What lies behind the missing girls in 19th-century Spain?

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Abstract: Infant and childhood sex ratios in 19th-century Spain were abnormally high, thus pointing to some sort of unexplained excess female mortality. This article analyses internal regional variation and shows that certain economic and social factors mitigated gender discrimination against newborn and/or young girls. In particular, the presence of wage labour opportunities for women and the prevalence of extended families where different generations of women cohabited had beneficial effects on girls' survival. Likewise, infant and child sex ratios were lower in dense, more urbanised areas.

Keywords: Missing girls, gender discrimination, mortality, 19th-century Spain

JEL classification: I14, I15, J13, J16, N33

I

Finding patterns of gender discrimination in infancy and childhood in historical Europe has proven a difficult task. According to Katherine Lynch, the European household formation system, together with prevailing ethical and religious values, limited female infanticide and/or the mortal neglect of girls early in life[1]. However, less extreme but perhaps more pervasive discriminatory practices may have had deleterious effects on the health of young girls. Several studies suggest that parents treated their sons and daughters differently via an unequal allocation of food, care and workload which negatively affected girls' heights and mortality rates[2].

[1] Lynch, 'Why weren't'.
[2] Johansson, 'Deferred infanticide'; Humphries 'Bread'; Baten and Murray, 'Heights'; McNay, Humphries and Klasen, 'Female infanticide'; Horrell and Oxley, 'Gender bias'. However, Harris, 'Gender', does not find evidence of a systematic gender bias in mortality rates.

In particular, recent research shows that infant and child sex ratios (the number of boys per hundred of girls) in 19th-century Spain, and probably in other countries in Southern Europe, were abnormally high, thus suggesting that some sort of gender discrimination was behind excess female mortality early in life[3]. Given the lack of anecdotal evidence on female infanticide or other extreme versions of mistreatment of young girls, this study argues that these patterns were the result of an unequal allocation of resources within the households. In a period of extremely high infant and child mortality, a slight discrimination in the way young girls were fed or treated when ill, as well as in the amount of work they were entrusted with, is likely to have increased female morbidity and, subsequently, mortality rates.

By relying on a rich dataset at the district level in mid-19th-century Spain, this article analyses regional variation in infant and child sex ratios in order to examine what lies behind the unbalanced sex ratios and thus disentangle the underlying motives driving excess female mortality early in life. We find that certain economic and social contexts mitigated gender discrimination against newborn and/or young girls. In particular, the presence of wage labour opportunities for women and the prevalence of extended families where different generations of women cohabited is associated with lower sex ratios early in life. Likewise, infant and child sex ratios were also lower in dense and more urbanised areas. As explained in the text, it is plausible to argue that higher levels of economic complexity may have improved the relative value of girls and, consequently, increased their survival rates.

II

[3] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls?'.

Discriminatory practices resulting in unbalanced sex ratios, such as female infanticide and the neglect of young girls, are well known in South and East Asia, especially in India and China[4]. Economic and cultural factors have long influenced the perceived relative value of women, thus resulting in strong son preference. On the one hand, while sons provide a crucial labour force to the family farm, the daughters' contribution to the household is seen as less relevant[5]. By increasing women's recognition and economic independence, the existence of female employment opportunities helps counterbalancing these trends[6]. Likewise, discrimination against girls seems to increase in adverse conditions due to the need to ration scarce household resources[7]. Extensive dowry systems also constitute a major drain on household resources, thus further disadvantaging young girls. Lastly, old age support usually falls on sons, a moral obligation which is particularly important for the poor who cannot save[8].

On the other hand, customs and cultural practices also play a role on explaining son preference[9]. In India, China and South Korea, for instance, only sons are in charge of worshipping their ancestors. Religious factors are indeed important. Christianity and Islam both explicitly prohibit infanticide, thus reducing the appeal to resort to female infanticide as a way to affect the sex of the offspring. Furthermore, in China, lineage is traced solely through the male, so failure to have a son implies the extinction of the family line, whose continuity is extremely important to the Confucian creed[10]. Kinship systems that isolate women from their original kin and keep them in a subordinate

[4] Sen, 'More than'.
[5] Das Gupta, Zhenghua, Bohua, Zhenming, Chung, and Hwa-Ok, 'Why is son preference'.
[6] Klasen and Wink, 'A turning point'; Qian, 'Missing women'.
[7] Duflo, 'Women empowerment', p. 1054. Extreme events such as wars and famines also place families under severe resource constraints which lead to a rise in discrimination against daughters as in Das Gupta and Shuzhuo, 'Gender bias'.
[8] Chung and Das Gupta, 'Why is son preference'.
[9] Das Gupta et al., 'Why is son preference'.
[10] Almond, Edlund and Milligan, 'Son preference'.

position in the household into which they marry are especially deleterious to women's status[11].

Das Gupta et al. argue that cultural factors dominate economic ones when explaining gender discrimination in South and East Asia[12]. Patrilineal and patrilocal kinship systems exert a powerful influence even when female job opportunities are widespread and dowry systems do not constitute an important burden. These authors go indeed a step further and argue that economic factors are themselves culturally constructed. These patterns do not indeed vanish with economic development, which is normally associated with improving opportunities for women[13]. In this regard, the situation of China and India is telling because they have experienced worsening sex ratios at birth despite rapid economic growth[14].

