It's Raining Men! Hallelujah?

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Abstract

We document the short- and long-run implications of male-biased sex ratios. We exploit a natural historical experiment that sent large numbers of male convicts and far fewer female convicts to Australia in the 18th and 19th centuries. In areas with more male-biased sex ratios, women were historically more likely to get married and less likely to work outside of the home. And still, today, in areas that were more male-biased historically, both genders have more conservative attitudes towards women working, and women work fewer hours outside of the home. These women enjoy more leisure. But they are also less likely to have high-ranking occupations. We demonstrate that the consequences of uneven sex ratios on cultural attitudes, labor supply decisions, and occupational choices can persist in the long-run, well after sex ratios are back to normal. We document the role of vertical cultural transmission and of marriage homogamy in sustaining this cultural persistence.

Keywords: Culture, gender roles, sex ratio, natural experiment, Australia

JEL codes: I31, N37, J16, Z13

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1. Introduction

Despite significant improvements in the last century, gender disparities persist. In the workplace, women continue to work less, earn less, and are less likely to reach positions of leadership. In the home, women still do more of the share of housework and remain the primary caregiver (Bertrand et al. 2013). In regions where heavily male-biased sex ratios prevail, gender disparities manifest themselves even more severely. There are now an estimated 100 million women "missing" in the world, 80 million in China and India alone, due to sex-selective abortion and differential gender mortality (Hesketh and Xing 2006). An important question is how male-biased sex ratios further affect female outcomes, and whether these effects will persist in the long-run. Answering this question is filled with reverse causality issues.

A surplus of men generally results from a lower value placed upon women because economic opportunities for women are limited (Qian 2008, Carranza 2014) or because of cultural preferences for sons (Almond et al. 2013). In these contexts, it is impossible to know for certain whether observed female outcomes are the cause or the consequence of a male-biased sex ratio. The ideal natural experiment would consist of placing a larger number of men than women on an isolated island, with these men and women being of a similar cultural background and operating in the same institutional environment, and then observe female outcomes from that point on. We exploit such an experiment.

In the late 18th and 19th centuries, the British policy of sending convicts to Australia resulted in heavily male-biased sex ratios (the number of males over the number of females). Men far outnumbered women among convicts, by a ratio of almost 6 to 1 (Oxley 1996). The vast majority of the white Australian population initially consisted of convicts.[3] Among free migrants, men also vastly outnumbered women well into the 20th century, as mostly men sought economic opportunities in mining and pastoralism. As can be seen in Figure 1, a male-biased sex ratio endured in Australia for more than a century.

The most obvious consequence of the number of men exceeding the number of women is that women will have a stronger bargaining position in the marriage market.

[3] There is still uncertainty and controversy about the number of Aborigines at the start of European settlement but in any case, they constituted a very different economy.

Bargaining models of intra-household decision making, such as the collective household model (Chiappori 1988, 1992) and the demand and supply model of marriage (Grossbard-Schechtman 1984) predict that in such conditions, the enhanced bargaining position of women should result in them being more likely to marry, reducing their labor supply in the market and at home, and enjoying more leisure. We directly test these hypotheses.

There are reasons to believe that these effects could persist in the long-run, even after the imbalance itself is corrected. Behaviors that are the result of short-run economic factors often become practices that persist in the long-run, as suggested by a thriving literature on historical and cultural persistence in economic development (Nunn 2009). For example, the Neolithic revolution and the use of plough cultivation still influence gender roles and female outcomes today (Alesina et al. 2011, 2013, Hansen et al. 2015).

We study the short- and long-term effects of male-biased sex ratios on female outcomes in the workplace and at home. We rely on spatial and, in sub-specifications, time variation in the historical sex ratio generated by the unique Australian natural experiment. We find that historically, male-biased sex ratios were indeed associated with women being more likely to marry and participating less in the labor force. They were also likely to work in high-ranking occupations. We then study the long-term implications of male-biased sex ratios by matching 91 historical counties from the first Australian Colonial Censuses to postal areas in the 1933 Census, the 2011 Census, and a nationally representative household survey collected between 2001 and 2011. In areas that were more male-biased historically, both genders today have more conservative attitudes towards women working. Women work less in the labor market, but they do not spend more time dealing with household chores or taking care of children. As a result, they enjoy more leisure. However, as a likely consequence of the reduction in their market labor supply and the conservative attitudes held, women are again less likely to reach high-ranking occupations in areas that were more male-biased in the past.

The effect of the historical sex ratio on current gender roles is sizeable. Regarding attitudes towards gender roles, it is comparable, at the mean, to 30% of the effect of a

being a female versus a male respondent.[4] Moreover, a one standard deviation increase in the historical sex ratio is associated with a 3.5% reduction in working hours supplied by females and a decrease in the share of women employed in high-raking occupations by 0.13 standard deviations. Historical circumstances explain more than 3% of the variation in the share of women employed in high-ranking professions that is left unexplained by traditional factors, even when accounting for the share of men employed in similar professions.

There are a few potential identification concerns that we have addressed in several ways. One concern is that the spatial variation in sex ratios may have been determined by characteristics that also influence the outcomes of interest, such as the presence of mineral resources. Our historical results are robust to formulations that control for time and county fixed effects, which remove the influence of any time invariant county characteristics that could be associated both with local sex ratios and with female work and marital outcomes.

Our long-run results rely on the initial spatial variation in the sex ratio, measured in the first Census in each state. We analyze the historical circumstances that determined such variation and control for such factors. In particular, we flexibly control for geographic and terrain characteristics and for the presence of minerals, as well as for the initial conditions in terms of economic specialization. State fixed effects are used throughout, removing unobserved heterogeneity related to differences in the legal environment or in the treatment of convicts.

Although we are able to account for the influence of a large number of geographic and historical characteristics, it remains possible that local sex ratios in the past could be influenced by unobservable characteristics that, in the present, still underlie female opportunities and attitudes. Endogeneity could arise, for example, from the systematic selection of women with stronger preferences for leisure, or of men with a taste for gender discrimination, to high historical sex ratio areas. To deal with this, we employ an instrumental variable strategy based on a unique feature of Australia's unique history: convicts were not free to choose where to locate, so we instrument the population sex

[4] The average historical sex ratio is 2 to 1. Women are 46% more likely to hold progressive attitudes compared to men.

ratio by the sex ratio among convicts only. This instrument is highly relevant, since the majority of the population actually consisted of convicts at the time we measure the historical sex ratio. We also control for the number of convicts to account for the potential long-run effect of a convict past independent of the effect of sex ratios, which would violate the exclusion restriction. All the results are robust to this instrumental variable strategy.

Our historical results, contemporaneous to sex ratios, are in line with previous literature and the predictions of bargaining models of intra-household decision making (Grossbard-Schechtman 1984, Chiappori 1988, 1992, Chiappori et al. 2002). More surprising is that the effects of male-biased sex ratios on female labor supply, occupational choice and leisure have persisted until today, even long after sex ratios have reverted back to normal. To explain this persistence, we argue that past sex ratios have shaped cultural norms about gender roles and we investigate the channels that underlie cultural persistence. Cultural norms are inherently sticky because they are generally transmitted from parents to children, through learning (Fernández 2013, Fernández et al. 2014) or active socialization by parents (Bisin and Verdier 2001, Doepke and Zilibotti 2008). Accordingly, we find that historical sex ratios are only associated with conservative views about gender roles among people born of Australian parents.

Moreover, the specific circumstances of the marriage market generate feedback mechanisms that underlie persistence. As people prefer to marry those with similar views, gender norms are strategic complements among potential spouses, which in itself implies that such norms can become evolutionary stable (Young 1998). Accordingly, we find that historical sex ratios are only associated with conservative gender views in areas where homogamy is high.

We rule out that other mechanisms explain persistence. Our results rely on within-country and even within-state variation, where formal legislation is identical. This rules out formal institutions as a persistence mechanism.[5] Another possibility is that past

[5] The legal framework operating in Australia with respect to gender discrimination has been constant across all states since the *Sex Discrimination Act 1984* (Cth), which operates at a federal level. This is a direct consequence of Australia's Constitution, with any state law inconsistent

circumstances in the marriage market influenced respective incentives of men and women to invest in education (Chiappori, et al. 2009). We find no evidence for this mechanism. Initial sex ratios could also have distorted industrial specialization towards male-intensive economic activities. Because we control for geographical endowments and for initial economic specialization, we view the remaining variation as integrant to cultural persistence. We also analyze local historiographies and document differences today between areas that had and still have a similar economic specialization but different past sex ratios.

