**ORIGINAL PAPER**

# Economic development, female wages and missing female births in Spain, 1900–1930

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## Abstract

Focusing on Spain between 1900 and 1930, a period characterised by significant structural transformations and rapid economic growth, this article shows that the sex ratio at birth (SRB) was abnormally high, at least until the 1920s. Apart from questioning whether female under-registration and different mortality environments alone can explain the results reported here, our analysis of regional information indicates that SRBs were higher in provinces where the economic structure was dominated by agriculture and manufacturing (relative to the service sector). In addition, exploiting the annual variation in low-skilled wages at the province level makes it possible to distinguish between the roles played by under-registration and outright neglect: while higher wages could increase the opportunity cost of registering a female birth (and therefore result in higher SRBs), they could also reduce the pressure to neglect female babies (and therefore result in lower SRBs). We find evidence of both effects (income and opportunity cost) of wages on SRBs between 1914 and 1920 in Spain, a period in which WWI arguably subjected the Spanish economy to an exogenous demand shock. These two effects, however, imply very different discriminatory practices. In fact, on average, the income effect was larger than the effect arising from the opportunity cost, which supports the idea that female neglect around birth was more prevalent than previously assumed during the early twentieth century in Spain. As expected, the relationship between wages and the SRB vanished during the 1920s, along with the unbalanced SRB. These results stress that gender discrimination around birth does not necessarily disappear with economic growth unless this process is accompanied by expanded labour opportunities for women.

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## 1 Introduction

Sex-selective abortions, female infanticide, and other types of female neglect around birth constitute a well-known phenomenon in low-income countries with strong son preference (Hesketh and Xing 2006; Echavarri and Ezcurra 2010). Chao et al. (2019) identify 12 countries which exhibited an unbalanced sex ratio at birth (SRB) between 1970 and 2017, resulting in around 25 million missing female births around the world.[1] Although exacerbated by fertility decline and the availability of prenatal sex determination technologies, these gender-discriminatory practices tend to be rooted in the past and the traditional status of girls and women in those societies (Bhaskar and Gupta 2007; Drixler 2013; Gupta 2014). The underlying son preference is linked to economic, social, and cultural considerations affecting the perceived value of girls (Das Gupta et al. 2003; Guilmoto 2018). In rural areas, boys are considered a crucial labour input for the family farm and the lack of female employment opportunities undermines girls' relative status (Rosenzweig and Schultz 1982). Cultural practices reinforce the economic implications of having a daughter instead of a son. Patrilocality and strict dowry systems constitute a drain on household resources and a wasted investment because daughters end up living with their in-laws (Dyson and Moore 1983; Bhalotra et al. 2020).[2] Preference for sons is reinforced under adverse conditions due to the need to allocate limited household resources (Das Gupta and Shuzhuo 1999). Additionally, women are disadvantaged in societies where sons are responsible for worshipping their ancestors and where lineage is solely traced though males (Abrevaya 2009; Almond et al. 2013). Interestingly, son preference and the subsequent sex-selective abortions do not necessarily disappear with economic growth or the spread of education, at least during the early stages of economic development, as the Indian experience illustrates (Echavarri and Ezcurra 2010).

Although previous literature has stressed that cultural and religious values, as well as household formation patterns, prevented female infanticide in historical Europe (Derosas and Tsuya 2010; Lynch 2011), recent research argues that female infanticide was more pervasive than traditionally thought, especially in Southern Europe. Baptismal records, for instance, suggest that this practice could have been in place in Early Modern France and Italy (16th-18th Centuries), especially under adverse circumstances (Hanlon 2016, 2022). Moreover, there is some evidence to suggest that female infanticide may have persisted both in France and Italy throughout the nineteenth century (Bechtold 2001; Derosas 2012; Beltrán Tapia and Cappelli 2022;

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[1] This figure is of course subject to a lively debate. See, for instance, Sen (1990), Klasen and Wink (2002) and Anderson and Ray (2010).

[2] In patrilocal systems, the responsibility for supporting parents in their old age also falls to sons. Kinship systems that isolate women from their original families also tend to be deleterious to female status.

see also Beltrán Tapia and Szoltysek 2022). Similarly, quantitative and qualitative evidence points to female neglect right after birth in modern Greece, at least until the 1920s (Beltrán Tapia and Raftakis 2022).[3]

Female neglect around birth was also visible in some rural areas in nineteenth-century Spain, especially at higher parity and among landless and semi-landless families, who were subject to harsher economic conditions and therefore more likely to resort to extreme decisions (Beltrán Tapia and Marco-Gracia 2022).[4] Not only was infanticide known in Spain, prompting specific regulation, but it also carried a mild punishment if it was done to safeguard the honour of the mother and in the first days after birth.[5] It is possible that this permissive legal context and the underlying social norms around death during the first days of life facilitated the prevalence of a moral construct that allowed female infanticide by action or omission (fatal neglect). It seems, however, that contextual factors were probably relevant since some regions did not exhibit a skewed SRB (Llopis et al. 2022).[6] Interestingly, using an extremely large number of parish records in Biscay, Catalán Martínez (2022) shows that the SRB increased well beyond the expected values during the last decades of the nine-teenth century, with the rapid industrialisation that this area was experiencing. The author argues that this process led to an increase in the prevalence of the nuclear family model, which, combined with the difficult circumstances faced by some seg-ments of the population, could have had a negative effect on girls. It is interesting to note that industrialisation in Biscay was heavily based around metal industries, a feature that profoundly altered the labour market in favour of males. By contrast, studying the development of the textile industry in the city of Alcoy between 1860 and 1914, Beneito and García-Gómez (2022) find that the growing contribution of female wages to household incomes reduced the relative mortality rates of female infants and girls. Neonatal discrimination against girls resurfaced again during the early 1940s due to the extremely difficult economic conditions brought about by the Spanish Civil War and the subsequent autarchic period (Echavarri 2022). The evi-dence presented so far therefore seems to suggest that discriminatory practices aris-ing from son preference in the Spanish context resulted mostly from poverty and the limited wage labour opportunities for females.

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[3] Child abandonment also especially affected female infants in some of these regions (see Beltrán Tapia and Szoltysek 2022, for a discussion on this issue).

[4] These authors also suggest that the dowry system may have also acted against girls (Beltrán Tapia and Marco-Gracia 2022, 236).

[5] As a punishment for this practice, the 1822 Spanish Penal Code established the expulsion from the village (and a radius of 50 km) for 25 years (Ministerio de Gracia y Justicia, 1822, art. 612). In 1848, expulsion was replaced by a correctional/minor prison sentence (Ministerio de Gracia y Justicia, 1848, art. 327), a regulation that persisted in the 1870 (art. 424) and 1932 (art. 416) Penal Codes (Ministerio de Gracia y Justicia, 1870a, Ministerio de Justicia 1932).

[6] Averages over time however conceal important differences: the SRB in the localities sampled in the province of Guadalaraja, for instance, exhibited extremely high values in the period 1860–1879 (Llopis et al. 2022, 21).

This article contributes to the literature by analysing the Spanish experience between 1900 and 1930, a period characterised by significant structural transformations and rapid economic growth, and it focuses on the economic dimensions that were behind female neglect around birth. On the one hand, it shows that the SRB in Spain was abnormally high until at least the 1920s. The national average, however, conceals important regional differences, so this article analyses the evolution of province-level SRBs over this period. Apart from questioning whether female under-registration and different mortality environments alone can explain these regional patterns, our study explores how the changes associated with economic development interacted with female neglect around birth. In this regard, our results indicate that SRBs were higher in provinces where the economic structure was dominated by agriculture and manufacturing (relative to the service sector). This finding is consistent with previous studies showing how, in nineteenth-century Spain, the sex ratio in infancy and childhood was lower in areas where there were greater employment opportunities for women (Beltrán Tapia and Gallego-Martínez 2020).

In addition, to further analyse whether behavioural factors lie behind the relationship between economic development and the SRB, we created a yearly province-level panel data set that, for the first time, includes information on wage labour opportunities separately for men and women for manual work in low-skilled positions (*braceros*). Wage levels have profound implications for the cost of raising children, as they influence nurturing and registration costs. On the one hand, nurturing costs are relatively lower for richer families than for poorer ones (Das Gupta and Shuzo 1999; Beltrán Tapia and Marco-Gracia 2022), and we therefore expect wage variation to produce an *income effect*: higher wages move families away from subsistence levels and thus reduce the need to select among their offspring. On the other hand, given that the SRB is measured at birth registration, the increase in wages produces an *opportunity cost effect*. That is, registering a birth entails a time-consuming activity at a specific point in time: a family member (usually the father) will spend time going to the registry instead of contributing to the family income. As such, any increase in wages in turn increases the opportunity cost of registration.

The analysis shows that, during World War I, which arguably subjected the Spanish economy to an exogenous demand shock, an increase in wages resulted in lower SRBs, thus evidencing that the income effect was larger than the opportunity-cost effect. Crucially, this result suggests that female under-registration was not the only explanation for the high SRBs during this period. The fact that we observe that higher wages were relatively beneficial to female babies indicates that the rise in wages reduced the pressure to neglect them. Importantly, this result is only observed during the winter season, when wage levels are linked to the availability of agricultural jobs and seasonal unemployment (Robledo 1993). Moreover, the protective effect of female wages was twice as large as that of males, thus highlighting the relevance of behavioural drivers of SRB decreases. A one-unit increase in women's average wages during the winter season reduced the predicted SRB by 1.2 male births (per 100 female births).