Direct evidence of gender discrimination towards newborns and young girls in pre-industrial Europe is however limited. The European household formation system, together with prevailing ethical and religious values, seems to have limited the extent of female infanticide[15]. Although child abandonment was more widespread, foundling hospitals do not appear to have sheltered more girls than boys[16]. Many of these children however died before reaching those institutions, so further research in needed[17].

Other studies suggest that parents treated their sons and daughters differently in 19th-century Europe, especially in adverse economic conditions or where wage labour

[11] Dyson and Moore, 'On kinship structure'.
[12] Das Gupta et al., 'Why is son preference'.
[13] Dilli, Rijpma and Carmichael, 'Achieving gender equality'.
[14] Declining fertility and the possibility of practicing sex-selective abortions thanks to ultrasound technology has reinforced previous trends. The relevance of cultural factors is confirmed by studies of migrants' reproductive behaviour is US and Canada. See Abrebaya, 'Are there missing girls'; Almond et al., 'Son preference'. Recent research also reports extremely son-biased sex ratios at birth among Asian-born parents in Spain. See González, 'Missing girls'.
[15] Lynch, 'Why weren't'.
[16] Ibid., p. 256.
[17] Likewise, Tikoff, 'Gender', argues that inferring gender biases from what it is observed in a single foundling hospital can be misleading because different institutions could be catering to different age and gender groups.

opportunities for women were scarce[18]. Discriminatory practices, either via an unequal intra-family allocation of food, care and workload, are likely to have negatively affected girls' health, thus contributing to excess female mortality during childhood[19].

Direct evidence of extreme discriminatory practices early in life is also lacking in the Iberian Peninsula. The literature analysing mortality rates has found no evidence of a female disadvantage at birth or during childhood[20]. Recent research, however, have shown that average infant and child sex ratios in 19th-century Spain were abnormally high, thus suggesting that some sort of gender discrimination was unduly increasing female mortality rates at those ages[21]. It is argued that, when infant mortality is extremely high, it is relatively easy to disguise the mortal neglect of infants as natural deaths. If this was the case, sex-specific mortality rates conceal the effect of discriminatory practices, thus making infant and sex ratios a better indicator to assess the importance of these practices[22].

This new evidence is consistent with an unequal allocation of resources within the household, observed both in terms of nutrition and educational investments[23]. In this regard, preferential attention given to male infants and children may have reduced the

[18] Johansson, 'Deferred infanticide'; Humphries 'Bread'; Pinelli and Mancini, 'Gender mortality differences'; Schofield, 'Short-run'; Baten and Murray, 'Heights'; McNay et al., 'Female infanticide'; Horrell and Oxley, 'Gender bias'. Recent research on medieval England also suggests excess female mortality probably arising from discriminatory practices. See Bardsley, 'Missing women'.

[19] Harris, 'Gender', however, does not find clear evidence of a systematic gender bias in differential mortality between boys and girls.

[20] See, for instance, Dopico, 'Regional mortality tables', Gómez Redondo, *La mortalidad infantil*, Reher *et al.*, 'Assesing change', Dopico and Reher, 'El declive de la mortalidad', Ramiro-Fariñas and Sanz-Gimeno, 'Structural changes', Ramiro-Fariñas and Sanz-Gimeno, 'Childhood mortality', and Reher and Sanz-Gimeno, 'Childhood mortality patterns'.

[21] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls'. On infanticide and child abandonment in Spain, see Pérez Moreda, *Las crisis de mortalidad*, pp. 167-187; Pérez Moreda, *La infancia*; Valverde, 'Illegitimacy'; Revuelta-Eugercios, 'Abandoned', or Berraondo, 'Los hijos'.

[22] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls', p. 3. Statistics on births, deaths and marriages in mid-19th century Spain were highly deficient (Gozálvez Pérez and Martín-Serrano Rodríguez, 'El Censo', p. 332). Moreover, Sánchez Aguilera argues that female infant mortality rates obtained from those statistics are biased downwards ('Las diferencias', p. 158).

[23] Borderías, Pérez-Fuentes and Sarasúa, 'Gender inequalities'; Sarasúa, 'El acceso'.

survival rate of their sisters[24]. Boys seem to have breastfed longer than girls, thus probably affecting girls' likelihood of falling ill[25]. Likewise, boys were comparatively better off than their sisters in a medium-size Spanish town at the turn of the century, thus suggesting that some sort of gender discrimination was in place[26].

III

As argued elsewhere, while sex-specific mortality rates are likely to hide the impact of unobserved discriminatory practices, infant and child sex ratios better reflect the cumulative impact of those practices[27]. In the absence of gender discrimination, the number of boys per hundred girls in different age groups tends to be remarkably regular. Comparing thus the observed figure to an expected gender-neutral sex ratio allows assessing the importance of potential discriminatory practices. Historical sex ratios, however, cannot be directly compared to current ones. The biological survival advantage of girls was more visible in the high-mortality environments present in pre-industrial Europe. The subsequent excess male mortality both in utero and early in life thus implies that infant and child sex ratios in the past should have been much lower than today's (sex ratios at birth in contemporary developed countries, including Spain, revolve around 105-106 boys per hundred of girls)[28].