The main contributions of this paper are two-fold. The first is to provide evidence of the long-term effects of male-biased sex ratios. We show that the effects of sex ratios on social norms and on female occupations have persisted for more than a hundred years, even though sex ratios have long reverted to normal. This suggests that the absence of the nearly one million women missing in the world today may deeply affect labor markets and gender norms not only in the few years to come, but also in the long-run, even if the imbalance itself was to be corrected. The study of the determinants of male-biased sex ratios has attracted a large literature.[6] The study of its consequences is much more limited because of evident reverse causality issues. We contribute to this literature by exploiting a unique natural experiment that resulted in male-biased sex ratios.

Our second contribution is to the literature on the influence of culture on economic outcomes and how culture emerges and persists. Until recently, the rise in female labor force participation, the expansion of women's economic and political rights, as well as the reduction in fertility that has been observed in developed countries were explained by technological change and the rise in returns to female labor.[7] However, several studies have also demonstrated how slow-changing cultural beliefs influence real work choices, family formation and welfare.[8] Regarding the origins of such beliefs, the literature so far

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with this act invalid to the extent of the inconsistency (Constitution s 109). The *Family Law Act 1975* (Cth) unifies family law in Australia at this federal level.

[6] See Rao (1993), Hesketh and Xing (2006), Chung and Das Gupta (2007), Qian (2008), Edlund and Lee (2009), Carranza (2014).

[7] See Goldin and Katz (2002), Greenwood et al. (2005), Doepke and Tertilt (2009), Doepke et al. (2012), Olivetti (2013).

[8] Fortin (2005) shows how gender role attitudes influence labor market outcomes. Alesina et al. (2013) establish a relationship between beliefs and participation of women in the economy and in

has argued that technological conditions that prevailed in the past have shaped gender specialization in the long-run (Alesina et al. 2013, Hansen et al. 2015). Our contribution is to document similar long-run effects of past conditions in the marriage market. We also illustrate a more rapid cultural change, which took place within a homogenous population.

2. Conceptual Background

In this section, we discuss how male-biased sex ratios may affect gender roles and cultural norms about gender roles in the short- and the long-run.

2.1. Short-run – Household Bargaining Models

In the short-run, bargaining models of intra-household decision making since Becker (1973, 1974) argue that conditions in the marriage market are an important determinant of intra-household utility distribution. Simple supply and demand models inform us that the bargaining position of one gender is proportional to its scarcity – the scarcer sex will benefit from being in the minority.

It follows from the collective household model (Chiappori 1988, 1992) and from the demand and supply model of marriage (Grossbard-Schechtman 1984) that marriage markets conditions influence individual labor supply decisions. Both models predict that when marriage market conditions are more favorable to females, for example because of male-biased sex ratios, men will transfer more resources to women. Women should marry more and as a result of an income effect, women will reduce their labor supply and consume more leisure (Chiappori 1988, 1992). Several empirical papers confirm these predictions, with increases in the sex ratio (i.e. more men relative to women) reducing female labor force participation and hours worked by women (Grossbard and Amuedo-Dorantes 2008, Angrist 2002, Chiappori et al. 2002). Addressing the possible endogeneity between local marriage conditions and local sex ratios, Francis (2011) exploits a natural experiment when the Chinese Nationalist Army fled to Taiwan in 1949.

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politics. Bertrand et al. (2013) find that households in which women earn more than men are less likely to form and, once formed, are more likely to lead to divorce. Fernández (2008, 2013) and Fernández and Fogli (2009) show that preferences for fertility and for female labor force participation change slowly.

He shows that a shortage of women leads to women marrying more[9], but does not explore the effect on female labor supply.[10] Angrist (2002) similarly provides evidence that male-biased sex ratios[11] in the early 1900s caused by sex-biased migration into the United States led to second-generation female immigrants marrying more and working less. He does not explore the effect on attitudes or leisure.

While the effect of sex ratios on the bargaining position of women provide a natural explanation for the correlation between sex ratios and female labor force participation, others have to be considered. The presence of a large number of men could crowd out female labor. However, the 19th century economy that we are studying was characterized by a very low substitutability between male and female labor. When fewer women are around, female labor should be in high demand and labor demand effects should run contrary to the prediction that more male-biased sex ratios are associated with lower female labor supply.

A potential criticism to the application of collective household bargaining models to the Australian colonial economy is that outside options were poor for women – there was wage discrimination and divorce was difficult to obtain (See Section 3). However, this was the case all over Australia. Therefore, it cannot constitute an explanation for the observed spatial correlation between sex ratios and female labor supply within Australia.

To sum up, collective household bargaining models predict that male-biased sex ratios lead to immediate improvements in conditions for women in the marriage market. As a consequence, women should marry more and reduce their labor supply. A possible consequence of women working less, coupled with possible changes in attitudes towards the appropriate place of a woman, is that they are less likely to progress to high-ranking occupations that generally require experience and a significant time commitment.

[9] Abramitzky et al. (2011) exploit another natural experiment: variation in World War I related deaths in France and find that, conversely, a shortage of men is associated with men marrying more and marrying up.

[10] More recently, Wei and Zhang (2011) suggest that male-biased sex ratios have increased the price of brides in China.

[11] The average sex ratio among immigrants arriving from1820 –1920 was about 1.5 (Angrist 2002).

2.2. Long-run – Cultural Persistence

As argued by Alesina et al. (2013), gender specialization that is the outcome of short-run economic forces can imprint onto cultural norms notions of the 'appropriate' role of women in society. Gender roles of the past can persist in the long-run because culture changes slowly. We define culture after Richerson and Boyd (2005, p. 5), as "rules of thumb" that affect behavior in complex and uncertain environments and that people acquire from other people through "teaching, imitation and other forms of social transmission". We view cultural norms as including beliefs about gender roles, which have direct consequences on female labor supply decisions (Bertrand et al. 2013), as well as the relative status of women and men in relationships, which affects the bargaining power, labor supply, and leisure consumption decisions made by partners.

Cultural traits that are successful, which in our context means getting a wife, will spread. Due to the persistent nature of culture, cultural norms about gender roles which were shaped by past sex ratios can persist even long after sex ratios have reverted back to normal, and even when such norms are no longer reflective of, or adapted to, current economic conditions. Several reasons may explain such persistence of cultural norms. Cultural beliefs can affect the design of formal laws and policies, which may crystallize certain gender roles. Economic specialization can also be shaped by gender roles, either directly or indirectly through cultural beliefs.

Another explanation, which we focus on, is that cultural norms are inherently sticky. Cultural norms can be transmitted from parents to children, through learning (Fernández 2013, Fernández et al. 2014) or active socialization by parents (Bisin and Verdier 2001, Doepke and Zilibotti 2008). Because parents try and transmit their own values to their children, cultural norms change slowly.

Moreover, the specific circumstances of the marriage market generate feedback mechanisms that reinforce persistence. Individuals with similar views are more likely to marry one another and more likely to stay married (Becker et al. 1977, Lehrer and Chiswick 1993). This phenomenon of marriage homogamy implies that views about gender roles are strategic complements among potential spouses. Norms about gender roles may then persist in the long-run solely because they are mutual best responses in the

marriage market.[12] Positive feedbacks of this kind are at the core of the persistence of cultural conventions in Belloc and Bowles (2013), even when such conventions are Pareto-dominated. Bisin and Verdier (2001) also argue that marriage homogamy reinforces cultural persistence by making family socialization more effective: when both parents hold similar values, children are more likely to inherit such values.

Cultural change has the characteristics of a collective action problem. The greater the cost of deviating from a given set of cultural traits, the less likely it is that any cultural change will occur. Deviation and experimentation may be particularly costly in the marriage market, where time is of the essence, uncertainty substantial, and search costs relatively high. If holding different views about gender roles leads to long delays in finding a spouse, people will conserve traditional views. Holding such views may be an efficient investment for a man, if this assists in helping him find a wife. This explains how homogamy in the marriage market should be associated with stronger persistence of norms. To the contrary, immigration should make experimentation easier and may accelerate transition towards gender views more adapted to current economic conditions rather than those of the past (Belloc and Bowles 2013).

3. Short-run Effects: Sex Ratios, Female Labor Supply, and Marriage in 19th century Australia

3.1. Historical Background

European settlement in Australia commenced after the independence of the United States, when it became the new destination of choice for the United Kingdom's overflowing jail population. Between 1787 and 1868, 132,308 and 24,960 convict men and women were transported to Australia, mostly to Tasmania and New South Wales (hereafter, NSW), which initially also included Queensland, the Australian Capital Territory, and Victoria (Oxley 1996, p. 3). These convict men and women were not "hardened and professional criminals" (Nicholas 1988, p. 3) but "ordinary working class men and women" (Nicholas

[12] Young (1998) shows theoretically that norms that are mutual best responses are evolutionary stable.