Likewise, in order to shed further light on the proposed causal relationship between real wages and the SRB, and to distinguish between the role played by under-registration and outright neglect, we analyse two sources of exogenous

variation in the status of girls and women in society. To examine the first source, which has its origins in the medieval period, we divide the provinces according to the historical prevalence of certainly family types, either nuclear or stem families. In the former, women's bargaining power was lower (Tur-Prats 2019), rendering the nurturing of girls more costly than that of boys. Interestingly, the distinctive historical characteristics of nuclear and stem provinces also led to specific inheritance systems that affected the (long-term) cost of raising girls. In nuclear provinces, inheritance laws forced parents to divide the family property equally between sons and daughters, regardless of their preferences (Echavarri 2022). We expect that the link between increasing wages and lower SRBs is stronger in those areas in which raising girls was more costly (larger income effects). The second source of exogenous variation is given by societal differences in the relevance of reporting women's status. In provinces where reporting female wages was unimportant, and therefore only male wages were reported, the opportunity costs in terms of registering female births would likely be higher, so we expect that an increase in wages would lead to higher SRBs (larger opportunity cost effects).

We find evidence of both effects (income and opportunity cost) of wages on SRBs between 1914 and 1920 in Spain, thus providing further support for the potential relationship between wages and the SRB. These two effects, however, imply very different discriminatory practices. While the opportunity cost reflects the presence of under-registration of female births, the income effect captures some sort of neglect that led to a rise in female mortality around birth. In fact, on average, the income effect is found to be larger than the effect arising from the opportunity cost, which supports the idea that female neglect around birth was more prevalent than previously assumed during the early twentieth century in Spain. Finally, it is worth mentioning that our results stress that discriminatory practices against female infants do not necessarily vanish with economic growth, unless this process is accompanied by expanded labour opportunities for women. As expected, the relationship between wages and the SRB disappeared during the 1920s, along with the imbalance in the SRB, as sustained opportunities for women helped erode son preference and therefore, the need to select the sex of one's offspring.

## 2 Data and Historical background

### 2.1 Sex ratios at birth, 1900–1930

The Spanish government only started to systematically compile vital statistics in 1858, when state officials gathered the number of baptisms from parish records (Livi Bacci 1968). Prior to that date, baptismal information was not centralised and was managed locally by the parish and archbishopric. This effort was, however, short-lived, and no further reports were published for the years between 1871 and 1899.[7] During this time, Spain created the civil registration office (1870) in order to have

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[7] Although more birth statistics were published for the years 1886–1892, they do not distinguish between male and female births (Instituto Geográfico y Estadístico 1895).

a public record of all births, marriages and births. Although the new system experienced many problems during the first years, it seems that, by the end of the nineteenth century, the information was of fairly high quality (Brel Cachón 1999).

These civil registration data, gathered in the yearbooks of the Natural Movement of the Population, allow us to compute the SRB (the number of male births per hundred female births). Following the accepted procedure in the literature, the incidence of missing female births is inferred by comparing the SRBs with the biologically expected benchmark in the absence of neonatal discrimination. In a recent study, Chao et al. (2019) report that the median SRB lies around 105.8 in contemporary societies where it is assumed that sex-selective abortion and/or female infanticide does not exist. Figure 1 shows that none of the 95% confidence intervals for the average SRBs at province level for the period 1900–1930 contain the biologically expected value of 106 male births per 100 female births. This figure also shows how the SRB seems to have declined gradually until 1920, before dropping more sharply between 1921 and 1931.[8]

Although we follow the literature in using the 105–106 benchmark as a measure of the biological SRB, there is very little evidence of what the SRB should look like in the past (Visaria 1967; Chahnazarian 1990). However, there are reasons to hypothesise that the historical figure in absence of human manipulation might be slightly lower, thus making the Spanish figures even more striking. Due to the female biological advantage, more male foetuses tend to die before birth (Di Renzo et al. 2007; Dipietro and Voegtline 2017)[9]; moreover, several studies have found that fewer boys are born under adverse circumstances (Schacht et al. 2021; Morse and Luke 2021). The probability of miscarriages was indeed higher in the harsher circumstances that characterised Europe in the past (Woods 2009), which would push the "natural" SRB down (Beltrán Tapia and Marco-Gracia 2022; Beltrán Tapia and Szoltysek 2022). In addition, in Spain during the period under study, a child was legally counted as born alive if it survived 24 h after having been separated from the mother (Brel Cachón 1999, 97; Echavarri 2022). Many infants in fact died before being registered, and this issue especially affected boys due to their greater vulnerability (Waldron 1998; Zarulli et al. 2018). Therefore, the observed sex ratios can again be considered a lower bound because more males than females would have died during the first day of life. The potential bias nonetheless probably declined over time as perinatal survival rates improved during the first decades of the twentieth century.

The national average nonetheless conceals stark regional differences. Figure 2 depicts province level SRBs in the four census years between 1900 and 1930 and confirms the existence of clear spatial patterns.[10] While the relative number of male

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[8] The statistically significant change in the pace of the decline before and after 1920 ($p < 0.01$) does not seem to have occurred in response to a one-time exogenous shock (such as the end of WWI). We find no evidence of a random discontinuity in levels in 1920. The break observed around 1920 is statistically significant only for time windows longer than four years (see table A1 in Appendix A in supplementary material).

[9] The mechanisms behind the higher vulnerability of male foetuses are still largely unknown (Dipietro and Voegtline 2017). As well as in perinatal and neonatal mortality, the female biological advantage continues through infancy and childhood (Waldron 1998; Drevenstedt et al. 2008; Peacock et al. 2012; Peelen et al. 2017; Zarulli et al. 2018).

[10] In order to mitigate random noise, we compute 3-year averages. However, the overall picture hardly changes if we just use the information from the corresponding census year.

and female births lies around the biologically expected ratio in many provinces, the SRB in particular regions is consistently above 110, especially in south-eastern and north-western Spain. Some of these provinces (Asturias, Albacete, Almería and Murcia) exhibit values well beyond 115, and sometimes even close to 130 male births per 100 female births (see also Figure A1 in Appendix A in supplementary material).[11] Although SRBs remain relatively unbalanced in most of these provinces in 1930, their absolute values substantially decreased during the 1920s.

## 2.2 Female under-registration?

Spanish law obliged families to register their newborns within three days of birth (Ministerio de Gracia y Justicia 1870b, art. 45). Failure to register a son or daughter entailed a substantial fine: the 1889 Civil Code established that the penalty for those failing to register births would range between 20 and 100 *pesetas* (Ministerio de Gracia y Justicia 1889, art. 331), a sanction equivalent to at least one week of manual low-skilled wages for men in the 1914 harvest season. Moreover, families had important incentives to register their offspring, as birth registration was proof of a legitimate descendant, offering protection, for instance, in the event of inheritance disputes (Ministerio de Gracia y Justicia 1889, art. 108).[12]

Although civil registration was compulsory and has been argued that the quality of birth data in the period under study is relatively good (Gómez Redondo 1992), it is true that records of the number of births may suffer from some omissions, even during the first decades of the twentieth century, and therefore potentially contaminate some of the figures employed here (Martínez Carrión 1983, 34–38; Gonzalvez Pérez 2003). In some scenarios, the costs of registration may have outweighed its benefits. One reason registration costs could have been high is because, although registration took place in municipal courts,[13] the time and difficulty of the journey for those living in sparsely populated areas might have been dissuasive, especially for less privileged families. In non-flexible working conditions, the journey to the registry office may have meant forgoing one full workday. In addition, the introduction to the 1920 Population Census states that religious prejudices are responsible for the under-registration of births in the civil registry in rural areas (Brel Cachón 1999, 93). Female under-registration, arising from entrenched cultural practices, is indeed routinely assumed to be the main explanation for the unbalanced SRBs observed during this period (Carreras and Tafunell 2005, 107; Duran Herrera 2014, 104).[14]

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[11] Studying infant mortality rates during the early 1930s, Gómez Redondo (1992, 214) also noticed discriminatory practices against girls in Murcia. Province names are included in Figure A2 in Appendix A in supplementary material.

[12] Lack of birth registration, on the other hand, was not an obstacle to accessing the labour market at that time. In litigation arising from accidents at work, it was the father who had to testify about the age of his child (Navas González 2022, 115).

[13] The general registration law of 1870 stated that birth registration would be carried out at the municipal level (Ministerio de Gracia y Justicia 1870b, art. 3). The civil code in force in the period under study also specifies that birth registration was carried out in the municipal courts (Ministerio de Gracia y Justicia 1889, art. 326).

[14] The propensity to protect the rights of offspring could, for instance, generate gender inequality in a social context where the perceived value of boys is higher than that of girls (see also Catalán Martínez 2022).
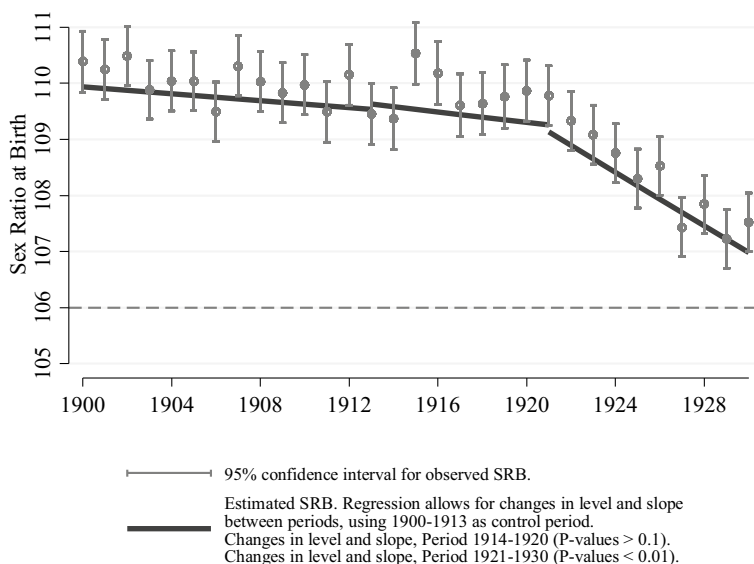
**Fig. 1** Sex ratio at birth. Spain, 1900–1930

Nevertheless, it is worth stressing that there is hardly any direct evidence, even anecdotal, indicating that some parents chose not to register their female babies.