In particular, in societies where infant mortality rates are around 250 children, such as the rates existing in mid-19th-century Spain, a gender-neutral infant sex ratio should be slightly below parity (100 boys per hundred girls; p=0.5)[29]. Relying on information for seventeen European countries between 1750 and 2001 and using infant

[24] Dopico and Reher, *El declive*, p. 86; Reher and Sanz-Gimeno, 'Childhood mortality patterns', pp. 27-29.
[25] Gómez Redondo, *La mortalidad infantil*, p. 205. Borderías et al., 'Gender inequalities', p. 183.
[26] Reher and González-Quiñones, 'Do parents', pp. 68-72.
[27] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls', p. 13.
[28] Ibid. See also Bhaskar and Gupta, 'India's missing girls'.
[29] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls', p. 7.

mortality rates as a proxy for material conditions, recent research estimates that, in countries with infant mortality rates around 250, child sex ratios (aged 0-4) should revolve around 99.5[30]. In contrast, the average infant and child sex ratios (aged 0-1 and 1-5) recorded in the 1860 Spanish Population Census were 104.7 and 103.8, respectively, thus pointing to some sort of unexplained excess female mortality. Moreover, these figures are not specific to 1860: the infant sex ratios in 1857 and 1877 were actually very similar: 104.2 and 104.7, respectively[31].

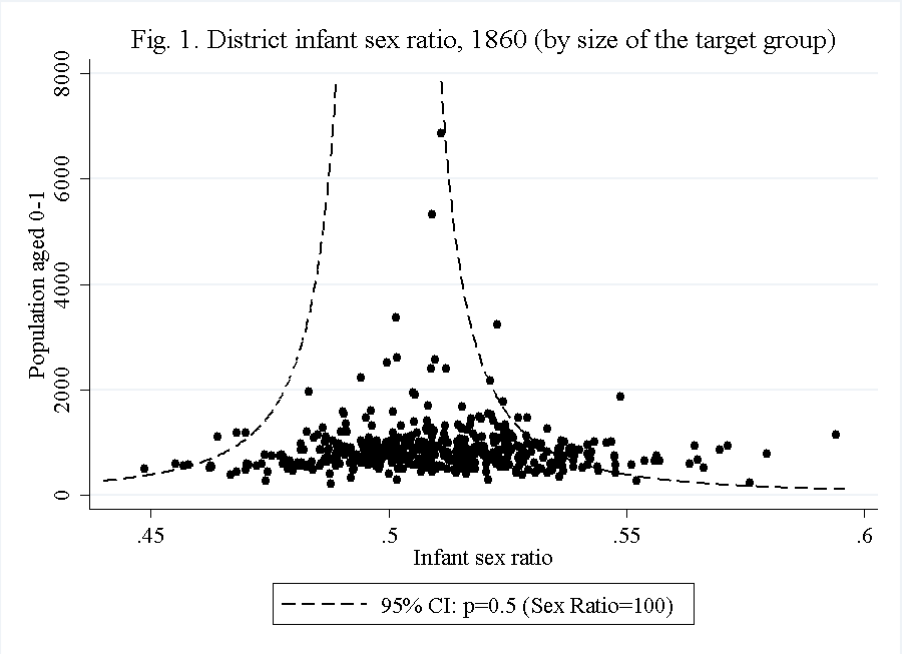
Notwithstanding that average sex ratios remained relatively high in 19th century Spain, some regions exhibited even more extreme figures. Relying on an extremely rich data set at the district level, this paper analyses regional variation within Spain in 1860 in order to examine what lies behind the unbalanced sex ratios, so we can have a better assessment of the underlying motives driving the observed gender discrimination. The 1860 Population Census provides a detailed picture of the situation characterising Spanish districts (*partidos judiciales*) when unbalanced sex ratios were at their highest[32]. In fact, 54 districts (out of 471 observations) have infant sex ratios above 115.

Although some of these districts are relatively small and therefore subject to high levels of random variation, it is very unlikely that most of these results occurred by chance. In the absence of pre-natal sex selection, a child's sex is basically a random process that conforms to the binomial distribution. While infant sex ratios tend to be quite homogenous at the societal level, due to the law of large numbers, sex ratios at smaller levels of aggregation show more random variation. Although this is the case at

[30] Ibid. Relying on the estimation exercise using life expectancy carried out by Klasen and Wink, 'A turning point', yields a similar figure (99.4).
[31] Although not perfectly comparable, the Floridablanca Census (1787) also reports a sex ratio of 104.5 at age 0-7.
[32] Infant sex ratios declined to 103.3 in 1887 and 102.3 in 1900 and then initiated an increasing trend throughout the 20th century. For more details, see Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls'.

the district level, the probability of obtaining such extreme values by chance alone is extremely low.

Figure 1 depicts the observed sex ratios and the size of the population behind those numbers. Given the statistical properties of sex ratios, instead of the male-to-female ratio, it is more adequate to express them as proportions, that is, as the number of boys divided by the total number of boys and girls[33]. As the 95 percent confidence intervals of a hypothetical distribution of a gender-neutral infant sex ratio revolving around parity testify, a large part of the extreme sex ratios observed falls beyond that threshold, thus indicating that some sort of gender discrimination was in place.