1988, p. 7). The majority of convicts were transported for property offences, such as petty theft (Oxley 1996).

The extent of free migration to Australia was rather limited until the 1830s. The male-biased sex ratio was sustained by ongoing convict transportation for nearly a century. Male convicts made up more than 80% of the adult male population of NSW in 1833. Even among free migrants, men vastly outnumbered women. It was mainly men who were attracted to the economic opportunities offered in Australia, which consisted largely of pastoralism and mining, especially after the discovery of gold in the beginning of the 1850s. As can be seen in Figure 1, a male-biased sex ratio endured in Australia for more than a century.

The European settler population of Australia was ethnically homogenous. The vast majority of convicts and free migrants came from England and Ireland. In the 1846 NSW Census, 90% of people born outside Australia came either from England or Ireland, with very little heterogeneity across different localities within Australia.[13]

Essential to our identification strategy is to understand what determined the variation in population and sex ratios within Australia. Upon arrival, convicts were not confined to prison cells. Initially, they were assigned to work under government supervision. Later, as the cost of caring for large numbers of convicts became too high, convicts were assigned for private employment. Employers were government officials, free settlers, or ex-convicts, since convicts were freed after the term of their sentence, generally 7 years. The placement of convicts was dictated by labor requirements and decided in a highly centralized way, as described by Governor Bligh of NSW in 1812:

"They (the convicts) were arranged in our book (…) in order to enable *me* to distribute them according" (cited in Nicholas 1988, p. 15, emphasis added).

As for free settlers, their spatial distribution was determined also by economic opportunities, namely in agriculture and mining, the two sectors in which Australia specialized in the 19th century (McLean 2012).

[13] 50% came from England and 40% from Ireland. The standard deviation of the two distributions is only 0.05.

Male labor was at a high premium in the colonial economy. In 1816, Governor Macquarie of NSW announced that male and female convicts must be paid £10 and £7 per annum, respectively (Nicholas 1988, p. 131). Meredith and Oxley (2005, p. 56) document an even larger gender pay gap in the non-convict population of 46%. Female labor force participation was low (Nicholas 1988). One explanation is that only men had the physical strength required for agricultural work and building the country (Nicholas 1988). However, the demand for female labor should have been high as the colonial economy was "desperate for labor" (Oxley 2005, p. 45), male and female labors were poor substitutes in the economy, and transported women had many skills valuable to 19th century Australia (Oxley 1994). Instead, Alford (1984, p. 243) suggests that the cultural norm that remaining within the home was a "woman's proper place" played a large role in explaining low female labor force participation.

Some convict women were confined to female factories, which were "a combination of textile factory and female prison" (Salt 1984, p. 142) for women who had committed a crime, borne a child out of wedlock, or displeased their assigned master.[14] Women worked in female factories for a very low or no wage.[15] Overall, Governor Macquarie of NSW put it best when he stated that convict women had 3 choices: become a domestic servant, live in a female factory, or marry (Alford 1984, p. 29). In the circumstances described above, marriage seemed like the most attractive option. And, given their scarcity, the demand for wives was high.

The authorities' concern that "the disproportion of the sexes" would have "evil effects" as men experienced "difficulty … in getting wives" (Select Committee on Transportation 1837-1838, p. xxvii) was well founded. Men were more than half as likely to be married than women (see Table 1). According to the historical Census, more than 70% of women in Australia were married in the 19th century, a much higher rate than in Britain at the same time period (60%) (Alford 1984, p. 26).

[14] No analogous male factory existed. NSW had 3 female factories in the counties of Cumberland, Northumberland and Macquarie. Queensland's county of Brisbane had 1 and Tasmania 5 (2 located in Hobart and the others in Launceston, George Town and Campbell Town).
[15] Third class women, those who committed a crime in the colony or misbehaved in the factory, received no wage (Salt 1984, pp. 86, 105).

The legal ability to divorce came rather late, particularly in NSW (1873). By the end of the 19th century (1892), there were a total of only 799 divorce petitions in NSW (Golder 1985). Moreover, marriage was enforced by strict laws, as well as by Victorian morality. For example, bearing a child out of wedlock was considered a crime for which women could be sent to prison.

In sum, 19th century Australia was an environment where women's economic opportunities outside marriage were limited and unattractive. As a consequence, it is expected that women would have been attracted to men who could fulfill the role of economic provider. The high bargaining power of women, due to their scarcity, would further reduce their incentives to work.

3.2. Historical Data

We collect data on the historical sex ratio and on the structure of the colonial economy from the Colonial Censuses taken in the 19th century in each of the six Australian states.[16] Other data sources, such as colonial musters that counted transported people, have high reporting error and are not representative of the entire population since participation was not compulsory (Camm 1978, p. 112).

Our measure of the historical sex ratio comes from the first Census in each state. This is because we want to rely on the earliest possible measure of the sex ratio and of its exogenous component, which came from convict transportation. We therefore rely mostly on the 1836 NSW Census (which also included the Australian Capital Territory at the time), the 1842 Tasmanian Census, the 1844 South Australian Census, the 1848 Western Australian Census, the 1854 Victorian Census, and the 1861 Queensland Census. These dates vary because states were independent colonies until 1901. The data Appendix describes in more detail the data sources and variable definitions.

Descriptive statistics for this first available historical cross-section are displayed in Panel A of Table 1. Although the total population of Australia at the time was only about

[16] The online data from the Historical Census and Colonial Data Archive was supplemented by the actual Census report due to errors in the 1881 Tasmanian Census. Only the Census reports are available consistently across the period, as some of the individual records were destroyed in a fire in 1882.

255,000 people,[17] more than 60% of the current population of Australia now lives in the areas that were covered by the data. The unit of observation in the Census is a county.[18] The average county had 4,764 individuals, and the majority of counties (about 85%) had between 300 and 10,000 people. On average, the sex ratio stood at over 3 men for every woman in the population but it was much higher among convicts, at nearly 30 men for every woman. As an extreme example, in the NSW county of Bligh the sex ratio was 11 in the whole population[19] and reached 219 among convicts. The historical Census also contains information on the number of married males and females and on economic occupations by gender. Unfortunately, available records do not provide any further break down of occupation by age or marital status.

Table 1 compares how well covariates are balanced between counties with historical sex ratios above or below the median (2.05). Agriculture was the largest employer in Australia at the time, accounting for 23% of the employed labor force. Next were domestic services with 14%, and manufacturing and mining with a combined total of 12%. The shares of people employed in these different activities do not differ systematically across high and low sex ratio areas (see Panel A of Table 1). Areas with high or low historical sex ratios are also broadly similar in terms of land characteristics and mineral endowments. Areas with high historical sex ratios are richer in major gold deposits, but poorer in major coal deposits (see Panel C of Table 1).

Figure 2 maps the sex ratio in the whole population and in the subset of the convict population in areas of Australia that were already settled at the time of the study. The concentration of sexes has no definite pattern: high and low sex ratios were found in the hinterland as well as along the coast.

[17] These numbers do not include Aboriginal or Torres Strait Islanders, who were not counted in the Census until the 1960s. Only very rough estimates are available for these populations.

[18] "Counties" will be used here to refer to historical administrative divisions in the different colonies of Australia, which were variously called "counties", "police districts", "towns", or "districts".

[19] Hereon, "whole population" includes convicts, emancipists (i.e. ex-convicts), free settlers and all individuals born in the colony (including children because there is not a consistent inclusion of different age groups in the Census). Hence, the historical sex ratio is inclusive of the convict sex ratio.

In addition to the first Census in each state, we also consider the full panel of 19th century Censuses, roughly from 1836 to 1881. The panel is described in Table A1. The panel is unbalanced across states because of their status as independent colonies until 1901 and for some of the years, the maps of counties are not available. The panel ends in 1881 because substantive redistricting occurred after that date and maps are not available. Descriptive statistics for this panel dataset are included in Panel B of Table 1. Due to the balancing influence of natural births,[20] the sex ratio over this whole period is lower than in the first Censuses, but still stands at 1.9 men for every woman. Female marriage rates were high throughout the period, particularly so in more male-biased areas. In high sex ratio areas, while they married more, women worked less. Female labor force participation[21] and the proportion of employed women in high-ranking occupations, which include clerical, legal, and medical professions and teaching, are statistically significantly lower in high sex ratio areas.