According to Gómez Redondo (1992, 8–14), the main source of inaccuracies in the vital statistics of the first decades of the twentieth century is the inconsistencies derived from the definition of "live birth." The civil code indicated that babies dying during childbirth and within the first day of life should not be counted as a live birth, but this rule caused confusion among the authorities in charge of registering these events. This issue, however, should not affect males and females differently. If anything, given the greater vulnerability of male infants, more boys should be subject to these uncertainties.[15] While the reports attached to birth statistics make it clear that the reported figures are not perfect, they do not mention the possibility that potential under-registration varied by sex (Instituto Geográfico y Estadístico 1901; 1903).[16] The same is true of the reports published during the second half of the nineteenth century, which could also have raised this issue (Junta General de Estadística 1863; Instituto Geográfico y Estadístico 1877, 1895). Furthermore, one such report also compiled all of the legislation referring to birth registration since 1813, and these legislative texts do not explicitly mention the possibility of girls being more subject

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[15] Blanes (2007, 60–63) estimates the under-registration of births comparing the number of surviving children using vital statistics (births minus deaths) with the corresponding cohort of children aged 5–9 registered in the population censuses. This method results in an under-estimation of 2.3 and 6.6 per cent of male and female births in 1911–15 but it fails to account for the fact that the quality of death statistics, especially during infancy, was also lacking. Given that males were especially vulnerable, this exercise under-estimates male deaths and therefore the under-registration of male births.

[16] The annual report containing the Spanish vital statistics published in 1905 considers tan around 5–6 per cent of births went unregistered between 1900 and 1905.
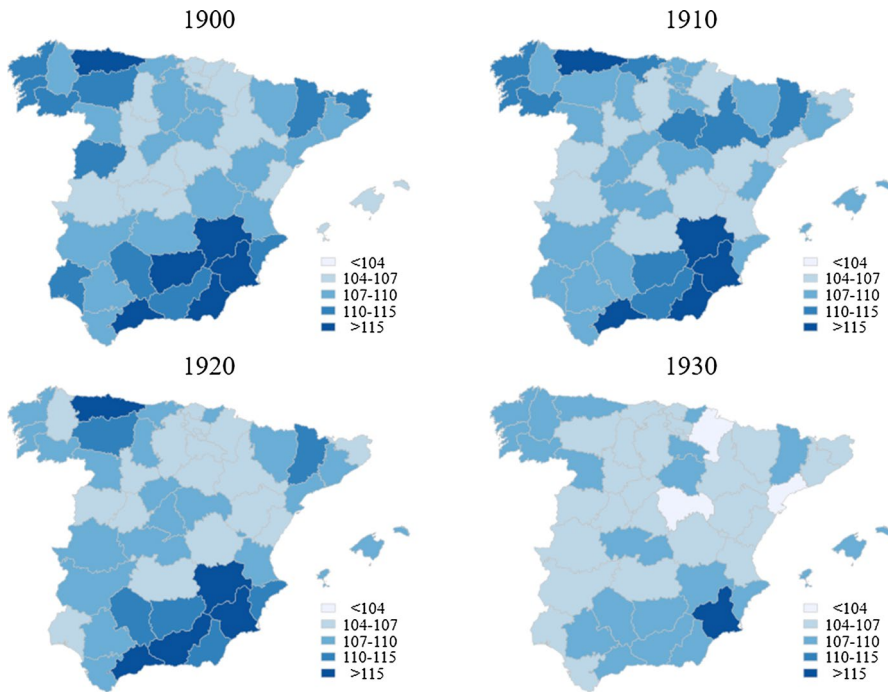
**Fig. 2** Sex ratio at birth (by province). Spain, 1900–1930. Source: Spanish vital statistics (1900-1930).

to registration problems during the nineteenth century (Junta General de Estadística 1863). In fact, contemporary reports suggest that sex-selective under-registration could even have targeted boys in order to avoid military recruitment later on (Ministerio de Trabajo, Comercio e Industria 1922; Brel Cachón 1999, 93).

The notable variation in the relative number of male and female births across regions allows us to shed further light on this issue (see Fig. 2). Although there is considerable year-to-year variation and random noise probably plays a role in the smaller provinces, part of the temporal and geographical variation in the SRB could potentially be explained by differences in the mortality environment. More males are likely to die in utero in provinces and/or years in which conditions were particularly harsh, thus leading to lower SRBs (Schacht et al. 2021; Morse and Luke 2021). Given that there is no direct information on conditions affecting foetuses in utero for this early period, we use infant mortality rates as a proxy for the overall health environment. As with the birth statistics, we collect the number of infant deaths at province level from the yearbooks of the Natural Movement of the Population. However, linking infant mortality rates and the SRB yields the opposite pattern to what we would expect (see Figure A3 in Appendix A in supplementary material). If anything, harsher conditions are associated with a larger number of male births relative to female births, suggesting that something else is going on.

The published statistics distinguish between male and female deaths, thus allowing us to explore the nature of the relationship between the SRB and the gender
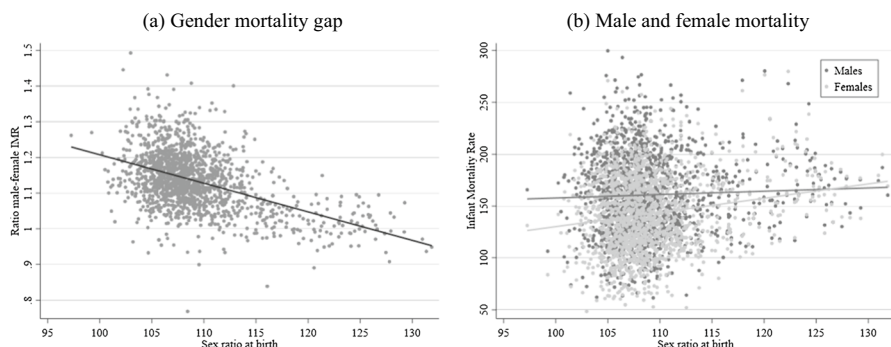
**Fig. 3** Gender mortality gap and the sex ratio at birth, 1900–1930 **a** Gender mortality gap **b** Male and female mortality

mortality gap during infancy, measured by the ratio between male and female infant mortality. Son preference may affect not only the selection of children who will survive the first days of life, but also those who will survive the first year of life. In this regard, son preference can result in a lower ratio of male-to-female mortality arising from either lower male mortality rates (protection) or higher female mortality rates (neglect). During the first third of the twentieth century in Spain, high SRBs were associated with more girls (or less boys) dying during infancy (Fig. 3a). This pattern is extremely telling for two main reasons. On the one hand, it suggests that some sort of gender discrimination was happening both around birth and during infancy. On the other hand, it mitigates the possibility that our results are driven by registration issues. In this regard, if female under-registration increased the SRB, female under-registration of deaths would increase the male-to-female infant mortality ratio.[17] What we observe (Fig. 3a), however, is exactly the opposite: the male-to-female mortality ratio is lower when the SRB is higher. Looking at Fig. 3a, we cannot discriminate between the possibility that families provided extra protection to sons and the possibility that they neglected daughters. However, plotting the SRB against male and female infant mortality rates suggests that gender discrimination mostly worked through female neglect: while the SRB and the male infant mortality rate are almost independent, high SRBs are associated with higher female infant mortality rates (Fig. 3b).

Moreover, we can assume that, even if under-registration was an important issue here, its importance would vary across provinces in response to provincial differences in the quality of the registration process, and it would decrease over time due to general improvements in registration procedures. Regressing annual SRB between 1900 and 1930 on the whole set of province and year dummies leaves 27 per cent of the variation in the data unexplained (360 observations: 31 years × 47

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[17] As with birth registration, under-registration of deaths was more problematic during the first days of life (Brel Cachón 1999, 96, 107–110). Stillbirths also posed problems since it was unclear whether they should be registered as births and/or deaths (Gonzalvez Pérez 2003; Duran Herrera 2014). See also the detailed discussion in Llopis et al. (2022), where it is argued that the under-registration of deaths during infancy was indeed higher for girls.

provinces; *R*-squared = 0.73). In order to mitigate concerns about the possibility that our results mostly reflect the quality of the registration, this article will solely focus on this unexplained variation. This is a conservative research strategy because province and year dummies may capture not only potential female under-registration, but also other discriminatory practices that increased female mortality around birth. The abnormally high SRBs detected in Spain during the first third of the twentieth century nonetheless deserve further attention, so the next sections explore whether economic considerations help explain the evolution of the ratio between male and female births.

