016/9/speech-by-lakshmi-puri-on-economic-costs-of-violence-against-women>.
- Felipe Valencia Caicedo. The mission: Human capital transmission, economic persistence, and culture in south america*. *The Quarterly Journal of Economics*, page qjy024, 2018. doi: 10.1093/qje/qjy024. URL <http://dx.doi.org/10.1093/qje/qjy024>.
- Javier Villanueva. Las primeras etapas de la politica aduanera argentina. *Instituto Torcuato Di Tella*, 2001.
- Harris Gaylord Warren and Katherine F Warren. *Paraguay and the Triple Alliance. the postwar decade, 1869-1878*, volume 44. University of Texas Press, 1978.
- Thomas L Whigham and Barbara Potthast. The paraguayan rosetta stone. new insights into the demographics of the paraguayan war, 1864-1870. *Latin American Research Review*, pages 174–186, 1999.
- John Hoyt Williams. Observations on the paraguayan census of 1846. *The Hispanic American Historical Review*, 56(3):424–437, 1976.

A1

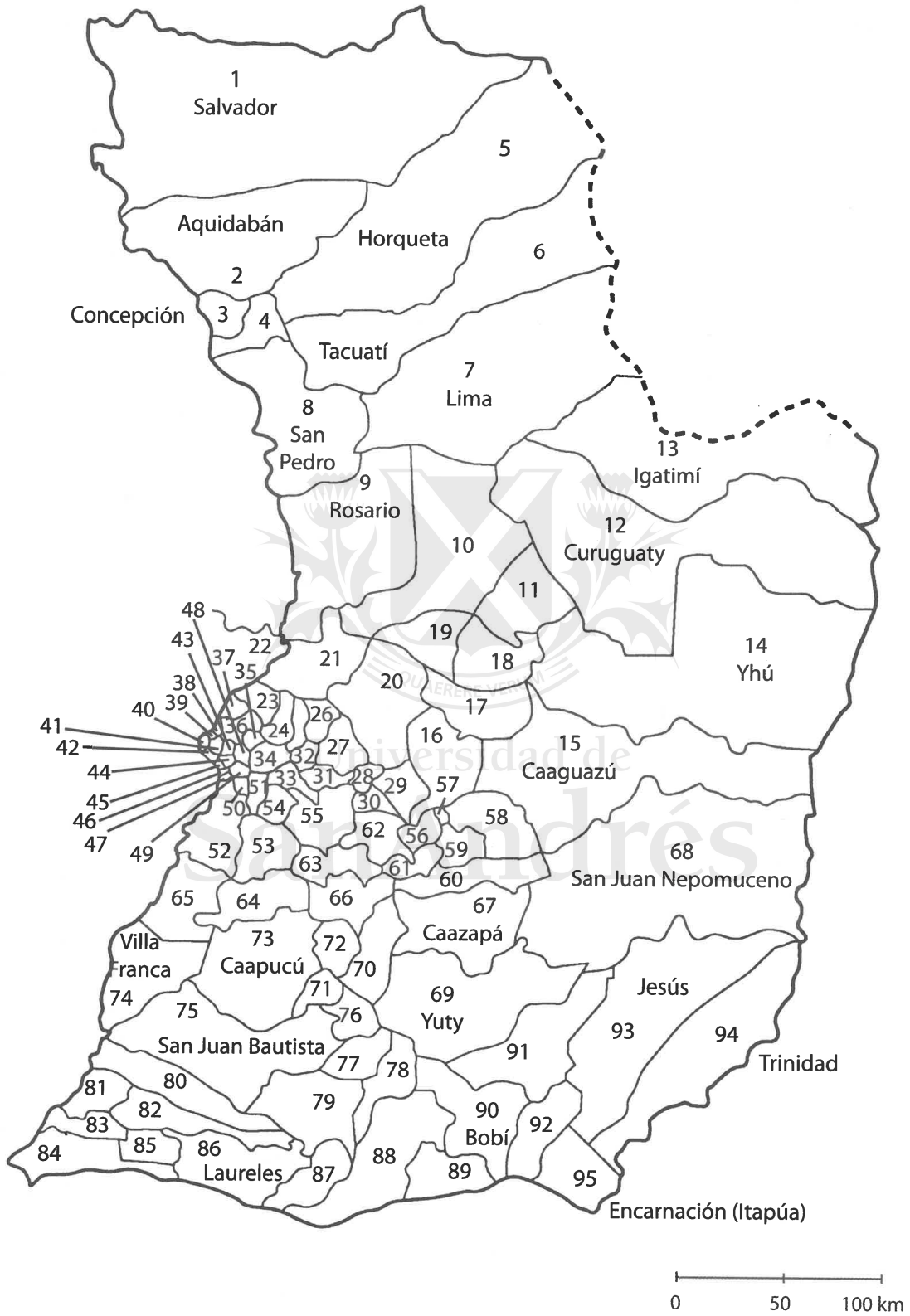


Figure A1: Paraguayan Municipalities (Kleinpenning 2003).

Table A1: Paraguayan Municipalities in 1860 (Kleinpenning, 2003).