3.3. OLS Specification and Results

We estimate the following regression in the panel of historical counties from 1836 to 1881:

(1) $$y_{ct} = \alpha + \beta SexRatio_{ct} + X_{ct}\theta + \delta_c + \delta_t + \varepsilon_{ct}$$

y_{ct} measures marital outcomes for men and women, female labor force participation and female occupations in county *c* at time *t*. $SexRatio_{ct}$ is the historical sex ratio: the number of males over the number of females in county *c* at time *t*. X_{ct} includes additional characteristics of county *c* at time *t*, namely male labor force participation and male occupations when the dependent variable is, respectively, female labor force participation and female occupations. δ_c and δ_t are county and time fixed effects. As the panel is unbalanced, we have grouped years together and consider half decades as time fixed

[20] No demographic study has found any evidence of distorted or abnormal historical sex ratios at birth in Australia (Opeskin and Kippen 2012).
[21] There is no consistent breakdown of age by gender across colonies and years. Therefore, we measure labor force participation as a percentage of married individuals, as married individuals are of working age.

effects. In alternative specifications, we model a polynomial of time of degree 3 from the 1836 start date.[22] Standard errors are clustered at the county level in all regressions.

County fixed effects remove the influence of time invariant county characteristics that could be associated with sex ratios and marriage or female work outcomes. Time fixed effects remove the influence of common time varying shocks, such as changes in overall economic specialization. Identification of the effect of the sex ratio requires either the absence of idiosyncratic shocks to the marriage market or to the female labor market, or at least that the sex ratio in a given county did not respond to such shocks systematically. While it is difficult to think of exogenous and idiosyncratic shock to the marriage market *per se*, it is possible to imagine idiosyncratic shocks to the labor market, which may also affect the marriage market. The main contender in the economy that we are studying consists of the discovery of minerals. The discovery of minerals would directly affect the sex ratio in a given county, by attracting male labor. However, if anything, a positive mineral shock would also increase the demand for female labor. Miners need to be lodged, fed, and cleaned, and their children educated, all traditionally female occupations. This would bias the results against the effect that we are trying to test in this paper. A positive economic shock would only result in a decrease in female labor force participation if the bargaining position of women in the marriage market improved and enabled them to reduce their labor supply. Similarly, it is hard to see why mineral discoveries would lead women to marry more, *independently* of marriage market bargaining effects.

Panel estimates of the historical relationship between sex ratios and marriage rates, female labor force participation and the quality of female occupations are displayed in Table 2. For each dependent variable, specifications in the first column only include county fixed effects, and we add time fixed effects in the second column.

In line with the prediction of bargaining models of intra-household decision making, a more male-biased sex ratio is associated with women marrying more and reducing their labor supply. All the effects are statistically significant at the 1% level. While women marry more, men marry less. Since we capture labor supply decisions by married women,

[22] All the results are unchanged in this alternative specification. The results are not displayed here. Contact the author for further detail.

the negative effect of the sex ratio captures more than a simple compositional effect due to women marrying more (as we have shown) and married women decreasing their labor supply. More male-biased sex ratios are also associated with a lower proportion of women employed in high-ranking occupations. This effect is statistically significant at the 1% level. As discussed in Section 2, we interpret this as a possible consequence of women working less and not accumulating the experience generally needed to attain high-ranking occupations. It is also possible that views about the appropriate role of women in these areas explain this result as suggested by Alford (1984). The lack of historical data on attitudes prevents us to test directly for this channel. Results pertaining to female labor force participation and to the nature of female occupations are robust to controlling for the county's male labor force participation or for males employed in similar occupations, respectively. The results are large in magnitude. An increase of one standard deviation in the sex ratio associated with a reduction in female labor force participation and in the share of women in high-ranking occupations by 0.27 and 0.43 standard deviations, respectively.

All these results carry through in the historical cross-section provided by the first Census in each state (see Table A2 in Appendix), even when controlling for geographical characteristics (latitude, longitude, presence of minerals and land type), initial economic specialization and state fixed effects.

To sum up, panel and cross-section estimates indicate that in areas with more male-biased sex ratios, women married more, worked less and were less likely to work in high-ranking occupations. The prediction of collective household models (Chiappori 1988, 1992) associated with the reduction in female labor supply is that women will increase their leisure. The lack of historical data prevents us from directly testing this prediction. In the next section, we study how 19th century economic and marriage conditions have shaped cultural traits and how they still influence outcomes in the present day, including how much women work and how much leisure they enjoy.

4. Long-run Effects: Cultural Norms, Women in the Workplace, and Women's Leisure Today

In this section, we explore the long-term consequences of male-biased sex ratios for female labor force participation and occupational choices and how it has shaped the cultural values of Australians. We are also able to provide direct evidence on the consumption of leisure. First, we discuss how we link historical data to present-day opinion surveys and Census data.

4.1. Present-day Data

Postal areas in modern-day datasets are not equivalent to historical counties. Prior to this study, digitized shapefiles on Australian historical Census boundaries did not exist. We collected and digitized hard copies of maps from the National Library of Australia and from State Libraries in order to construct these boundaries and match historical counties to present-day boundaries.[23] The Appendix lists the maps used and has more details on this matching process.

We explore the long-term effects of male-biased sex ratios on female labor force participation and occupational choices with data from the most recent Australian Census, taken in 2011. The unit of observation is the postal area. There are 2,515 postal areas in total. We match around 2,000 of these postal areas to historical counties, the remaining 500 or so being areas that were not settled at the time of the historical Censuses. To capture the long-term effects of male-biased sex ratios on female work choices, we focus on women in high-ranking occupations: women employed as professionals as a proportion of employed women.

Present-day data on time allocation and on cultural attitudes are from the Household, Income and Labour Dynamics in Australia survey (HILDA), a nationally representative survey available since 2001. The location of respondents is identified by the postal area. After matching to historical data, we are left with a sample of between 30,000 and 50,000 individual observations, depending on the questions used, in more

[23] When a postal area was found in multiple counties, we assigned it to the county in which it was mostly located.

than 1,500 postcodes. Due to restricted survey coverage, the number of postcodes is lower than in the Census.

The main question of interest in order to capture views about gender roles in HILDA asks to what extent respondents agree that: "*it is better for everyone involved if the man earns the money and the woman takes care of the home and children*." Response categories range from 1 (strongly disagree) to 7 (strongly agree). We recoded this so that a higher value indicates stronger disagreement with this statement, which we interpret as more progressive attitudes.

Data on time allocation deals both with labor supplied in the labor market and at home. To proxy individual hours worked in the labor market, we rely on the following question: "*How many hours per week do you usually worked in all jobs?"* HILDA also records how many hours and minutes a week each individual spends taking care of children[24] and doing housework.[25] As a proxy for how much leisure an individual enjoys, we use the following two questions: "*How often to you feel rushed or pressed for time?*" and "*How often to you have spare time that you don't know what to do with?*" Answers to these questions are coded from 1 (never) to 5 (almost always).

We retain several individual characteristics from HILDA and variables from the Census as well as data on mineral and land type from Geoscience Australia as controls. Descriptive statistics are provided in Panels C and D of Table 1. The balance of these covariates across areas below or above the median historical sex ratio is also presented in the last two columns of Table 1. We observe no statistically significant difference across high and low historical sex ratio areas in terms of age, gender, ancestry composition, income, or education today. We have already discussed how areas with high or low historic sex ratio have similar endowments and land types. Areas that were more imbalanced historically tend to be less urbanized today and, probably as a consequence, marginally still more male-biased. We include urbanization and the sex ratio today as controls.

[24] i.e. playing with children, helping them with personal care, teaching, coaching, or actively supervising them, getting them to daycare, school, or other activities.
[25] i.e. preparing meals, washing dishes, cleaning house, washing clothes, ironing, sewing, shopping, banking, paying bills, and keeping financial records.

4.2. OLS and Instrumental Variable Specifications

OLS Specification. Having matched historical data to postal areas today, we are able to examine the long-term effects of male-biased sex ratios on present-day attitudes, female labor force participation, female occupational choices, and time use by estimating the following equations:

(2) $y_{ipc} = \alpha_1 + \beta_1 SexRatio_c + X_{pc}^{G}\Gamma_1 + X_c^{H}\Pi_1 + T_{pc}^{C}\Lambda_1 + X_{ipc}^{C}\Theta_1 + \delta_s + \delta_t + \varepsilon_{ipc}$

(3) $y_{pc} = \alpha_2 + \beta_2 SexRatio_c + X_{pc}^{G}\Gamma_2 + X_c^{H}\Pi_2 + T_{pc}^{C}\Lambda_2 + \delta_s + \varepsilon_{pc}$

y_{ipc} is the survey-based measure of attitudes or of time allocation of individual *i* in postal area *p*, part of historical county *c*. y_{pc} are the Census-based measures of female labor force participation or occupations in postal area *p*, part of historical county *c*. $SexRatio_c$ is the historical sex ratio: the number of males over the number of females in historical county *c*, as per the first Census in each state. X_{pc}^{G} is a vector of time-invariant geographic characteristics at the postal area level and X_c^{H} is a vector of historical controls. T_{pc}^{C} and X_{ipc}^{C} are vectors of postal area-level and individual-level contemporary controls, respectively. δ_s is a vector of state dummies. δ_t is a vector of HILDA wave dummies, when applicable. Since historical data at the level of the 91 historical counties is less granular than present-day data at the postal area or individual level, all standard errors are clustered at the county level.