### 2.3 Urbanisation, economic opportunities, and missing female births, 1900–1930

The evolution towards a modern society may have influenced the SRB. Although the first steps towards modernisation were taken during the nineteenth century, industrialisation and economic growth in Spain accelerated after 1900 and particularly during the 1920s (see Table 1). Increasing migratory flows fuelled the concentration of population in urban areas and this economic dynamism not only brought about a rise in living standards and profound social changes, but also meant disruptions and growing inequalities. Previous literature acknowledges that female opportunities for wage labour expands with the development of the manufacturing and service sectors, raising the visibility of women in socially-valued roles and facilitating women's collective action (Evans 2019). It is nonetheless possible that the first waves of rural–urban migration may have benefited from women's expanded opportunities only to a limited extent, as families may have experienced adaptation pressures. They may have had to adapt their skills and learning acquired through the accumulation of knowledge over generations to a new context in which those skills may not have been the most appropriate (for example, moving from mining or agriculture to industrial work). Moreover, it is possible that women initially lost employment opportunities, as women who had been active in rural areas may not have achieved the same employment status in urban areas at the outset.

**Table 1** Economic growth and structural change, 1900–1930

|  | 1900 | 1910 | 1920 | 1930 |
|---|---|---|---|---|
| GDP per capita (in thousands, GEKS $2011) | 3184 | 3359 | 3859 | 4668 |
| Agriculture and fishing (% of the active population) | 66.3 | 66.0 | 57.2 | 45.5 |
| Urbanisation (%) | 32.2 | 34.8 | 38.4 | 42.6 |

Source: Prados de la Escosura (2017), Carreras and Tafunell (2005, 150) and Rosés et al. (2010). Urbanisation refers to the percentage of the population living in population centres with more than 10,000 inhabitants

In this regard, the impact of economic growth on women's status and subsequently on the importance of missing female births would likely be dependent on the type of employment that was being generated and whether or not women were indeed benefiting from the new economic opportunities (Beltrán Tapia and Gallego-Martínez 2020). While the textile sectors, for instance, tended to largely employ women, the same is not true of other economic activities. As well as the existence of female labour opportunities, another important consideration might be the relative wage levels. If women are poorly remunerated, this can limit their bargaining power within the household and may therefore sustain the male breadwinner ideology. Even if women's status and son preference had changed little during our period of study, economic growth alone could have helped female survival at birth. The potential increase in families' wealth and living standards may have alleviated the pressure to select which of their offspring would survive. Likewise, urbanisation and economic growth went hand in hand with declining fertility, a dimension that may have also influenced the pressure to select among offspring. It is therefore an empirical, yet unexplored, question whether the early social changes towards modernity reduced or widened the gap in the likelihood of male and female infants surviving childbirth and therefore the observed SRB. Using province-level panel data, the following sections explore: (1) the extent to which structural change and economic modernisation is associated with missing female births; and (2) the extent to which this association may be related to variation in under-registration (opportunity cost effects) or outright neglect (income effects).

In addition, we develop a conceptual framework for analysing families' decisions that extends the work by Lin et al. (2014) and helps to interpret the relationship between wages and the SRB (see Appendix B in supplementary material). The first theoretical result shows how, if the income effect were larger than the opportunity cost effect, we would expect an overall negative relationship between wages and the SRB (Result 1 in Appendix B in supplementary material). Otherwise, we would expect an overall positive relationship between wages and the SRB. Moreover, the dominance of income effects over opportunity cost ones also implies that the decline in SRB with higher wages would be more pronounced (more negative) in seasons with harsh conditions. Thus, one would expect the reduction in the SRB to be larger in the winter season than in the harvest season (Result 2 in Appendix B in supplementary material). As the theoretical framework also indicates, it could be the case that wages had a negligible effect on the SRB in scenarios of sufficiently high wages, i.e., during the harvest season. Our conceptual framework also allows for a more granular analysis of the relationship between wages and the SRB, making it possible to examine the coexistence of income and opportunity cost effects. On the one hand, the existence of income effects implies that the relationship between wages and the SRB differs between provinces with high and low nurturing costs. Specifically, the SRB is expected to decrease more with higher wages in societies where nurturing costs are larger (Result 3 in Appendix B in supplementary material). Moreover, the existence of opportunity cost effects can be assessed by comparing societies that vary in terms of the costs of registering female births. The relationship between wages and the SRB will be less negative where registration costs are higher. This is because the opportunity cost effect (positive) counteracts the income

effect (negative) and can make this relationship insignificant when registration costs are sufficiently high (Result 4 in Appendix B in supplementary material). This theoretical framework is used to assess the relevance of under-reporting and fatal neglect of female babies in Spain during the first third of the twentieth century.

## 3 Structural change and missing female births

This section firstly explores the relationship between economic modernisation and the SRB using provinces in four different census years as the unit of analysis. This panel data set comprises 49 provinces measured in the years 1900, 1910, 1920 and 1930. The corresponding censuses allow us to compute the percentage of the population living in towns and cities of more than 10,000 inhabitants as a proxy for urbanisation. In addition, Rosés et al. (2010) have estimated GDP per capita in each province-year. The calculation of GDP involves aggregating income from a wide variety of sources, which could hide significant regional diversity in terms of the underlying economic structure and, therefore, economic modernisation. We thus supplement the analysis by considering the relevance of different economic sectors, computing the percentages of the province's population that worked in agriculture, manufacturing and services. The latter, the sector with the highest potential to facilitate women's entry into paid work, will serve as the reference category.[18] In order to examine the relationship between economic modernisation and the SRB ($SRB_{it}$ of province $i$ in year $t$), we estimate the following linear econometric specification:

$$SRB_{it} = \alpha + Econ_{it}B_{econ} + X_{it}B_{cont} + \lambda_i + \lambda_t + \varepsilon_{it,} \tag{1}$$

where $Econ_{it}$ is a vector of variables capturing the economic structure in $i$ at $t$ that constrained families' decisions. Vector $X_{it}$ includes province-year characteristics that might affect the relationship between economic modernisation and the SRB. Given that the first third of the twentieth century was a particularly dynamic period, $X_{it}$ includes controls for fertility (measured by the average number of children in each household), male literacy and the predominant family type (proxied by the percentage of adult women in the household, following Tur-Prats 2019). To capture the underlying mortality environment, $X_{it}$ also accounts for male infant mortality rates.[19] In addition, $\lambda_i$ are province fixed effects that control for other unobserved

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[18] The service sector, as well as some manufacturing industries, would have facilitated women's entry into paid work in the early twentieth century in countries such as the United States (Costa 2000). It is possible that Spain would have followed a similar pattern of women's entry into paid work.

[19] We rely on male infant mortality because, in our context, girls' infant mortality might be affected by deviations in neglect resulting from gender discrimination (Beltrán Tapia and Gallego-Martínez 2017, Marco-Gracia and Beltrán Tapia 2021; Echavarri 2022). Male infant mortality is thus a better proxy of the external environment that influenced the family's ability to ensure the survival of its offspring. Contrary to the population censuses which were published every 10 years, vital statistics (births and deaths) were published annually. To mitigate the role of random noise arising from unexplained year-to-year variation, SRB and infant mortality rates are computed here using a three-year average around each census year. In any case, the results do not change if the figures are calculated using only the information from the census year but become noisier (or if we employ average infant mortality instead of male infant mortality).

time-invariant differences between provinces that may affect the SRB, $\lambda_t$ are time fixed effects that account for unobserved temporal heterogeneity that may have affected the SRB,[20] and $\varepsilon_{it}$ are the idiosyncratic characteristics of $i$ in $t$ normally distributed within their provinces. $B_{econ}$, is a vector of the parameters of interest as they capture the conditional correlation between the economic structure and the SRB. Summary statistics of the variables employed here can be found in table A4 in Appendix A in supplementary material.

Table 2 presents estimates of Eq. (1), suggesting that economic factors might play an important role in explaining the level of neonatal discrimination. In this regard, although the GDP per capita and urbanisation show the expected negative coefficients, the relationships are not statistically significant. This could be due to the GDP per capita measure including activities with countervailing effects. Interestingly, considering the relevance of economic sectors (columns 4 and 5) instead of the aggregate income level better captures the link explored here. The greater importance of agriculture and manufacturing (relative to the service sector) is associated with higher SRBs, thus suggesting a link between missing female births and the prevalence of sectors where wage labour opportunities are mostly for men. Specifically, a one-standard-deviation increase in agriculture (16.4 percentile points) and manufacturing (9.1 p.p.) is associated with 3.1 and 2.8 more male births per hundred female births, respectively (calculations based on the estimates in Table 2, column 5). Using services as the reference category, the larger the weight of agriculture in the economy, the more missing female births, which could be a result of the relatively few opportunities for women to have paid work. This result is consistent with patterns observed throughout the nineteenth century (Beltrán Tapia and Gallego-Martínez 2020). The high SRBs in rural areas could have resulted from outright neglect or from the existence of higher barriers to registering babies, which may have especially affected females due to the prevailing cultural norms. Including the importance of agriculture and manufacturing in the model also helps mitigate the fact that our urbanisation variable does not capture the presence of agro-towns, since the association between the proportion of the population living in cities and the SRB is estimated controlling for the effect of the underlying economic structure.

These same mechanisms could explain why the greater the weight of the manufacturing sector in the economy (relative to the weight of services), the greater the discrimination against female births. Although the manufacturing sector may also include certain industries as feminised as the service sector (e.g., the textile industry), early industrialisation could well have been very demanding for families, especially in the early stages, and particularly for women, because the nature of factory work may have created additional incompatibilities between paid work and caring for large families. These difficulties may have forced some of them to select among their offspring, resorting to sex-selective infanticide at birth. Higher wages in manufacturing, on the other hand, may have increased the opportunity cost of registering births, which again may have especially affected girls. Interestingly, the estimates in

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[20] Social and cultural dimensions, such as different dowry, inheritance and family-type systems, would therefore be captured by the province dummies. Similarly, the effect of phenomena that affected the whole country, such as the Spanish flu, is captured by time fixed effects.