Assuming a gender-neutral sex ratio close to parity (p=0.5), 43 districts happen to have infant sex ratios that are significantly higher than what would be expected. Given

[33] Wilson and Hardy, 'The statistical analysis' p. 48; Brian and Jaisson, *The Descent*, pp 228-229. The distribution of the proportion of boys depends on the expected proportion of males (*p*) and the sample size (*n*), where the variance equals [*p*(1- *p*)]/*n*. The male/female ratio is not well suited for statistical analysis because such ratios are asymmetrical and undefined. See Wilson and Hardy, 'The statistical analysis', p. 52.

that this is a two-tailed test at the 95 per cent significance level, we would expect that only around 12 districts would fall beyond that threshold (2.5 per cent of 471 observations). Even considering a more conservative scenario, which assumes a gender-neutral sex ratio of 102 (p=0.505), 29 districts would have statistically significant extreme values[34].

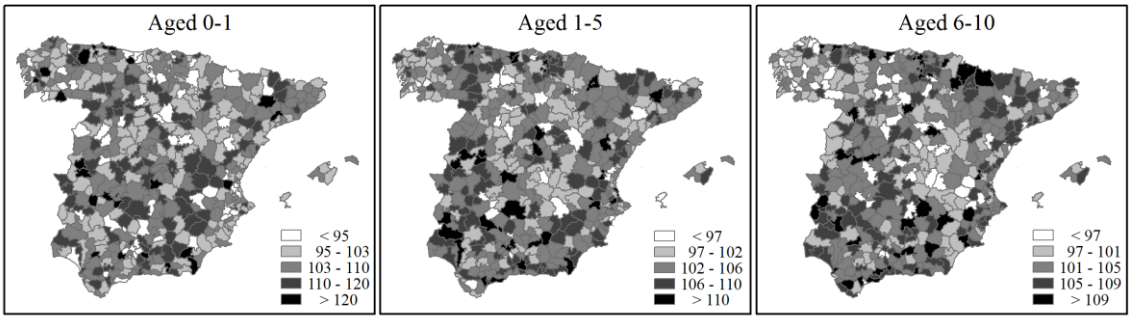
It is also worth stressing that the fact that we also observe relatively lower infant sex ratios is not necessarily related to the absence of discriminatory impulses. It could be the case that although the incentives to discriminate were present, especially in unfavourable contexts, these impulses might be counterbalanced by social and cultural practices, practices that may not be present in other contexts. Nonetheless, the random component of our variable of interest decreases as districts grow in size and, as a result, the observed sex ratio tends to get closer to its hypothetical true value. Next section will therefore take this feature of the data into account when carrying out the econometric analysis.

In order to assess whether gender discrimination is also visible during childhood, we have also collected data on later age-cohorts: 1-5 and 6-10. These older cohorts include many more individuals than the infant population and their distributions thus contain much less random noise. Likewise, given that the female survival advantage continued throughout childhood, child sex ratios should be smaller than infant sex ratios. As expected, average sex ratios decreased with age: from 104.7 for the 0-1 age-group to 103.8 and 102.6 in the older age-groups respectively. Map 1 depicts regional sex ratios for these three age-groups. Unsurprisingly, finding geographical patterns is

[34] Table A1 in the Appendix reports the actual probabilities of obtaining such extreme values for all the districts with infant sex ratios above 115. Figure A1 in the Appendix shows that child sex ratios (aged 1-5) are also heavily skewed to the right. Given that we do not have a reliable estimation of a gender-neutral sex ratio at older ages, the same graph cannot be depicted for the 6-10 age-group.

not straightforward due to the high levels of random variation characterising these ratios in small districts. Next sections, however, manage to unveil some interesting patterns.

Map 1. Infant and child sex ratios (by district and age-group), 1860



IV

Given that high sex ratios suggest gender discrimination early in life, a behaviour that was more pronounced in some regions, we are now interested in analysing the large variation in infant sex ratios within Spain so as to explore the factors behind this variation[35]. In this regard, instead of trying to estimate causal relationships, our aim is to unveil general patterns behind the data, test existing hypothesis and set the basis for further research[36].

Apart from pure random variability, the regional disparities in the sex ratios may arise from multiple causes, including factors that are not related to the presence of a gender bias. A different disease environment, for instance, may harm girls more than boys and may therefore explain the unbalanced sex ratios observed in Spain and other countries in Southern Europe[37]. In order to shed more light on these issues, we identify

[35] Although primarily interested on a composite measure of the long-term evolution of gender equality, Dilli et al., 'Achieving gender equality', also perform a cross-country analysis of the factors affecting sex ratios at age 0-5. They find that gender discrimination diminishes with higher incomes and increases in countries where stem family systems are more widespread.
[36] Gelman and Imbens, 'Why ask why?'
[37] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls'.

economic, social and environmental factors that may theoretically explain this variability and then regress district sex ratios on that set of variables:

$$SR_i = \alpha + \beta_1 ECON_i + \beta_2 SOCIAL_i + \beta_3 ENVIRON_i + \varepsilon_i \quad (1)$$

The dependent variable is the sex ratio (at aged 0-1, 1-5 and 6-10) in each district measured as a proportion. Following the literature on gender discrimination in infancy and childhood (as explained below), the independent variables aim to capture the economic, social and environmental factors characterising those areas. Taking into account all these factors simultaneously allows us to isolate the ones that are directly associated with unbalanced sex ratios. It is also worth stressing that finding patterns from this type of data is particularly challenging. Not only is our dependent variable extremely noisy, but discriminatory practices are likely to have only taken place in the bottom part of the population, thus making those practices less visible when using information based on the whole population.