X_{pc}^{G} and X_c^{H} are intended to capture geographic and historic characteristics that may have been correlated with the sex ratio in the past and may still influence present-day outcomes. In particular, as discussed in Section 3, Australia in the 19th century specialized in the production of primary commodities in agriculture and mining. Such economic opportunities influenced where convicts were assigned and where free settlers located. If economic specialization persists over time for reasons separate from the cultural channel we are interested in, these initial conditions could also influence present-day economic opportunities for women and ignoring them would bias our estimates. In order to flexibly account for geographic differences across counties that may be correlated with agricultural potential, we control for latitude and longitude in all specifications. To control more precisely for mining and agricultural opportunities, we

control for 9 detailed categories of mineral deposits[26] and for land characteristics.[27] We do not include elevation because it shows very little variation, with 95% of our population being in a low-grade area. We also control directly for the county historical economic specialization, by including in X_c^H the historical shares of the population employed in the main categories of employment discussed in Section 3: agriculture, domestic services, mining and manufacturing, government and learned professions (including teaching). Total historical population in the county is also included in X_c^H.

In the models of individual attitudes and time allocation, present day individual controls taken from HILDA include gender, marital status, age, income, education, and whether the respondent was born in Australia. Postal area-level controls include the sex ratio today and urbanization, taken from the Census.

In the models of female labor force participation and occupational choice, contemporary controls include the sex ratio today, urbanization and average education. Controlling for the proportion of married people or for the full range of industrial specialization is problematic, as these are endogenous outcomes. However, to account for sectorial differences across counties that influence the share of women employed as professionals today, we check for the robustness of the results to controlling for the share of men employed in similar occupations. Considering that we are keeping the formal legislation constant by exploiting within-country and even within-state variation, controlling for the share of men employed in similar occupations should leave us with the variation that is due to culture, as opposed to formal institutions, technology, or employment opportunities.

Instrumental Variable Strategy. We include in equations (2) and (3) a battery of geographic, historical, and contemporary controls. Yet, where men and women chose to locate historically may have been driven in part by unobservable characteristics, for example, on the basis of female preference for leisure or male taste for discrimination. To address this concern, we adopt an instrumental variable approach. We instrument the

[26] Minor coal; minor other; major coal; major copper; major gold; major mineral sands; major oil and gas; major others. The excluded category is no deposits or traces only. Source: Geoscience Australia.

[27] Plains, plateaus and sand plains; hills and ridges; low plateaus and low hills; mountains. Source: Geoscience Australia.

overall sex ratio $SexRatio_c$ by the sex ratio among the convict population only. This instrument is relevant because, as explained in Section 3, convicts constituted a large proportion of the population where they were present. This means that the sex ratio among convicts is an important component of the overall sex ratio. Since convicts were not free to choose where to go, using the sex ratio among convicts as an instrument alleviates the self-selection issue that men and women chose to locate historically based on unobservable preferences. Yet, convict assignment was not purely random. In particular, it may have been influenced by spatial differences in economic specialization. As before, we remove this potential endogeneity bias by controlling for historical employment sectorial shares and for the full set of geographic factors, including the location of minerals and land type.

Another potential source of violation of the exclusion restriction resides in the possibility that the presence of convicts had a direct effect on attitudes, labor force participation, occupations and time use today, independently of the effect on sex ratios. This could be the case, for example, if convicts were different from the rest of the population because they had different preferences for leisure or held different views about gender roles. This is unlikely since it has been widely documented that convicts were representative of English and Irish societies at the time (Oxley 1994, Meredith and Oxley 2005). Nevertheless, we control for the number of convicts in our 2SLS procedure in order to alleviate this concern.[28] Because convicts constituted the majority of the population where they were present, we have to drop total population from the set of historical controls when we control for the number of convicts because of multicollinearity issues.

As only NSW and Tasmania were penal colonies, convicts are only present in 31 of our 91 historical counties. To adjust for the small number of clusters, we provide two alternative corrections to the standard errors. The first is to bias-correct the cluster-robust variance matrix by inflating standard errors by a factor of $\sqrt{G/(G-1)}$ with G the

[28] The presence of female factories, which hosted some female convicts, may have influenced the convict sex ratio as well as attitudes towards these women, who were considered outcasts. Controlling for the location of these factories does not alter our results and the effect of female factories is never significant. The potential endogeneity bias would run against the direction of our main result: we would find more conservative attitudes where there were more women.

number of clusters, as suggested by Cameron and Miller (2015). In our case, this amounts to multiplying standard errors by a factor of 1.018 in the regressions with HILDA data and by a factor of 1.016 in the regressions with Census data. The second is to compute standard errors using the Wild cluster bootstrap method based on 1,000 replications, as recommended by Cameron, Gelbach and Miller (2008) and Cameron and Miller (2015).

4.3. OLS Results

The estimates displayed in Table 3 show that in the present-day in areas where sex ratios were most severely male-biased in the early days of colonial settlement in Australia, people are more likely to hold the view that women should stay at home, women work less, and women are less likely to occupy high-ranking occupations. Even though women work fewer hours in the labor market, estimates in Table 4 show that they do not spend more time working inside the home on housework chores or household errands and, if anything, they actually spend less time taking care of their children. As a result, women today consume more leisure in areas that were more male-biased in the past. They are significantly less likely to feel rushed, and significantly more likely to have more spare time.

For each dependent variable, Table 3 reports estimates of specifications in which we first include only state fixed effects, the basic geographic controls and individual and postal areas controls. We then add the full range of historical controls as well as controls for the presence of minerals and for land type.

Attitudes. The relationship between attitudes towards gender roles and historical sex ratios is statistically significant at the 1% level even when controlling for the full set of geographic, historic, and contemporary controls. In terms of magnitude, the effect of the historical sex ratio on attitudes is comparable, at the mean, to 30% of the effect of being a female versus a male respondent.[29] Moreover, the relationship between the historical sex ratio and attitudes today is specific to views about women working. Male-biased sex ratios in the past do not explain sexist attitudes in general. Columns 1 and 2 of Table A3

[29] The mean values of the historical sex ratio and female respondent in the HILDA sample are 2.04 and 0.54 respectively.

show the estimation results of equation (2) when the dependent variable captures respondents' views about the quality of female leaders. There is no significant relationship between historical sex ratios and such attitudes.

Female Labor Force Participation at the Extensive and Intensive Margins. The relationship between female labor force participation and the historical sex ratio remains negative but falls short of standard levels of statistical significance when we include all contemporary controls. However, when we look at the intensive margin with the log of hours worked per week as the dependent variable in Columns 6 and 7 of Table 3, the negative relationship between historical sex ratios and female labor supply is robust to the inclusion of the full battery of controls. The coefficient associated with the interaction between the historical sex ratio and a dummy variable for being a female respondent is negative and statistically significant at the 1% level. Meanwhile, the main effect of the historical sex ratio, which measures the relationship between historical sex ratios and male labor supply, is positive and statistically significant. This means that where sex ratios were more male-biased in the past, women work significantly fewer hours today, while for men the opposite is true. The magnitude of the effect for men is about 70% of the magnitude of the effect for women.

In sum, although past sex ratios do not seem to have a robust effect in the long-run on female labor supply at the extensive margin, they do still affect labor supply at the intensive margin, with women working fewer hours. Another piece of supporting evidence for this effect is that women substitute full-time work for part-time work, as shown by regression results using Census data in Columns 3 to 8 of Table A3 in the Appendix.

Type of Occupations. A likely consequence of women working fewer hours, being more likely to occupy part-time positions, and society holding more conservative attitudes is that women may not be able to rise to high-ranking occupations. This is confirmed when we examine the type of work undertaken by women in Columns 8 to 10 of Table 3. We find that the share of women in high-ranking occupations is negatively and robustly associated with historical sex ratios, even when controlling for the full set of controls, including the share of men employed in similar occupations. A one standard deviation increase in the historical sex ratio is associated with a decrease in the share of

women employed as professionals by 0.13 standard deviations. In terms of the share of the variation explained, adding historical characteristics to the full set of controls increases the R-squared by 2.5 percentage points. This is equivalent to more than 3% of the remaining unexplained variation in the share of women employed as professionals.[30]

Time Use. Table 4 reports estimates of equation (1) when the dependent variables measure time allocation. We add in equation (1) an interaction term between historical sex ratio and gender to measure the differential effect of historical sex ratios on males' and females' time allocation. For economy of space, we only report in Table 4 the results with the full set of geographic, historical, and present-day controls. For time spent with children and time allocated to housework, we first present estimates for the whole sample and then only estimates at the intensive margin.