Table 2 show that the mortality environment did not affect the variation observed in the SRB in the first third of the twentieth century. Due to the male vulnerability in utero and around birth, harsher mortality environments are expected to reduce the SRB. The fact that this is not observed in our data provides further evidence that some unobserved behaviour was keeping the SRB abnormally high, even after controlling for province and year fixed effects.

The SRB was quite high and stable before 1920, but that year marked the beginning of a strong downward trend (see Fig. 1). This points to the possibility of a nonlinear relationship between economic structure and the SRB over the period. Table 3 presents estimates for an expanded version of Eq. (1) that allows for the interaction between the agriculture and manufacturing variables and the time dummy variables. The expanded specification also allows for the nonlinear effect of urbanisation. While the relationship between urbanisation and the SRB seems to have remained invariant over time, this does not seem to have been the case with economic structure. The difference between the SRBs in the provinces with the greatest weight of the most masculinised sectors (agriculture and manufacturing) was greater in 1900 than in the subsequent decades. The results therefore suggest the presence of threshold effects,

**Table 2** Sex ratio at birth. Spain, 1900, 1910, 1920 and 1930

|  | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Urbanisation (%) |  | −0.011 | −0.006 | −0.001 | 0.009 |
|  |  | [0.105] | [0.107] | [0.106] | [0.109] |
| GDP per capita |  | −0.754 | −0.950 |  |  |
|  |  | [1.468] | [1.835] |  |  |
| Agriculture (%) |  |  |  | 0.189** | 0.192** |
|  |  |  |  | [0.089] | [0.090] |
| Manufacturing (%) |  |  |  | 0.317** | 0.304** |
|  |  |  |  | [0.142] | [0.136] |
| Inf. Mort., M | −0.001 | −0.000 | −0.008 | −0.005 | −0.011 |
|  | [0.017] | [0.017] | [0.016] | [0.016] | [0.015] |
| Constant | 1.101*** | 1.107*** | 1.168*** | 0.932*** | 0.976*** |
|  | [0.033] | [0.049] | [0.129] | [0.107] | [0.155] |
| Controls | No | No | Yes | No | Yes |
| Province FE | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 192 | 192 | 192 | 192 | 192 |
| R-squared | 0.784 | 0.784 | 0.790 | 0.794 | 0.799 |
| Within R-squared | 0.297 | 0.298 | 0.318 | 0.330 | 0.347 |

Clustered standard errors at province level in brackets. $*p<0.1$, $**p<0.05$, $***p<0.01$. Dependent variable is the male to female sex ratio at birth, 3-year average. GDP per cap is measured in one hundred million monetary units, and Inf. Mort, M is the proportion of male children who died before their first birthday, 3-year average. The set of controls include fertility (children per household), male literacy and family type (number of adult women per household). R-squared includes the variation explained by province and year variables

**Table 3** Sex ratio at birth. Spain, 1900, 1910, 1920 and 1930

|  | (1) | (2) |  | Cont. (1) | Cont. (2) |  | Cont. (1) | Cont. (2) |
|---|---|---|---|---|---|---|---|---|
| Urban. (%) | 0.012 | 0.020 | Agric. (%) | 0.333*** | 0.356*** | Manuf. (%) | 0.465** | 0.507** |
|  | [0.113] | [0.111] |  | [0.115] | [0.114] |  | [0.185] | [0.196] |
| ×1910 | 0.019 | 0.018 | ×1910 | −0.136 | −0.153 | ×1910 | −0.217 | −0.251 |
|  | [0.031] | [0.031] |  | [0.099] | [0.095] |  | [0.177] | [0.167] |
| ×1920 | 0.032 | 0.031 | ×1920 | −0.162** | −0.179** | ×1920 | −0.243* | −0.277* |
|  | [0.038] | [0.038] |  | [0.079] | [0.080] |  | [0.140] | [0.153] |
| ×1930 | −0.053* | −0.056* | ×1930 | −0.227*** | −0.249*** | ×1930 | −0.230** | −0.271* |
|  | [0.029] | [0.031] |  | [0.062] | [0.088] |  | [0.108] | [0.153] |
| Constant | 0.805*** | 0.831*** |  |  |  |  |  |  |
|  | [0.128] | [0.160] |  |  |  |  |  |  |
| Controls | No | Yes |  |  |  |  |  |  |
| Province FE | Yes | Yes |  |  |  |  |  |  |
| Year FE | Yes | Yes |  |  |  |  |  |  |
| Observations | 192 | 192 |  |  |  |  |  |  |
| R-squared | 0.821 | 0.822 |  |  |  |  |  |  |
| Within R-squared | 0.417 | 0.420 |  |  |  |  |  |  |

Clustered standard errors at province level in brackets. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Dependent variable is the male to female sex ratio at birth, 3-year average. The set of controls include male infant mortality (3-year average), fertility (children per household), male literacy and family type (number of adult women per household). Cont. (1) and Cont. (2) refers to the continuation of columns (1) and (2). R-squared includes the variation explained by province and year variables

which might be related to the level of development and the potential change in the role of women in the economy and the society. By the end of the 1920s, Spain had become a much more modernised country and the SRB was no longer related to the structure of the economy (or at least to a much lesser extent than in earlier decades). In this regard, it is also plausible that living standards were high enough by then and, even in the presence of son preference, registration costs were not relevant and/or families no longer needed to resort to extreme forms of female neglect.

## 4 Wage labour opportunities and missing female births

Although the previous exercise provides interesting insights on the relationship between economic modernisation and missing female births, it does not allow us to properly identify changes in families' income and the relative importance of female under-registration or fatal neglect. In order to dig deeper into this issue and assess how changes in households' available resources, whether produced by men or women, may have affected short-term changes in the level of discrimination at birth, this section now explores the impact of real wages on the SRB.

Estimating a version of Eq. (1), where wage variation measures the economic structures that constrain families' decisions, allows us to evaluate the extent to

which there was a prevalence of outright neglect (i.e., dominance of income effects) over under-registration (dominance of opportunity cost effects). While a negative sign implies that, on average, higher wages had a protective effect on female infants (reducing the SRB), a positive sign indicates that the opportunity cost of forgoing work to register births was large enough to increase female under-registration (increasing the SRB). Moreover, if there were a dominance of the income effect, the reduction in the SRB with higher wages would be more pronounced under harsh wage conditions (see Results 1 and 2 in Appendix B in supplementary material).

The richness of the historical data for this period allows us to explore these hypotheses. The Spanish Statistical Yearbooks reported the average daily wages paid to manual low-skilled labourers (*braceros*) in the Spanish provincial capitals. These wages were reported separately for men and women and were published annually between 1914 and 1931 (Spanish Statistical Yearbooks).[21] This low-skilled labour was related to agricultural activities carried out in urban areas, so wages therefore reflect the bridge between the rural and the urban context. In addition, these reports published wages during both the harvest and the winter season; wages were higher during the former due to the high demand for agricultural labour. Crucially, the lower wages paid during the winter season also reflect the structure of the labour market. In provinces where access to land was extremely unequal and there was a large number of landless labourers, seasonal unemployment was very high and low wages also reflect the destitution in which many families lived (Robledo 1993). Figure A4 in Appendix A (in supplementary material) displays the evolution of wages (PPP adjusted), during both the harvest and the winter season for both males and females, between 1914 and 1931. Daily average real wages of manual low-status labour seem to have decreased slightly during the first years of WWI, before starting an upward trend towards the end of the war and in the early post-war years, and remaining stable in the 1920s.[22] This evolution of real wages is consistent with that documented for industrial workers in the same period in Barcelona by Galofré-Vilà and Harris (2021).

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[21] The statistical yearbooks include average daily wages for some occupations in the Spanish provincial capitals, including manual low-skilled workers. The data were submitted by the chief statisticians in each province. No statistical yearbooks were published for the years 1917 and 1925. The Spanish Statistical Yearbooks provide nominal wages. To avoid capturing potential non-real monetary effects and the effects of regional differences in purchasing power on discrimination, we convert nominal wages into real wages adjusted for purchasing power parity (PPP). To do so, we compute a deflator, D, that combines time-varying changes in the consumer price index (CPI) and spatial variation in PPP. Specifically, $D = CPI*(PPP/100)$, where CPI is the annual percentage change in prices at national level, which was compiled by De Zwart (2015), and using 1914 as the base year; PPP is Gómez-Tello et al.'s (2019) index of PPP spatial variation for Spanish provinces with Barcelona as the base province. Specifically, Gómez-Tello et al.'s (2019) estimates of the interprovincial variation in purchasing power are based on data for the period 1910–1920. Our strategy of applying this estimated spatial variation to the entire period assumes that regional differences during the 1910s remained constant during the 1920s. These computations, however, do not affect the results reported here since they remain virtually identical even if we use the un-deflated raw wages.

[22] Table A2 in Appendix A (in supplementary material) supplements this information by showing how the wage increase between the 1910s and the 1920s was statistically significant for both men and women.

An additional reason for using wages to measure the changes affecting families' constraints is that wages incorporated a significant component of exogenous variation during our study period. The Spanish economy suffered an exogenous demand shock resulting from WWI (Rosés and Sánchez-Alonso 2004; Gómez-Tello et al. 2019; Galofré-Vilà and Harris 2021). Rosés and Sánchez-Alonso (2004) show how the outbreak of the war interrupted the convergence of real wages across regions and occupations that had been underway until then in Spain. The authors provide evidence that the convergence process resumed after the end of WWI (i.e., in the 1920s). At the same time, Gómez-Tello et al. (2019) find that WWI created a price increase in Spain that affected some provinces more than others. In other words, the conflict created a temporal scenario with geographic variation in the degree to which increasing real wages were exogenous to the pre-existing perceived value of women. This enables us to take a further step towards identifying the short-term effect of wages on the SRB. In addition, the distinction between male and female wages allows us to examine whether these effects were gender-specific.