ID	Name	ID	Name	ID	Name
1	Salvador	33	Pirayu	65	Oliva
2	Aquidaban	34	Ytaugua	66	Ybucui
3	Concepcion	35	Aregua	67	Caazapa
4	Belen	36	Luque	68	San Juan Nepomuceno
5	Horqueta	37	Limpio	69	Yuty
6	Tacuati	38	Asuncion - Santisima Trinidad	70	Mbuyapey
7	Lima	39	Asuncion - Recoleta	71	San Isidro
8	San Pedro	40	Asuncion - Catedral + Encarnacion	72	Quiquyo
9	Rosario	41	Asuncion - San Roque	73	Caacupu
10	San Estanislao	42	Lambare	74	Villa Franca
11	Carimbatai	43	Capiata - Aldana y Toledo	75	San Juan Bautista
12	Curuguaty	44	San Lorenzo del C Grande	76	San Miguel
13	Igatimi	45	San Lorenzo de la Frontera	77	Santa Maria
14	Yhu	46	San Antonio	78	Santa Rosa
15	Caaguazu	47	Ypane	79	San Ignacio
16	Ajos	48	Capiata	80	Tacuaras
17	Carayao	49	Rojas y Yatayty	81	Pilar
18	San Joaquin	50	Guarambare	82	Guazu-Cua
19	Union	51	Ita	83	Isla Umbu
20	Caraguatay	52	Villeta	84	Pedro Gonzalez
21	Arroyos y Esteros	53	Carapegua	85	Desmochados
22	Occidental	54	Yaguaron	86	Laureles
23	Emboscada	55	Paraguari	87	Yabebiri
24	Altos	56	Hiati	88	Santiago
25	Atyra	57	Yataiti	89	San Cosme
26	Tobati	58	Mbocayaty	90	Bobí
27	Barrero Grande	59	Villa Rica	91	San Pedro del Parana
28	Ytacuribi	60	Y(h)acanguazu	92	Carmen del Parana
29	San Jose de los Arroyos	61	Itape	93	Jesus
30	Valenzuela	62	Ybitimi	94	Trinidad
31	Piribebuy	63	Achay	95	Encarnacion
32	Caacupe	64	Quiindi		

A2

Table A2.a: Inv. Distance to Humaita and Female Teachers Per Child at School in 1887 (OLS)

	(1)	(2)	(3)	(4)
	FTPC	FTPC	MTPC-FTPC	MTPC-FTPC
Inv Distance to Humaita (km)	0.0778* (0.0423)	0.0845* (0.0470)	0.0163 (0.0749)	-0.00362 (0.0917)
Observations	87	87	87	87
Adjusted R ²	0.026	0.108	-0.011	0.141
Controlling for OSR	No	Yes	No	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes:

(1) FTPC stands for Female Teacher per Child at School

(2) MTPC stands for Male Teacher per Child at School

(3) OSR stands for Out of School Rates

Table A2.b: Inv. Distance to Humaita and female labour participation (Logit with clusters)

	(1) FLP	(2) FLPOHH	(3) FLP	(4) FLPOHH
Inv Distance to Humaita (km)	38.82*** (12.25)	5.985 (10.10)	9.050 (5.945)	-14.59 (9.444)
Marginal Effects	9.515*** (3.005)	1.181 (1.993)	2.206 (1.449)	-2.687 (1.741)
N	13516	5813	13516	5813
Ind. level controls	No	No	Yes	Yes
pseudo R ²	.003	8.4e-05	.1091	.0914
Nr of clusters	507	494	507	494
Dep. var. mean	0.430	0.730	0.430	0.730
Dep. var. st. dev.	0.495	0.444	0.495	0.444

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes:

- (1) FLP stands for female labour participation.
- (2) FLPOHH stands for female labour participation outside the household.
- (3) Individual level controls include the number of people in the household, age, area (urban/rural), highest education level, whether the female speaks spanish and whether the female has a partner.

Table A2.c: Inv. Dist. to Humaita and type of female labour participation (Logit with clusters)

	(1) Employed	(2) Daily Paid	(3) Self Emp.	(4) Employer	(5) Employed	(6) Daily Paid	(7) Self Emp.	(8) Employer
Inv Distance to Humaita (km)	24.28*** (9.396)	-1.447 (13.55)	-25.92* (13.32)	-37.06 (31.13)	20.44** (8.055)	7.792 (14.46)	-26.16** (11.90)	-75.98 (46.41)
Marginal Effects	4.897*** (1.900)	-0.0975 (0.913)	-3.738* (1.925)	-0.429 (0.362)	3.964** (1.571)	0.414 (0.765)	-3.416** (1.564)	-0.479 (0.298)
N	4241	4241	4241	4241	4241	4241	4241	4190
Ind. level controls	No	No	No	No	Yes	Yes	Yes	Yes
pseudo R ²	.0011	3.7e-06	.0011	.001	.0621	.069	.0676	.0961
Nr of clusters	468	468	468	468	468	468	468	461
Dep. var. mean	0.719	0.0726	0.175	0.0118	0.719	0.0726	0.175	0.0119
Dep. var. st. dev.	0.449	0.260	0.380	0.108	0.449	0.260	0.380	0.109

Standard errors in parentheses

Notes:

- (1) Employed stands for females that responded affirmatively to being employed in a contract.
- (2) Daily Paid stands for females that responded affirmatively to being employed by the day.
- (3) Self Emp. stands for females that responded affirmatively to being self employed.
- (4) Employer stands for females that responded affirmatively to employ others.
- (5) Individual level controls include the number of people in the household, age, area (urban/rural), highest education level, whether the female speaks spanish and whether the female has a partner.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$