Even though women today work fewer hours in the labor market in areas that were more male-biased in the past, estimates in Columns 1 to 4 of Table 4 show that they do not increase their labor supplied at home. If anything, women spend less time taking care of their children (almost an hour less at the mean, for those who have children), while they spend no more time on housework and running household errands. These results strongly suggest that women today consume more leisure in areas that were more male-biased in the past. This is confirmed in Columns 5 and 6 of Table 4, which present the regression results of the best proxies available in the HILDA survey for how much leisure one enjoys. In areas where sex ratios were more male-biased in the past, women today are significantly less likely to "fell rushed" and significantly more likely to enjoy "spare time". The coefficients are statistically significant at the 1% level and robust to the inclusion of the full battery of controls.

4.4. Robustness of OLS Results

All the results pertaining to attitudes, female labor supply at the intensive margin, the share of women in high-ranking occupations, time use and the consumption of leisure are robust to non linear effects of the historical sex ratio, as well as to excluding metropolitan areas, counties that had fewer than 300 people or more than 40,000 people, or counties

[30] (0.573-0.559) / (1-0.559). 0.559 is the R-squared of a regression with all but historical controls.

that had very few women historically (less than 100). They are also robust to controlling for: distance to major ports of entry and to the main metropolitan areas; population density today; the shares of different religions in the population, historically and today[31]; and the average income in the county and its quadratic. Some of these additional robustness tests are presented in Tables A4 and A5. We also check that the results are robust to propensity score matching. To do so, we predict the historical sex ratio as a flexible function of extended geographic characteristics (latitude, longitude, presence of minerals, land type) and historical employment shares in different sectors, as well as all interactions between geographic and historical characteristics and second order polynomials. We then condition on this predicted propensity score in the main specification. All the results described so far carry through (see Columns 6, 20, and 27 of Table A4 and Columns 6, 20, and 27 of Table A5). We also present in Tables A4 and A5 the results of placebo specifications in which historical sex ratios are randomly re-allocated between historical counties, while keeping the overall average share of men relative to women constant. As expected, the results are never significant.

Placebo specifications in which male work outcomes, such as male labor force participation, the share of men employed as professionals and the share of men working full- or part-time time are regressed on the historical sex ratio bear no significant results. The results are in Table A6.

We implement a recent statistical test developed in Oster (2013). Based on the recommended assumption that the maximum R-squared is 1.3 times the R-squared obtained with the full set of controls, the influence of unobservable variables (the delta) would need to be more than 12 times as large as the influence of all controls included in Column 2 of Table 4 to explain away the influence of the historical sex ratio for progressive attitudes. For other outcomes, such as hours worked by women, the share of women in high-ranking occupations, time spent on household chores or taking care of children, and proxies of leisure consumption, the delta is either well above the recommended threshold of 1, and in many cases negative, which indicates that the

[31] Information on ethnicity is very sparse in the historical Census. Religion seems to be an adequate proxy. For example, in the above mentioned 1846 NSW Census, 50% of the population was Church of England, and 31% Roman Catholics, which corresponds well to the respective 50% and 40% shares of the population of English or Irish ancestry.

inclusion of controls actually increases the magnitude of the coefficient associated with historical sex ratios.

4.5. Instrumental Variable Results

Tables 5 and 6 present the results of instrumental variable specifications in which we instrument the population sex ratio by the sex ratio among convicts only. Table 5 includes estimates pertaining to attitudes, female labor force participation, and occupations. Table 6 includes estimates pertaining to time allocation and the consumption of leisure. The instrumental variable specifications are estimated on a reduced population because convicts were only present in 31 of our 91 historical counties; only in the states of Tasmania and NSW. We adjust standard errors for the small number of clusters as detailed in Section 4.2. In all specifications, we include the full set of geographic, historical and present-day controls, which are identical to those in Tables 3 and 4 with one exception. We do not include total historical population when we control for the total number of convicts because the two variables are strongly correlated since convicts were such a large proportion of the population where they were present. We only present the results of the instrumental variable strategy for the sample of females when relevant (hours worked, time use, consumption of leisure). We present IV results both for the extensive and intensive margins for the 2 categories of time use. Given that the populations in Tables 5 and 6 are different from those in Tables 3 and 4, we present not only the results of the first and second stages, but also the OLS specifications (1) and (2) in the relevant population and samples, as well as the reduced form in which we regress outcomes directly on the convict sex ratio.

Given that convicts were a large proportion of the population, it is not surprising that the first stages, for which statistics are displayed in Panels B of Tables 5 and 6, are very strong and all above conventional levels below which instruments may be considered weak.

All the second stage results pertaining to attitudes towards gender roles, to female work hours, and to female occupational choice are robust to the instrumental variable

strategy. The instrumented sex ratio is associated with more conservative attitudes towards gender roles, fewer hours worked by females, and a lower proportion of women employed as professionals, and the relationships are statistically significant at the 1 to 5% level. As for time allocated by women to their children or to household work, the point estimates are still negative but no longer statistically significant. However, the relationship between the consumption of leisure by women and the (instrumented) sex ratio is still positive and statistically significant at the 1% level. Even though they may not significantly reduce their supply of labor at home, women still reduce their labor supplied outside the home and enjoy more leisure as a result.

For female occupations, the IV coefficient is similar to the OLS coefficient displayed in Panel C of Table 5. For attitudes, hours worked and leisure enjoyed by females, the IV coefficient is larger in magnitude than the OLS. Two reasons may explain this. The first is that the IV coefficient measures the local average treatment effect on the convict subpopulation. The sex ratio was much higher in this subpopulation and while convict women married free men, the reverse was rarely true. Convict women were therefore in a particularly well-suited situation to extract a high bargain. The second is that the OLS coefficient may suffer from attenuation bias. Convicts were all of marriageable age, being between 15 and 50 years of age when transported (Nicholas 1988, p.14), whereas the rest of the population in the Census also includes younger and older people. The convict sex ratio therefore measures more precisely the sex ratio that is relevant for the marriage market and the mechanism we describe.

4.6. 1933 Results

We have so far documented the short-run implications of a male-biased sex ratio, and its implications in the long-run, about 150 years later. In this section, we document medium-term implications, in particular before the onset of multicultural migration to Australia. Australia experienced its first significant influx of free migrants after the discovery of gold in NSW and Victoria in the 1850s. However, deteriorating economic conditions in the late 19th century and the White Australia Policy in the early 20th century restricted migratory flows (McLean 2012). The second period of mass immigration into Australia

occurred after the Second World War and the relaxation of the White Australia Policy in the 1970s. In order to capture outcomes before these changes, we rely on data on female work and occupations in the 1933 Census. We match 552 local government areas (the unit of observation in the 1933 Census) to our historical counties from the first Censuses. The total population of Australia in 1933 was 4.5 million people. In 1933, the sex ratio still stood well above parity, at 1.16 (see Figure 1).

We estimate specification (2) with female labor force participation and the share of women employed in high-ranking occupations in 1933 as the dependent variables. There is no urban/rural indicator in the 1933 Census. We control instead for the share of people employed in agriculture, in addition to tertiary education and to the sex ratio in 1933. As before, we also control for male labor force participation or for the share of men in similar occupations when relevant.

Regression results with the full set of controls are reported in Table A7. Female labor force participation and the share of women in high-ranking occupations are negatively associated with the historical sex ratio. The relationship remains statistically significant at the 5% level for the quality of female work with the full set of controls.

We implement our instrumental variable strategy, where we instrument the sex ratio in the whole population by the sex ratio among convicts only. We are left with 155 local governments areas in 1933 where convicts were present in the past. First and second stage regression results, as well as the OLS results and the reduced form in this subpopulation, are presented in Table A8. We control for the full set of covariates, including the 1933 sex ratio. The first stage is still strong, with the F-stat of the excluded instrument well above 30. In the second stage, the share of women in high-ranking occupations in 1933 is still negatively associated with the (instrumented) sex ratio a century earlier. In this reduced population, the effect is bordering standard levels of statistical significance with a P-value of 0.109. The point estimate of the second stage is larger in magnitude than the OLS point estimate in the whole population of 552 local governments areas in Table A7, but nearly identical to the point estimate in the OLS specification in the subpopulation of 155 areas where convicts were present. The OLS coefficient associated with the historical sex ratio in this population is statistically significant at the 5% level. The magnitude suggests that a one standard deviation increase

in the historical sex ratio was associated with a reduction in the share of women employed in high-rank occupations a century later by 20% of its standard deviation.