Given that our previous results (i.e., the discontinuity in the pace in the evolution of the SRB around 1920 and the non-linear relationship between modernisation and the SRB) confirm the existence of two historical periods with distinct socio-economic characteristics, an analysis of a pooled time period is likely to conceal the potential effect of wages on the SRB. This is the case when the data generation processes vary across historical moments: while the wages might play a role in historical periods of high discrimination, they might play only a marginal role (or no role at all) in periods of low discrimination. Therefore, we divide the analysis into two periods: one characterised by the persistence of high average SRBs and the existence of exogenous aggregate demand shocks from WWI (1914–1920); and the other one shaped by an accelerated decline in the SRB and the end of the war (1921–1931).

Table 4 presents estimates of Eq. (1), using wages as a finer measurement of economic structures that constrain families' decisions, and using the sample of province-years for which sex-specific wages were reported during the period 1914–1920. Columns 1 and 2 use wages in the winter season while columns 3 and 4 use wages in the harvest season. Our conceptual framework predicts a more pronounced change in the SRB with higher wages under harsh conditions (Result 2 in Appendix B in supplementary material). Likewise, we expect greater reductions in the SRB with wage increases when using winter wages, because of high levels of seasonal unemployment in those provinces. The results indeed provide support to the idea that behavioural factors skewed the SRB. Increases in the average winter daily wages protected against sex-based neonatal discrimination, regardless of whether the wages were earned by men or women. The results therefore show that, on average, income effects were larger than opportunity cost effects in the first third of the twentieth century in Spain. Interestingly, the protective role of female wages was twice that of male wages: while a one-unit increase in female wages leads to a decrease in the predicted SRB of 1.2 male births (per 100 female births), the equivalent decrease for a one-unit increase in male wages was 0.6 male births (see summary statistics in table A5 in Appendix A in supplementary material). The effect of harvest wages on the SRB is smaller and statistically insignificant (columns 3 and 4 of Table 4), which

**Table 4** Sex ratio at birth and average daily real wages. Province-years for which sex-specific wages were reported, Spain, 1914–1920

|  | (1) | (2) | (3) | (4) |
|  | Winter wages | | Harvest wages | |
| --- | --- | --- | --- | --- |
| Wages, M | –0.006[*] | | –0.003 | |
|  | [0.004] | | [0.002] | |
| Wages, F | | –0.012[*] | | –0.007 |
|  | | [0.007] | | [0.005] |
| Inf. Mort, M | 0.500[**] | 0.489[**] | 0.446[**] | 0.467[**] |
|  | [0.207] | [0.207] | [0.207] | [0.221] |
| Constant | 1.026[***] | 1.027[***] | 1.029[***] | 1.029[***] |
|  | [0.033] | [0.031] | [0.032] | [0.032] |
| Prov. FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Observations | 152 | 152 | 154 | 154 |
| $R$-squared | 0.805 | 0.807 | 0.799 | 0.800 |
| Within $R$-squared | 0.138 | 0.144 | 0.111 | 0.116 |

Clustered standard error at province level in brackets. *$p<0.1$, **$p<0.05$, ***$p<0.01$. Dependent variable is the male-to-female sex ratio at birth. Wages, M is the average daily real wages of male manual low-skilled labourers (columns 1 and 2 winter wages, columns 3 and 4 harvest wages). Wages, F is the same wage measure, but for female labourers. Inf. Mort, M is the proportion of male children who died before their first birthday. $R$-squared includes the variation explained by province and year variables

suggests that wages did not have a protective role during this part of the year (or at least that it was offset by the opposite effect of the opportunity cost of registering female births).

It is interesting to note that the results displayed in Table 4 provide further evidence of sex-based discrimination at birth during the 1910s in Spain. High-mortality environments, proxied by male infant mortality, had an independent and positive effect on the SRB. This result goes against the idea that the biological male vulnerability would result in lower SRBs in adverse circumstances (Di Renzo et al. 2007; Dipietro and Voegtline 2017) and therefore suggests that harsh conditions triggered discrimination against female births. As expected, the protective role of daily average winter wages disappeared during the 1920s (see table A6 in Appendix A in supplementary material). This is in line with the findings from the previous section showing that the effect of structural change on the SRB was significantly reduced during the 1920s.[23]

In order to shed further light on the relationship between wages and the SRB and identify the distinct roles played by female under-registration and female neglect, we exploit two sources of exogenous variation in the status of girls and women in

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[23] The idea that discriminatory practices during the 1920s were probably negligible is also supported by the fact that the positive link between the mortality environment and the SRB is no longer visible, thus suggesting that the relative number of male and female births was mainly influenced by random variability or at least by variation unrelated to economic considerations.

society: (1) the distinction between the prevalence of stem or nuclear families (i.e., capturing variation in relative costs of raising girls), and (2) the distinction in the gendered reporting of wages in province-years (i.e., capturing variation in relative costs of registering female births).

On the one hand, the prevalence of different types of families implied (among other constraints) the development of specific inheritance laws and shaped the relative cost of raising a female child. In this regard, previous work has documented exogenous factors that divide provinces between stem and nuclear ones based on the historical prevalence of these kinship systems (Tur-Prats 2019; Beltrán Tapia and Gallego-Martinez 2020; Echavarri 2022). Under nuclear structures, each generation created its own family unit, where the wife was expected to take on the burden of unpaid care work. Tur-Prats (2019) argues that this burden limited women's ability to engage in productive activities, thus reducing their bargaining power and their ability to shift resources towards women and girls. The situation was not the same in extended households comprising more than one generation, where the elder women took on the unpaid care work and women could participate in the labour market. Not only did women have less bargaining power in nuclear provinces, but the legal regime there protected the inheritance of all offspring. Having to provide inheritance to all daughters, in a historical context of widespread son preference, arguably increases the perceived cost of raising girls in nuclear provinces (Echavarri 2022). We should also bear in mind that preference for sons characterised both nuclear and stem provinces and that the cost of registration may well be similar for both groups of provinces, so it can be argued that the changing effect of increasing wages would be channelled through a reduction in female neglect immediately after birth.

On the other hand, provinces differed in terms of registration practices. While reporting on men's wages was considered a relevant practice, with their wages thus reported systematically over the years, the same was not true for reporting on women's wages. Out of 49 provinces in our study, five did not publish any data on women's wages, while six published them for each of the periods. On average, each province published female wages during half of the years analysed here. Specifically, information for male and female wages is available for 389 out of the 882 possible observations (see Figure A2 in Appendix A in supplementary material). Interestingly, the subsample of province-years in which both male and female wages were reported, the subsample of province-years in which neither were reported, and the subsample in which male wages (but not female ones) are reported, are balanced in the prevalence of family types (see table A7 in Appendix A in supplementary material).[24] Interestingly, the mental models of the historical period under study were rooted in a culture that deemed the labour of women and children as marginal and

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[24] Table A7 in Appendix A (in supplementary material) presents a balance analysis across wage-reporting groups: the group of province-years for which both female and male wages were published (our main group); the group of province-years for which male wages were published (regardless of whether female wages were also published), and the group of province-years for which no wages were published (male or female). The table shows that there are no statistically significant differences between the infant mortality in our main group and in the group that published male wages (column (2)). However, our main wage-reporting group had lower infant mortality and higher wealth than the group that did not release wage information (column (3)), but lower wealth than the group that released male wages (column (2)).

less important (regardless of the real social and individual value of their work). Borderías et al. (2014) explain how women's and children's work was considered of lesser value. Thus, gendered reporting of wages might reflect the importance that society attached to reporting on female wages and therefore reflect the cost of registering the birth of a female baby (relative to the cost of registering a male one). The changing effect of increasing wages in gendered-reporting societies (as compared with standard ones) would arguably be channelled through an increase in under-registration of female births.

Bearing this in mind, we use the distinction between the prevalence of stem or nuclear families as an indicator of the relative costs of nurturing girls in a province, and the distinction in terms of gendered reporting of wages as an indicator of the costs of registering female babies in each province-year. Therefore, we extend Eq. (1) as follows:

$$\text{SRB}_{it} = \alpha' + \beta_{w\_\text{nuc}} W_{it} \, \text{Nuclear}_i + \beta_{w\_\text{NonGen}} W_{it} \, \text{GenReport}_{it} + M_{it} A + \lambda'_t + \varepsilon'_{it,} \tag{2}$$

where variable $W_{it}$ captures wages in $i$ at $t$, $Nuclear_i$ is an indicator that takes value 1 if $i$ is a nuclear province, and $\text{GenReport}_{it}$ is an indicator that takes value 1 if $i$ in $t$ reported male wages only. $M_{it}$ is a vector for control variables such as child mortality in $i$ at $t$, and it also includes the main variables baseline effects. Note that, in contrast to Eq. (1), this specification does not include province fixed effects because the indicator for nuclear province is time invariant and, therefore, we supplement the specification by controlling for the historical (Foral) Civil Law of the province. The parameters of interest in Eq. (2), $\beta_{w\_\text{nuc}}$ and $\beta_{w\_\text{GenReport}}$, reflect the existence of *income* and *opportunity cost* effects, respectively. On the one hand, if income effects existed, we expect that $\beta_{w\_\text{nuc}} < 0$ because higher wages will reduce the fatal neglect of female babies and this effect will be larger where girls are more costly (Result 3 in Appendix B in supplementary material). On the other hand, if opportunity cost effects existed, we expect that $\beta_{w\_\text{GenReport}} > 0$ because higher wages will increase the likelihood of underreporting female births in those areas where the cost of reporting on women's information is higher, and therefore the protective role of wages will be reduced (see Result 4 in Appendix B in supplementary material).