a) Economic context

Economic conditions directly affected the nutritional status of the population during this period. An important part of the population lived close to subsistence levels and their situation clearly worsened in times of economic stress. Apart from potential starvation, food deprivation reduces the capacity to survive infectious diseases. Malnourishment as a factor contributing to mortality rates in Spain did indeed not disappear until the 20th century[38]. Due to the female biological survival advantage in utero and infancy, sex ratios should theoretically be lower under severe economic conditions[39]. If, on the contrary, economic deprivation shows a positive relationship with the prevalence of boys, it would be evidence of potential gender discrimination

[38] Reher and Sanz-Gimeno, 'Childhood mortality patterns'.
[39] Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls'.

either in the form of female infanticide or the neglect of young girls, especially in terms of nutritional deprivation and susceptibility to infection. It may be the case that both effects offset each other, so the lack of a clear relationship between these variables and the sex ratio might be (cautiously) interpreted as weak evidence of gender bias.

Economic conditions are measured using population density and the level of urbanisation. The existence of large agro-towns, especially in southern Spain, also advises to include the importance of the manufacturing sector. Given that social standing also influences nutritional status and living conditions and, subsequently, mortality rates in infancy and childhood, economic conditions are further captured using the extent of access to land and the incidence of poverty[40]. Likewise, demographic pressures, and the resource constraints involved, are proxied by the number of children (aged 0-10) per women aged 20-40. Infant mortality increases with family size[41], what would again tend to reduce the male-to-female ratio but, in the presence of gender bias, competition for scarce resources could result in higher female mortality.

Several authors have also stressed the presence of waged-labour opportunities for women as a crucial factor mitigating gender discrimination within the household[42]. In order to include this variable, we have computed the fraction of the working-age female population (aged 16-40) that was involved in paid jobs[43]. Although not remunerated, cattle rearing also constituted an important source of working opportunities for women in rural areas[44], so the importance of these activities has also been considered by

[40] While access to land is measured as the fraction of landowners and tenants over the total agricultural population, the poverty ratio is computed as the percentage of destitute individuals over the active population. The 1860 Population Census refers to the poor as *pobres de solemnidad*.
[41] Reher and Sanz-Gimeno, 'Childhood mortality patterns', pp. 30-32.
[42] Klasen and Wink, 'A turning point', Qian, 'Missing women'.
[43] The immense majority of women working outside the household fell within that age-range. See Ferrer, 'Notas'; Camps, 'Transitions'. Nevertheless, extending the definition of female working-age to older ages does not change the results reported here. The 1860 population census enumerates women working as schoolteachers, industrialists, artisans, factory workers and servants.
[44] Humphries, 'Enclosure'

including a measure of livestock density[45]. Furthermore, our variable of interest could be influenced by the proximity of urban markets and administrative and political entities, so distance to big cities and to provincial capitals is therefore included in the model. Including distance to provincial capitals is especially relevant because foundling hospitals were mostly based there[46].

b) Social context

Social and cultural factors are also likely to have played an important role either fostering or mitigating gender discrimination. In this regard, the potential role of different families systems is unclear. Strong family ties have been related to lower levels of female labour force participation and more traditional views on gender roles[47]. Family systems are also linked to inheritance rules and dowry systems, which are widely linked to skewed sex ratios in South and East Asia[48]. Analysing the Spanish case, Tur-Prats argues that co-residence with the mother-in-law increased the wife's contribution to farming work in traditional peasant families, which in turn has resulted in lower levels of intimate-partner violence nowadays[49]. Although nuclear households with partible inheritance prevailed, stem families were quite numerous in parts of northern Spain. In the latter, the heir brings a spouse to the family house where different generations then co-reside and, although inheritance rules prioritised sons, daughters could become the heiress in cases where there were no male alternatives. Following

[45] According to Voigtländer and Voth (2013), women in pre-industrial societies had comparative advantage in animal husbandry. Alesina et al. (2013) argue that gender norms are more unequal in societies where agriculture has been traditionally based on the use of the plough. Rearing cattle stands here in contrast to farming. Obviously women in families devoted to agriculture also contributed but their role was, or at least was perceived as, secondary.
[46] Pérez Moreda, *La infancia abandonada*.
[47] Alesina and Giulano, 'The power'.
[48] Das Gupta et al.', Why is son preference'.
[49] Tur-Prats, 'Family types'. Likewise, Valverde, 'Illegitimacy', argues that extended families provided an environment that reduced the incidence of child abandonment in the Basque country during the pre-industrial period.

Reher, the complexity of family arrangements has been measured as the number of female adults (aged 26-80) per household[50].