5. Cultural Persistence: The Roles of Vertical Transmission, Migration, and Marriage Homogamy

We have documented that male-biased sex ratios have effects on female labor supply, time use, and occupational choices not only in the short-run but also in the long-run, even long after sex ratios have reverted back to normal. We have also shown that variation in historical sex ratios is associated with systematic variation today in cultural attitudes towards gender roles, even though the European settler population of Australia was ethnically and culturally homogenous to start with. Our focus on sex ratios affecting gender roles through the marriage market suggests specific cultural persistence mechanisms, which rely on homogamy in marriage and on child socialization within families, which we explore in detail in this section.

If, as discussed in Section 2.2, gender norms are transmitted within families, and if Australia's past shaped a specific norm in the way we describe, people whose parents are born in Australia should be more likely to hold this norm. To test for such cultural vertical transmission in more detail, we add interaction terms between historical sex ratios and a dummy indicating at least one Australian parent (mother or father) when we examine the determinants of progressive attitudes towards gender norms, using the same question as before.[32] The excluded category consists of persons born to two non-Australian born parents.

Regression results are in Columns 1 and 2 of Table 7. The coefficient associated with the historical sex ratio alone is no longer statistically significant, suggesting that historical sex ratios have no influence on people who are not born of Australian parents. The main effect of having an Australian parent is positive and statistically significant, but its interaction with the historical sex ratio is negative, statistically significant and large in magnitude: more than twice as large as in the sample as a whole. In other words,

[32] Splitting this further into Australian born mother and Australian born father is problematic due to multicollinearity.

Australian parents transmit more progressive norms, but not where sex ratios were more male-biased historically.[33]

Consistent with the theoretical prediction regarding the role of migration in Belloc and Bowles (2013) discussed in Section 2, we find that recent migration has an attenuating influence on cultural persistence. Belloc and Bowles (2013) discuss how immigration should make experimentation easier and may accelerate transition from one cultural convention to another. Consistent with this prediction, we find that the historical sex ratio is associated with more conservative gender norms in areas where migration in recent years[34] was low, but not where it was high (Columns 3 and 4).[35] These results also reveal that people of different ancestry systematically display different attitudes although they live in the same area. This implies that the relationship between historical sex ratios and present-day outcomes is unlikely to be due to unobservable local characteristics or to self-selection of people to localities on the basis of taste.

We have discussed in Section 2 other mechanisms that might contribute to persistence and in particular the issue of coordination on the marriage market and homogamy. We document the relationship between homogamy in the marriage market and the persistence of conservative gender norms in Columns 5 and 6 of Table 7. We define homogamy as the probability that one's partner is born in Australia when one is born in Australia, 86% on average. Table A9 in the Appendix illustrates that homogamy brings direct benefits: people are happier in their relationship when married to someone ethnically similar.

As we are concerned that homogamy is an endogenous outcome to the degree of cultural persistence, we rely on a measure of homogamy predicted by several characteristics of the postal area: education, the degree of urbanization, ancestry composition, average median income, the sex ratio today and employment shares in 18 different sectors. We define high and low homogamy postal areas as above or below the median predicted homogamy.

[33] The coefficient associated with the historical sex ratio itself (the sum of the main effect and the interaction with having an Australian parent) is overall negative and significant (P-value of 0.000).
[34] The Census reports migration over the last 5-year period.
[35] The coefficient associated with the historical sex ratio itself (the sum of the main effect and the interaction with having low migration) is overall negative and significant (P-value of 0.000).

The results show that historical male-biased sex ratios are associated with conservative views only in areas where predicted homogamy is high. By contrast, no effect is found in areas with low homogamy.[36] Such strategic complementarities in the marriage market are compatible with the apparent paradox of rapid adaptation of cultural norms yet cultural persistence. The situation we study is that of a large shock to the marriage market, one able to lead to rapid adaptation towards social norms that guaranteed success in finding a wife. Holding such views would be an efficient investment in a market with such excess demand (Angrist 2002). Our interpretation of persistence is that these norms locked in, even after sex ratios had reverted back to normal, because of the strategic complementarity of gender views in the marriage market, together with vertical transmission within families.

All these results are robust to instrumenting the historical population sex ratio by the sex ratio among convicts only. Results of the first and second stage, as well as of the reduced form and the simple OLS specification in the reduced sample where convicts were present historically, are presented in Table A10. We correct standard errors for the small numbers of clusters using the two methods discussed in Section 4.2. Because all the results pertain to interaction effects between the historical sex ratio and either: having at least one Australian parent, living in a low migration area, or living in a high endogamy area, we perform the 2SLS analysis in each of the three relevant subsamples. As before, the convict sex ratio is a strong instrument, with the F-stat of the excluded instrument in the first stage regressions around 20. All the results discussed so far are robust to this instrumentation strategy.

In Appendix Tables A11 and A12, we explore another mechanism that could explain persistence. Past circumstances in the marriage market may have durably affected the respective incentives of women (undermining them) and men (with the opposite effect) to invest in education (Chiappori et al. 2009). This in turn could explain why fewer women today make it to high-ranking occupations in areas where sex ratios were most male-biased in the past. To test for this, we regress the shares of women and men with a tertiary education in 2011 and in 1933 on the historical sex ratio, controlling for

[36] The coefficient associated with the historical sex ratio itself (the sum of the main effect and the interaction with homogamy) is overall negative and significant (P-value of 0.002).

historical and contemporaneous employment in different sectors of the economy, the usual geographic controls and the contemporaneous sex ratio. The relationships are not statistically significant for women.[37] Moreover, descriptive statistics show no evidence of differential selection of women into the labor force, or even into part- or full-time occupations, across high and low sex ratio areas. On average, 24.41% of working women in high sex ratio areas (defined as above the median historical sex ratio) have studied beyond high school, against 24.95% in low sex ratio areas. The difference is not statistically significant. At the intensive margin, 15.93% of full-time working women in high sex ratio areas have studied beyond high school, against 16.96% in low sex ratio areas (P-value of the difference in means: 0.31). The OLS relationship between men's educational outcomes and the historical sex ratio is not statistically significant in 1933, but it is statistically significant and negative in 2011, which goes contrary to the prediction that men should invest more in education in order to enhance their income earning ability and their attractiveness to potential spouses. However, this result is not robust to the instrumentation strategy, as shown in Column 2 of Table A12. Overall, the results point to the absence of a robust relationship between educational outcomes and the historical sex ratio.

Another possible channel is that initial male-biased sex ratios distorted industrial specialization towards male-intensive economic activities and that economic specialization persisted over time. Since we control for initial economic specialization and for geographical endowments, such as land characteristics and mineral discoveries, we view the remaining variation as integrant to cultural persistence. Moreover, high and low sex ratios areas actually did not differ systematically from one another in terms of initial economic specialization, land characteristics, or mineral discoveries. We also carefully analyzed local historiographies in order to contrast the outcomes of areas that had a similar economic specialization in the past and are highly comparable on most observable dimensions, but that had very different historic sex ratios. For example, county Bligh and county Dalhousie are two inland counties bordered by the Goulburn

[37] In the second stage of the 2SLS, the relationship between female educational outcomes in 2011 and the historical sex ratio is negative (see Column 1 of Table A12) but this result is not robust to correcting standard errors for clustering at the county level and correcting for the small number of clusters (see Wild cluster bootstrap P-value at the bottom of the Table for Column 1).

River and roughly equidistant from the nearest port. Both have major coal deposits and consist mostly of low hills terrain. Both are rural counties that were, and are still, predominantly specialized in agriculture. However, the sex ratio was much more male-biased in Bligh, with nearly 11 men for every woman, against slightly over 2 in Dalhousie. Today, in Bligh, female labor force participation is 47%, with 17% of women employed as professionals, against 54% and 21% respectively in Dalhousie. Our progressive attitude variable takes an average value of 2.05 in Bligh, against 3.78 in Dalhousie.

6. Conclusion

This paper shows that sex ratios that prevail at one point in time can leave a large and persistent imprint on the labor supply decisions of women and on women's occupations in the short-, medium-, and long-run. Male-biased sex ratios result in women reducing their labor supply. We have also documented, in the long-run when the data enables us to do so, that these effects translate into the consumption of more leisure by women and into more conservative views held about gender roles. As a likely consequence of the reduction in their labor supply and of more conservative attitudes, women are less likely to rise to high-ranking occupations. These findings consistent with the predictions of household bargaining models that male-biased sex ratios lead to an improvement in the bargaining position of women, and subsequently a reduction in the labor supply of women and an increase in their consumption of leisure. However, to the best of our knowledge, this paper is the first to document that these effects can persist into the long-run, well after sex ratios have reverted back to normal.