Table 5 provides estimates of Eq. (2) using winter wages in Spain between 1914 and 1921. The results show that, although the baseline SRB was higher in nuclear provinces (thus reflecting the higher nurturing cost of girls in those regions), increases in winter wages reduced the SRB more in nuclear provinces than in stem ones as our model predicted. This finding provides support for the presence of income effects, that is, higher wages are linked to more pronounced decreases in the SRB in provinces where nurturing girls was costly, and therefore strongly suggests that female neglect played a significant role in explaining high SRBs in areas where the nuclear family predominated. In addition, the estimates provide evidence of the effect of opportunity costs (related to forgoing work to register female births). On the baseline, there are no statistically significant differences in SRBs between provinces that only reported male wages and the rest. However, increases in wages led to higher SRBs, an effect that is larger in provinces where it was less socially important to report female wages. Interestingly, in the control group (stem provinces

**Table 5** Sex ratio at birth and real (winter) wages, males. provinces, Spain 1914–1920

|                              | (1)       | (2)       | (3)      |
| ---------------------------- | --------- | --------- | -------- |
| Nuclear                      | 0.051[***] | 0.049[***] | 0.046[**] |
|                              | [0.016]   | [0.017]   | [0.017]  |
| Gendered reporting           | −0.017    | −0.019    | −0.018   |
|                              | [0.021]   | [0.022]   | [0.023]  |
| Wages                        | 0.001     | 0.000     | 0.000    |
|                              | [0.006]   | [0.006]   | [0.007]  |
| Nuclear and Wages            | −0.011[**] | −0.010[*]  | −0.010[*] |
|                              | [0.005]   | [0.005]   | [0.005]  |
| Gendered Report. and Wages   | 0.014[**]  | 0.015[**]  | 0.015[**] |
|                              | [0.006]   | [0.007]   | [0.007]  |
| Constant                     | 1.120[***] | 1.123[***] | 1.128[***] |
|                              | [0.036]   | [0.037]   | [0.045]  |
| Observations                 | 279       | 271       | 253      |
| Prov FE                      | No        | No        | No       |
| Time FE                      | Yes       | Yes       | Yes      |
| *R*-squared                  | 0.106     | 0.106     | 0.105    |

Clustered standard error at province level in brackets. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Dependent variable is the SRB. Nuclear is for provinces with historical prevalence of nuclear families. Gendered Reporting takes value 1 for province-years that reported male wages, but not female ones. Wages, M is the average daily real wages of manual low-skilled labourers in winter. Column 1 includes all the provinces, column 2 excludes Madrid and Barcelona, column 3 excludes Madrid, Barcelona, Bilbao, Valencia and Sevilla. All the columns control for infant mortality and historical Civil Law system in the province

that reported male and female wages), we find no evidence of behavioural drivers of the SRB, as variation in wages had no statistically significant effect on SRBs. This outcome is in line with previous literature, which shows that violence against women is less prevalent in provinces where women enjoyed a better status (Tur-Prats 2019). The results are robust to excluding the provinces where the biggest cities were (while column 2 excludes the provinces of Madrid and Barcelona, column 3 also ignores information from the provinces of Bilbao, Valencia and Seville). This exercise rules out the possibility that our results are due to the inclusion of provinces where the demand for *braceros* (low-skilled agricultural labour) might have been small.

## 5 Concluding remarks

This article sheds light on how structural transformations affected long-standing gender-discriminatory practices around birth in Spain. Our findings confirm previous evidence showing that son preference was stronger in rural areas due to the lower perceived relative value of girls in those contexts (Beltrán Tapia and Gallego-Martínez 2020). However, the role of industrialisation appears to have been mediated by how it affected female labour opportunities. In this regard, more industrial

provinces recorded higher SRBs, probably because many of these industries were mostly employing men. We should also bear in mind that industrial cities grew thanks to the inflow of rural migrants who, along with their labour, brought their cultural values with them. Likewise, the disruptions caused by industrialisation, especially in its early stages, may have also played a role since increasing inequality and marginalisation can fuel the need to get rid of unwanted babies in the most precarious segments of the population (see also Catalán Martínez, 2022).[25] Although the lack of sectoral information prevents us from providing a more fine-grained assessment of the impact of industrialisation,[26] previous research on a growing town specialising in textiles shows that expanding labour opportunities for women improved the chances of survival of female infants and children (Beneito and García Gómez 2022).

Moreover, our analysis shows that the inflated SRBs found in the official statistics during the first decades of the twentieth century not only reflect female under-registration (as previously assumed), but also female neglect resulting in higher female mortality right after birth. The SRB decreased markedly during the 1920s and, by 1930, Spain's SRB was practically indistinguishable from that of other countries. The link between the economic structure and the relative numbers of male and female births also disappeared during this period. This is probably explained by the existence of threshold effects. On the one hand, living standards had probably improved enough so that families no longer needed to resort to neglecting female babies, even in the presence of son preference. On the other hand, female labour opportunities had also become much more widespread, which may have altered the perception of the relative value of sons and daughters. This mechanism was probably reinforced by the possibility of migration. Not only had migratory flows grown substantially, but women increasingly formed part of these flows (Beltrán Tapia and Miguel Salanova 2017; Santiago Caballero 2021). Even parents living in rural areas where female labour opportunities were limited could envision their daughters having a better future in the growing cities. These improvements were, however, interrupted by the Spanish Civil War (1936) and the harsh economic conditions that characterised the 1940s (Echavarri 2022). Female neglect, both around birth and during infancy and early childhood, resurfaced during this dark period in Spanish history.

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[25] It is also argued that factory work was not compatible with child rearing, which may have forced many families to resort to abortions and infanticide in order to continue working.

[26] The variable "manufacturing" does not distinguish between the type of industries that were predominant in each province, so this coefficient conflates the impact of textiles, metallurgy, etc.

# References

Abrevaya J (2009) Are there missing girls in the United States? Evidence from birth data. Am Econ J Appl Econ 1(2):1–34

Almond D, Edlund L, Milligan K (2013) Son preference and the persistence of culture: evidence from South and East Asian immigrants to Canada. Popul Dev Rev 39(1):75–95

Anderson S, Ray D (2010) Missing women: age and disease. Rev Econ Stud 77:1262–1300

Bechtold BH (2001) Infanticide in 19th century France: a quantitative interpretation. Rev Radic Pol Econ 33(2):165–187

Beltrán Tapia FJ, Gallego-Martínez D (2017) Where are the missing girls? Gender discrimination in 19th-century Spain. Explor Econ Hist 66:117–126

Beltrán Tapia FJ, Gallego-Martínez D (2020) What explains the missing girls in nineteenth-century Spain? Econ Hist Rev 73(1):59–77

Beltrán Tapia FJ, Marco-Gracia FJ (2022) Death, sex and fertility: Female infanticide in rural Spain, 1750–1950. Eur Rev Econ Hist 26(2):234–254

Beltrán Tapia FJ, Miguel Salanova S (2017) Migrants' self-selection in the early stages of modern economic growth, Spain (1880–1930). Econ Hist Rev 70(1):101–121

Beltrán Tapia FJ, Raftakis M (2022) Sex ratios and gender discrimination in modern Greece. Popul Stud 76(2):329–346

Beltrán Tapia FJ, Szoltysek M (2022) 'Missing girls' in historical Europe: reopening the debate. Hist Fam 27(4):619–657

Beltrán Tapia, FJ, and Cappelli, G. (2022) Missing girls in liberal Italy, 1861–1921. CEPR. *Discussion Paper* Series 17416.

Beneito P, Garcia-Gómez JJ (2022) Gender gaps in wages and mortality rates during industrialization: the case of Alcoy, Spain, 1860–1914. Fem Econ 28(1):114–141

Bhalotra S, Chakravarty A, Gulesci S (2020) The price of gold: Dowry and death in India. J Dev Econ 143:102413

Bhaskar V, Gupta B (2007) India's missing girls: biology, customs, and economic development. Oxf Rev Econ Policy 23(2):221–238

Blanes Llorens A (2007) La mortalidad en la España del siglo XX. Tesis Doctoral, Barcelona, Universidad Autónoma de Barcelona, Análisis demográfico y territorial

Borderías C, Pérez-Fuentes P, Sarasúa C (2014) La desigualdad en el consumo familiar. Diferencias de género en la España contemporánea (1850–1930). AREAS Revista Internacional De Ciencias Sociales 33:105–120

Brel Cachón MP (1999) Comparación de los libros parroquiales y de los registros civiles. Una Aportación a La Validez De Las Fuentes Demográficas a Finales Del Siglo XIX. Boletín De La Asociación De Demografía Histórica 2:91–114

Carreras A, Tafunell X (2005) Estadísticas Históricas de España: siglo XIX-XX. Fundación BBVA, Bilbao

Catalán Martínez E (2022) Razones de masculinidad y crisis de mortalidad en el País Vasco, 1550-1899. Paper presented at the XIII AEHE International Congress

Chahnazarian A (1990) Historical trends in the sex ratio at birth. *Hopkins Population Center Working Paper* 90, 1