Due to the explicit prohibition of infanticide, the role of the Catholic Church appears to have been very important in explaining European families' behaviour on this issue[51]. Nevertheless, it is also true that religious authorities favoured a strong patriarchal system, so its effect on gender discrimination may not be altogether clear. Although Catholicism was the only religion present in Spain during this period, the level of identification with Catholic teachings could vary across regions. The importance of the Church has been proxied computing the percentage of priests over the total active population[52]. In addition, the educational level of the population, especially of mothers, has also been associated with the incidence of female excess mortality[53]. More education helps overcoming long-lasting cultural practices, so literacy levels have also been included in the model.

c) Environmental factors

Climatic factors have been put forward to explain part of the variation in sex ratios at birth[54]. Many diseases affect males and females differently, so sex ratios can also reflect these differences[55]. Anderson and Ray argue that, in India, China and Sub-Saharan Africa, infectious, parasitic and respiratory diseases account for a significant fraction of excess female deaths in childhood[56]. It is well known that infant mortality in

[50] Reher, *Perspectives*.
[51] Lynch, 'Why weren't'.
[52] This variable has been shown to be positively related to literacy levels during this period (Beltrán Tapia and Martínez-Galarraga 2015).
[53] Klasen and Wink, 'A turning point'.
[54] Warm temperatures are apparently related to higher sex ratios in Scandinavian countries. See Catalano, 'Ambient temperature'; Helle, Helama and Lertola, 'Evolutionary'.
[55] Waldron, *Too young*.
[56] Anderson and Ray, 'Missing women'.

Southern Europe is highest in summer due to the incidence of digestive diseases[57]. Regional variations in mortality rates are indeed pronounced within Spain and partly reflect diverse climatic conditions[58], so it may therefore be possible that high sex ratios are not caused by gender discrimination, but by a different disease incidence and/or composition by region.

In order to try to capture these environmental factors, measures of temperature and rainfall, together with altitude, ruggedness and distance to the coast, are included in the analysis and treated as controls[59]. Given the potential existence of further unobserved heterogeneity, it is important to also test the model including provincial fixed-effects. Tables A2 and A3 in the Appendix outline how all the variables employed here have been constructed and report summary statistics.

V

Equation (1) is estimated using a generalised linear model (GLM) that fits maximum-likelihood methods assuming a binomial distribution and using a logit function. This approach presents two advantages over a conventional linear model estimated using ordinary least squares[60]. On the one hand, this specification, by transforming sex ratios into logits, adequately deals with bounded data such as sex

[57] Wrigley, Davies, Oeppen and Schofield, English population.
[58] Cusso and Nicolau, 'La mortalidad'; Dopico and Reher, El declive; Ramiro-Fariñas and Sanz-Gimeno, 'Structural changes'.
[59] Coastal areas and northern Spain, colder and more humid, enjoyed lower mortality rates during the period of analysis. See Dopico and Reher, *El declive*; Ramiro-Fariñas and Sanz-Gimeno, 'Structural changes'. Moderate temperatures in summer and abundant rainfall limited infectious diseases (especially digestive diseases so important for infant mortality). The interior of the Peninsula constituted a region of extremely high mortality (see Dopico, 'Regional mortality'; Pérez Moreda, *Las crisis*), so distance to the coast has also been included as control. Although already partly captured by livestock density, the variable ruggedness may also further capture the relative importance of agriculture and cattle rearing. Controlling for environmental variables also helps alleviating potential bias arising from other unobserved factors that are related to climate/geography such as agricultural productivity or the type of diet available.
[60] Wilson and Hardy, 'Statistical analysis'.

ratios. On the other hand, this method also allows taking into account the accuracy of each observation, that is, the sample size underlying each sex ratio.

The results of regressing infant sex ratios on the set of variables explained above are reported in table 1. While column (1) presents the baseline specification, column (2) extends the model by adding provincial fixed effects. The number of infants belonging to this age-cohort might be relatively small in some districts, thus potentially introducing high levels of random variability in the dependent variable. Although, as discussed above, our specification takes into account the sample size from which our observed sex ratios arise, columns (3) and (4) repeat the exercise restricting the sample to those districts in which the population aged 0-1 is larger than 500 individuals in order to limit this concern. Columns (5) and (6) further test the robustness of our results by excluding those districts with extreme sex ratios (above 120). As expected, the model performs better (lower deviance from a theoretical model that would fit the data perfectly) when we restrict the analysis to the larger districts and the outliers are excluded[61]. More importantly, the results remain qualitatively unchanged regardless of the specification employed.

[Table 1]

It appears that living in urban and densely populated areas is associated with lower infant sex ratios. Although these effects may point to the idea that economic dynamism reduced gender discrimination, we should bear in mind that the higher overall infant mortality provoked by those contexts should have negatively affected boys more than girls, thus pushing infant sex ratios down[62]. It is therefore difficult to

[61] As the target population becomes larger, sex ratios approximate their *true* value, thus reducing the random component. Also, as the decrease in the deviance evidences, relevant regional variations are captured by the inclusion of province dummies.

[62] See Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls'. In 1900, while life expectancy at birth only reached 29.5 years in the provincial capitals, it was about 36 years in rural areas (Dopico and Reher, *El declive*, p. 14). Higher population densities, together with lacking or deficient water and sewage

disentangle these two influences. The coefficients on distance to the provincial capital and other big cities also suggest that proximity to urban centres reduces infant sex ratios. Again, it may be the case that, rather than facilitating differential female mistreatment, more rural areas enjoyed better access to food, as well as a lower incidence of respiratory and digestive diseases. Ramiro-Fariñas however argues that rural-urban differences in mortality rates are mostly explained by the presence of public institutions such as hospitals, prisons, mental and foundling hospitals[63]. If urban and densely-populated areas did then not suffer worse living conditions, the negative coefficient shown by these variables would suggest that their economic dynamism alleviated gender discrimination early in life.

Other economic and social factors clearly mitigated female infanticide and/or the mortal neglect of newborn girls. On the one hand, the existence of waged labour opportunities for women, by enhancing women's economic and social status, seems to have improved the value of girls within the household. On the other hand, the prevalence of extended families where different generations of women co-habited also had a beneficial effect on girls' survival[64]. The effect of these two variables gives support to a behavioural explanation of excess female mortality in the first year of life.

The rest of the variables included in the model do not show any clear association with the infant sex ratio. Although the coefficient on literacy levels shows the negative expected sign, its effect is not statistically significant. The lack of a more visible relationship might be explained bearing in mind that literacy levels in Spain were extremely low during this period. In this regard, it is likely that discriminatory practices

systems, resulted in deplorable living conditions and facilitated the spread of diseases. The presence of orphanages and hospitals also contributed to raising mortality rates in cities. The incidence of respiratory diseases on childhood mortality was especially higher in towns than in the countryside. The urban penalty would only disappear in the 1920s. On these issues, see Dopico and Reher, El declive; Ramiro-Fariñas and Sanz-Gimeno, 'Structural changes', Reher, 'In search'.

[63] Ramiro-Fariñas, 'Mortality'.

[64] Although the effect of *family type* becomes statistically insignificant when provincial dummies are included, this is because most of the variation in this variable takes place at that level of aggregation.

mostly occurred in the lower segments of the population, where illiteracy was widespread, so it is possible that we do not have enough variation in our data. Likewise, considering the poor knowledge about the spread of diseases, education could perhaps add little to improve child survival. Even in the early 20th century, women were apparently relatively slow to modify their habits regarding infant feeding and care[65]. Similarly, infant sex ratios seem to be lower in regions where the presence of priests is higher. Although religious observance or the moral control exerted by the Catholic Church may have mitigated female infanticide and/or the mortal neglect of newborn girls, its effect is not statistically significant.

The intrinsic random nature of the dependent variable may mask the effect of some of the variables analysed here. Also, as commented above, it is plausible that some counteracting effects offset the potential impact of gender discrimination. For instance, poverty and the number of children within the household constrain family resources and are thus likely to trigger gender discrimination towards girls. However, economic deprivation, by negatively affecting overall health conditions, also tends to take a greater toll in boys[66]. Likewise, the positive influence that the existence of livestock may have had on the perceived value of women and, consequently, on lower sex ratios might have been counterbalanced by the resources they provided to families, especially meat and dairy products, thus improving their net nutritional intake what, in turn, reduced the male excess mortality present both in utero and during the first months of life.

[65] Reher and Sanz-Gimeno, 'Childhood mortality patterns', p. 27.
[66] In this regard, using micro-level data from a medium-size industrial town in Catalonia, Ramon-Muñoz and Ramon-Muñoz, 'Sibship size', show that, c.1860, boys from single-child families were much taller than those raised in larger families.

Although female under-reporting was not the main factor behind the extreme infant and child sex ratios observed in 19th-century Spain[67], it should be stressed that under-reporting may affect our results if the poor enumeration of girls was somewhat related to the variables analysed here. However, although this problem may be an issue during the first year of life, this concern is less plausible at older ages. Nevertheless, in order to overcome this issue and test the robustness of our results, we repeat the exercise but employing now sex ratios during childhood. Table 2 presents the results of this analysis: while columns (1) to (4) focus on children aged 1-5, columns (5) to (8) centre on those aged 6-10[68]. By controlling for the sex ratio in the previous age-cohort, the specifications reported in columns (3) and (4) and (7) and (8) allows shedding light on whether differential treatment continued throughout childhood.

[Table 2]

These results not only strongly confirm our previous findings but also evidence that the same factors behind the variation in infant sex ratios continued to affect sex-specific mortality patterns at older ages[69]. Although anecdotal evidence is scarce, a report from the doctor of Tineo, a small town in North Western Spain, suggests that girls continued to be treated differently as they grew older: deaths from anaemia and lung tuberculosis, resulting from nutritional deprivation and unhygienic conditions,

[67] Although parents may have failed to report girls early in life, they should be visible in the census when older. The evolution of sex ratios at older ages (1-5) and (6-10) mimic that of infant sex ratios, thus evidencing that the poor enumeration of girls cannot account for the extreme sex ratios reported here (Beltrán Tapia and Gallego-Martínez, 'Where are the missing girls', p. 5). Similarly, although pointing to significant under-registration in the early population censuses, David Reher does not find that under-reporting varied by sex ('En los umbrales', 254). On these issues, see also Reher and Valero Lobo, *Fuentes*; and Gozálvez Pérez and Martín-Serrano Rodríguez, 'El Censo'.

[68] Given that the groups object of study are large enough, it is not necessary now to restrict the analysis to the larger districts: except one district whose sex ratio at age 6-10 is based on 879 children, all the remaining districts contain more than 1,000 children in each age-cohort. In any case, repeating the exercise restricting the sample to the larger districts as done in table 1 does not alter the results reported here.

[69] Although our results are robust regardless of the age-group employed, we cannot completely rule out the possibility that female under-registration may also partly explain biased sex ratios in rural areas far from administrative centres.

disproportionately affected female children[70]. Apart from discrimination in the allocation of resources within the household, Horrell and Oxley also point to the 'double burden', arising from working both outside and within the domestic sphere, that girls usually suffered without compensating nutrition[71]. Under circumstances of economic deprivation, excess labour would reduce net nutritional status and increase girls' susceptibility to diseases. Sarasúa indeed claims that young girls in Spain were supposed to help their mothers with housekeeping and taking care of their siblings, an obligation which did not fall upon their male brothers[72].