Chao F, Gerland P, Cook AR, Alkema L (2019) Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. Proc Natl Acad Sci 116(19):9303–9311

Costa DL (2000) From mill town to board room: the rise of women's paid labor. Journal of Economic Perspectives 14(4):101–122

Das Gupta M, Shuzhuo L (1999) Gender bias in China, South Korea and India 1920–1990: effects of war, famine and fertility decline. Dev Chang 30(1999):619–652

Das Gupta M, Zhenghua J, Bohua L, Zhenming Z, Chung X, Hwa-Ok B (2003) Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. J Dev Stud 40(2):153–187

De Zwart, P. (2015). Inflation. IISH Data Collection, V1. https://hdl.handle.net/10622/UJ3H1Q

Derosas R (2012) Suspicious deaths: Household composition, infant neglect, and child care in nineteenth-century Venice. Annales De Démographie Historique 123(1):95–126

Derosas R, Tsuya NO (2010) Child control as a reproductive strategy. In Tsuya, N.O., et al. (eds.). *Prudence and Pressure: Reproduction and Human Agency in Europe and Asia, 1700–1900* (Cambridge: Cambridge University Press): 129–155

Dipietro and Voegtline (2017) The gestational foundation of sex differences in development and vulnerabililty. Neuroscience 342:4–20

Di Renzo GC, Rosati A, Sarti RD, CrucianiCutuli L (2007) Does fetal sex affect pregnancy outcome? Gend Med 4(1):19–30

Drevenstedt GL, Crimmins EM, Vasunilashorn S, Finch CE (2008) The rise and fall of excess female infant mortality. Proc Natl Acad Sci 105(13):5016–5021

Drixler F (2013) Mabiki: Infanticide and population growth in Eastern Japan 1660–1950. Univ of California Press, Berkeley

Dyson T, Moore M (1983) On kinship structure, female autonomy and demographic behavior in India. Popul Dev Rev 9(1):35–60

Echavarri R (2022) Neonatal discrimination and excess female mortality in childhood in Spain in the first half of the twentieth century. Cliometrica 16(1):79–104

Echavarri R, Ezcurra R (2010) Education and gender bias in the sex ratio at birth: evidence from India. Demography 47(1):249–268

Evans A (2019) How cities erode gender inequality: a new theory and evidence from Cambodia. Gend Soc 33(6):961–984

Galofré-Vilà G, Harris B (2021) Growth before birth: the relationship between placental weights and infant and maternal health in early twentieth-century Barcelona. Econ Hist Rev 74(2):400–423

Gonzalvez Pérez V (2003) Natalidad y mortalidad de la población valenciana (1858–1960). Cuadernos De Geografía 73(74):277–302

Guilmoto CZ (2018) Sex ratio imbalances in Asia: an ongoing conversation between anthropologists and demographers. In: Scarce Women and Surplus Men in China and India, ed. S. Srinivasan, S. Li Cham Springer: 145-161

Gupta B (2014) Where have all the brides gone? Son preference and marriage in India over the twentieth century. Econ Hist Rev 67(1):1–24

Gómez Redondo R (1992) La mortalidad infantil española en el siglo XX. Siglo XXI, Madrid

Gómez-Tello A, Díez-Minguela A, Martinez-Galarraga J, Tirado D (2019) Regional prices in early twentieth-century Spain: a country-product-dummy approach. Cliometrica 13:245–276

Hanlon G (2016) Routine infanticide in the West, 1500–1800. History Compass 14(11):535–548

Herrera AD (2014) Grado de fiabilidad del Movimiento Natural de la Población en los municipios de la provincia de Badajoz, 199–1935. Revista De Demografía Histórica-J Iberoam Popul Stud. 32(2):77–115

Hesketh T, Xing ZW (2006) Abnormal sex ratios in human populations: causes and consequences. Proceed Natl Acad Sci. 103(36):13271–13275

Instituto Geográfico y Estadístico (1877) Movimiento de la Población de España, Madrid, 1861–1870

Instituto Geográfico y, Estadístico (1895) Movimiento de la Población de España, Madrid, 1886–1892

Instituto Geográfico y Estadístico (1901) Movimiento de la Población de España, Madrid, 1900

Instituto Geográfico y Estadístico (1903) Movimiento de la Población de España, Madrid, 1901

Junta General de Estadística (1863) Movimiento natural de la población, 1858–1860 (Madrid)

Klasen S, Wink C (2002) A turning point in gender bias in mortality? Un update on the number of missing women. Popul Dev Rev 28(2):285–312

Lin MJ, Liu JT, Qian N (2014) More missing women, fewer dying girls: The impact of sex-selective abortion on sex at birth and relative female mortality in Taiwan. J Eur Econ Assoc 12(4):899–926

Livi Bacci M (1968) Fertility and nuptiality changes in Spain from the late 18th to the early 20th century: Part I. Popul Stud 22(1):83–102

Llopis E, Quiroga G, Sánchez Salazar F, Velasco AL, de la Fuente A, García Calvo R, Ramos L, Sierra Víctor M (2022) Excess female mortality in early infancy? Missing girls in Ciudad Real and Guadalajara, 1840-1899. AEHE Working Paper Series 2201

Lynch KA (2011) Why weren't (many) European women "missing"? History of the Family 16:250–266

Marco-Gracia FJ, Beltrán Tapia FJ (2021) Son preference, gender discrimination and missing girls in rural Spain, 1750–1950. Popul Dev Rev 47(3):665–689

Martínez Carrión JM (1983) La población de Yeste en los inicios de la transición demográfica (1850–1935). Instituto de Estudios Albaceteños, Albacete

Ministerio de Gracia y Justicia (1822) Código Penal Español. Imprenta Nacional, Madrid

Ministerio de Gracia y Justicia (1848) Código Penal de España. Imprenta Nacional, Madrid

Ministerio de Gracia y Justicia (1870a) Código Penal Reformado. Imprenta del Ministerio de Gracia y Justicia, Madrid

Ministerio de Gracia y Justicia (1870b) Ley provisional de Registro Civil. https://www.boe.es/datos/pdfs/BOE/1870b/171/A00001-00002.pdf

Ministerio de Gracia y Justicia (1889) Código Civil. https://www.boe.es/datos/pdfs/BOE/1889/206/R00249-00312.pdf

Ministerio de Justicia (1932) Ley el Código Penal del 5 de noviembre de 1932. https://www.boe.es/datos/pdfs/BOE//1932/310/A00818-00856.pdf

Ministerio de Trabajo, Comercio e Industria (1922) Censo de la Población de España. Talleres de la Dirección General del Instituto Geográfico, Madrid

Morse A, Luke N (2021) Foetal loss and feminine sex ratios at birth in sub-Saharan Africa. Popul Stud 75(2):239–254

Navas González R (2022) La legislación laboral y las condiciones de trabajo a principios del siglo XX. Revista Crítica De Relaciones De Trabajo, Laborum 5:109–130

Peacock JL, Marston L, Marlow N, Calvert SA, Greenough A (2012) Neonatal and infant outcome in boys and girls born prematurely. Pediatr Res 71(3):305–310. https://doi.org/10.1038/pr.2011.50

Peelen M, Kazemier B, Ravelli AJ, De Groot CJM, Van der Post JAM, Mol BWJ, Hajenius PJ, Kok M (2017) Impact of fetal gender on the risk of preterm birth, a national cohort study. Acta Obstet Gynecol Scand 95(9):1034–1041

Prados de la Escosura (2017) Spanish economic growth, 1850–2015. Palrave MacMillan

Qian N (2008) Missing women and the price of tea in China: the effect of sex-specific earnings on sex imbalance. Q J Econ 123(3):1251–1285

Robledo R (1993) Economistas y Reformadores Españoles: la Cuestión Agraria, 1760–1935. Ministerio de Agricultura, Pesca y Alimentación, Madrid

Rosenzweig MR, Schultz TP (1982) Market opportunities, genetic endowments, and intrafamily resource distribution: child survival in rural India. American Economic Review 72(4):803–815

Rosés JR, Martínez-Galarraga J, Tirado-Fabregat DA (2010) The upswing of regional income inequality in Spain (1860–1930). Explor Econ Hist 47(2):244–257

Rosés JR, Sánchez-Alonso B (2004) Regional wage convergence in Spain 1850–1930. Explor Econ Hist 41(4):404–425

Santiago Caballero C (2021) Domestic migrations in Spain during its first industrialisation, 1840s–1870s. Cliometrica 15:535–563

Schacht R, Hollingshaus M, Hanson H, Macfarlan SJ, Tharp D, Bruckner T, Smith KR (2021) Frail males on the American frontier: The role of environmental harshness on sex ratio at birth across a period of rapid industrialization. Social Sciences 10(9):319

Sen A (1990) More than 100 million women are missing. The New York Review of Books 37(20)

Tur-Prats A (2019) Family types and intimate partner violence: A historical perspective. Rev Econ Stat 101(5):878–891

Visaria PM (1967) Sex ratio at birth in territories with a relatively complete registration. Eugen Q 14(2):132–142

Waldron I (1998) Sex differences in infant and early childhood mortality: Major causes of death and possible biological causes. In: Waldron (ed.) Too young to die: Genes or gender (New York: United Nations): 64–83

Woods R (2009) Death before birth: Fetal health and mortality in historical perspective. Oxford University Press, Oxford

Zarulli V, Barthold Jones JA, Oksuzyan A, Lindahl-Jacobsen R, Christensen K, Vaupel JW (2018) Women live longer than men even during severe famines and epidemics. Proceed Nat Acad Sci. 115(4):832–840