The lack of association between infant sex ratios and those at aged 1-5 is nonetheless puzzling. This may indicate that some sort of female under-reporting was probably important during the first year of life. Alternatively, we should note that the mortality crises that took place between 1855 and 1858 did influence the older age-cohorts but hardly affected infant sex ratios in 1860. Given that boys were more vulnerable to adverse conditions, if the incidence of famines and epidemics was higher in areas that for other reasons had more boys (i.e. less dense, urbanised areas), those initially high sex ratios would have been mitigated by the subsequent male excess mortality.

In any case, we should be cautious when comparing the coefficients on the sex ratios of the different age-groups because, apart from the differential incidence of the 1850s mortality crises, other factors are likely to affect them in complex ways. The physiological survival advantage of girls, for instance, decreases as children get older. Likewise, due to the protection afforded by breastfeeding, the closer infants are to birth,

[70] Borderías et al., 'Gender inequalities', p. 183.
[71] Horrell and Oxley, 'Gender bias'.
[72] Sarasúa, 'El acceso'.

the lower the incidence of economic conditions on mortality[73]. Once older children are weaned, their sensitivity to economic conditions increased due to insufficient hygiene in infant feeding practices[74]. Furthermore, sex-specific migration is less probable at younger ages. In this regard, sex ratios increase as we move further from big cities but this pattern is less clear for older children (aged 6-10). Although evidence on migratory patterns for children is lacking, it is plausible that, given the risks associated with migration, boys were more likely to move, or sent away, than girls.

Lastly, in order to further test the robustness of our results, we have re-estimated our model but using infant and child sex ratios in 1887 as dependent variables. Although the quality of the 1860 Population Census has been favourably considered by the literature[75], Reher argues that the 1887 Population Census constituted a great improvement from the previous ones[76]. The information provided at the district level by the latter, however, is not so rich as in the 1860 Census and it is thus not possible to capture important features of our previous analysis such as land access inequality, poverty rates or livestock density. Therefore, we have tested whether our previous results, which refer to variables measured from the 1860 Population Census, hold when linked to sex ratios extracted from the 1887 Population Census[77]. As shown in Table A.4 in the Appendix, the results of this exercise provide further evidence that our previous analysis is not biased by potential problems of that Census and confirm the picture described above.

[73] Reher and Sanz-Gimeno, 'Mortality', p. 139. Providing the health and nutritional status of the mother does not affect the health of the newborn.
[74] It should be noted that older children may be more able to resist certain forms of infection than very young infants. Ibid, p. 140.
[75] Gozálvez Pérez and Martín-Serrano Rodrígue, 'El censo', p. 336.
[76] Reher, *España a la luz del censo de 1887*, p. 33.
[77] We are grateful to David Reher, *España a la luz del censo de 1887*, for kindly sharing his data.

VI

Discriminatory practices resulting in excess female mortality early in life constituted a veiled feature of Spanish society during an important part of the 19th century. The results presented here indicate that, in a strongly patriarchal society, certain economic and social conditions were likely to trigger gender discrimination against newborn and/or young girls during the period under study here. On the one hand, the existence of wage labour opportunities for women and the prevalence of extended families where different generations of women cohabited clearly mitigated discriminatory practices. On the other hand, excess female mortality in infancy appears to be higher in rural areas. Although the relative value of girls in these contexts was probably lower than in denser and more urbanised areas and, therefore, may have promoted female discrimination, it is also possible that healthier conditions resulting from a better access to nutrition and less exposure to the disease environment prevalent in densely populated areas contributed to reduce boys' excess mortality and thus increase male to female sex infant and child sex ratios.

The findings reported here are nonetheless tentative. Given the random nature of the subject of study, research on sex ratios should rely on very large samples[78]. Although our smallest districts never contain less than 200 children aged 0-1, this sample size may not be big enough as the high volatility of this variable evidences. We have nonetheless employed statistical techniques that mitigate this concern. The analysis of the older age-cohorts, whose sex ratios are based on much larger populations, also helps alleviating this problem. Similarly, female under-enumeration might also affect infant sex ratios. This issue, however, is unlikely to be present in older age-groups and our results persist when analysing these cohorts. Likewise, although we

[78] Gelman and Weakliem, 'Of beauty'.

have tried to cover as many variables as possible, it is still possible that we may be missing some important factors. We cannot thus claim that there is a direct causal link between the variables examined here and unbalanced sex ratios.

Rather than the result of female infanticide or the mistreatment of young girls, the excess female mortality discussed here was likely due to an unequal allocation of resources within the household. In high-mortality environments, a slight discrimination either in the way young girls were fed or treated when ill, as well as in the amount of work they were entrusted with, would easily lead to higher morbidity and mortality rates. Given its own nature, these subtle forms of gender discrimination are difficult to detect. The type of discriminatory practices suggested here probably only occurred among certain segments of the population, so relying on aggregate data is likely to conceal relevant information. Uncovering patterns of gender discrimination in pre-industrial Europe thus requires putting certain populations under a magnifying glass. The evidence examined nevertheless is highly suggestive and should serve as a basis to further research. We hope that this modest step will lead other scholars to become involved in such a neglected topic.