Although our results may be specific to a certain technological context – work opportunities for women were very poor in 19th century Australia – and although the average deviation from a balanced sex ratio that we study is larger than deviations observed today in certain parts of the world, a noteworthy implication is that a temporary imbalance in the sex ratio can have significant consequences on society that endure well beyond the imbalance itself.

The differences that we find in women's employment outcomes are associated with persistent differences in cultural attitudes towards women working. This indicates that cultural norms can emerge as an adaptive evolutionary response to a large shock in the marriage market and persist in the long-run, when they are no longer necessarily adaptive.

We find that the presence of strategic complementarities between cultural norms, which we discuss here in the context of the marriage market, underlies the persistence of culture. We believe that the presence of strategic complementarity between cultural norms solves the apparent paradox of rapid adaptation of cultural norms yet cultural persistence over a long period of time. One implication is that persistence will be stronger and last longer for norms that exhibit stronger strategic complementarities and in situations, like the marriage market, where experimentation is costly. A more detailed exploration of this mechanism is left for future research.

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TABLES

Table 1: Summary statistics and balance of covariates

Variables	Obs.	Mean	s.d.	Min	Max	Above - below historic sex ratio (i)	t-stat of diff. (ii)
Panel A: First Historical Cross-Section for Use in Present-Day Regressions							
Historical sex ratio	93	3.10	2.95	1.01	18.83	3.11	6.04***
Historical sex ratio among convicts	36	28.86	42.04	1.27	219.00	32.9	3.55***
Historical population (in thousands)	93	4493	11876	36	101080	-4,019	-1.63
Sectors – % of county employed in:							
Agriculture, pastoral, horticulture, wine	90	0.23	0.12	0.02	0.75	0.036	1.38
Domestic and personal service	90	0.14	0.14	0.03	0.81	-0.0094	-0.32
Manufacturing or mining	90	0.12	0.20	0.00	1.23	-0.042	-0.95
Government and learned professions	90	0.02	0.02	0.00	0.13	-0.0042	-0.97
Panel B: Historical Panel Data (1836 - 1881)							
Historical sex ratio	446	1.88	1.57	0.93	18.83	1.23	8.63***
Prop. female married	406	72.37	26.60	6.26	284.36	12.3	6.05***
Prop. male married	406	39.53	12.93	5.34	138.58	-13.6	-8.75***
Female labor force participation (% married women)	205	43.93	28.03	0	100.00	-20.6	-4.13***
Women in high-ranking occupations (% working women)	247	24.45	23.17	0	77.97	-10.3	-3.67***
Panel C: HILDA data matched with the historical Censuses and controls from 2011 Census and Geoscience Australia							
Progressive attitude gender roles	42,918	4.47	1.98	1	7	-0.37	-2.07**
Log hours worked (+1)	31,297	3.50	0.58	0	4.98	0.08	2.44*
Time spent with children	30,306	6.30	14.24	0	140	0.19	0.25
Time spent in housework and household errands	31,150	15.13	14.17	0	140	0.99	1.48
Feel rushed	43,556	2.23	0.93	0	4	-0.08	-1.29
Have spare time	43,663	1.17	0.88	0	4	0.04	0.79
Individual Controls:							
Married or de facto	48,991	0.62	0.49	0	1	-0.02	-0.50
Age	49,019	43.69	18.42	14	101	1.33	0.94
Beyond year 12 education	48,989	0.34	0.47	0	1	-0.03	-0.55
Australian born	49,006	0.76	0.43	0	1	0.03	0.64
Female	49,019	0.53	0.50	0	1	0.02	0.64
Postal area controls:							
Urban	49,019	0.93	0.25	0	1	-0.20	-2.05**
Contemporary sex ratio	49,017	0.97	0.09	0.64	13.53	0.04	2.10**
Plains and plateaus	49,017	0.48	0.50	0	1	-0.13	-1.20
Hills and ridges	49,017	0.03	0.16	0	1	-0.11	-2.02**
Low plateaus and low hills	49,017	0.06	0.23	0	1	0.07	1.82*
Minor coal	49,017	0.04	0.20	0	1	-0.01	-0.87
Minor other	49,017	0.01	0.04	0	1	0	0.90
Major coal	49,017	0.27	0.44	0	1	-0.21	-2.86***
Major copper	49,017	0.01	0.05	0	1	0.05	1.68*
Major gold	49,017	0.32	0.47	0	1	0.21	2.04**
Major mineral sands	49,017	0.06	0.24	0	1	0.06	1.08
Major other	49,017	0.00	0.01	0	1	0.00	0.97
Panel D: 2011 Census matched to the historical Censuses							
Female labor force participation rate (FLFP)	1900	56.00	9.47	0	100	-2.04	-2.27**
Women in high-ranking occupations	1890	21.31	8.48	0	46.50	-3.05	-3.29***
Additional Postal area controls:							
Prop. with professional college education	1895	0.21	0.05	0	1	-0.004	-0.87

Notes: (i) is the difference between counties above or below the median historic sex ratio. (i) and (ii): differences and t-stat are from regressions at the county level with state fixed effects and robust standard errors. In Panels A and B, observations are historical counties. In Panel C, observations are individuals. In Panel D, observations are present-day postal areas. The excluded land category is "mountains". The excluded mineral category is "no traces or deposits". 'Prop.' refers to proportion.

Table 2: Short-run results: sex ratios, female labor supply and marriage between 1836 and 1881

	1	2	3	4	5	6	7	8	9	10
	Married women (% women)		**Married men (% men)**		**Female labor force participation (% married women)**			**Women in high-ranking occupations (% working women)**		
Sex ratio	2.396***	2.481***	-2.135***	-1.515***	-21.136***	-12.961**	-13.205**	-19.663***	-13.832***	-14.100***
	(0.714)	(0.794)	(0.495)	(0.285)	(6.482)	(5.076)	(5.579)	(3.452)	(3.551)	(3.603)
Male labor force participation							0.088***			
							(0.026)			
Male high-ranking occupations										0.110
										(0.106)
Observations	412	412	412	412	205	205	205	247	247	247
R-squared	0.026	0.234	0.055	0.120	0.077	0.335	0.377	0.101	0.617	0.619
Number of counties	94	94	94	94	70	70	70	77	77	77
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes

Notes: The table reports fixed effects regression estimates. All regressions are with a constant. The unit of observation is a historic county-year (see Table A1 for years in each state). 'Sex ratio' is the number of men to the number of women. 'Female (respectively, Male) labor force participation' is the proportion of females (respectively, male) employed, as a proportion of married females (respectively, males). 'Women (respectively, Men) in high-ranking occupations' is the proportion of women (respectively, men) employed in 'commerce and finance', as a percentage of employed females (respectively, males). See Table 1 for summary statistics. Robust standard errors clustered at the county level are reported in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 3: Long-run effects: historical sex ratios, gender role attitudes and female labor supply – OLS results

	1	2	3	4	5	6	7	8	9	10
	Progressive attitude		**Female labor force participation**			**Hours worked (log)**		**Women in high-rank occupations**		
Historical sex ratio	-0.024***	-0.036***	-0.577***	-0.349**	-0.116+	0.011**	0.015***	-0.759***	-0.662***	-0.445***
	(0.005)	(0.009)	(0.212)	(0.171)	(0.075)	(0.004)	(0.003)	(0.142)	(0.149)	(0.135)
Female	0.467***	0.464***				-0.288***	-0.291***			
	(0.018)	(0.017)				(0.022)	(0.023)			
Female * Historical sex ratio						-0.022***	-0.021***			
						(0.007)	(0.007)			
Male labor force participation					0.788***					
					(0.040)					
Male high-ranking occupations										0.394***
										(0.051)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	-	-	-	Yes	Yes	-	-	-
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	No	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Minerals and land type	No	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
Observations	42,866	42,284	1,889	1,862	1,862	31,264	30,894	1,888	1,861	1,861
Number of counties	81	78	91	88	88	81	78	91	88	88
R-squared	0.166	0.168	0.137	0.185	0.731	0.144	0.148	0.236	0.277	0.573

Notes: The table reports OLS estimates. All regressions are with a constant and HILDA wave fixed effects when using HILDA data. Dataset used in Columns 1, 2, 6, 7: HILDA. Dataset used in remaining columns: 2011 Census. The unit of observation is an individual in a postal area matched to a historic county in HILDA and a postal area matched to a historic county in the Census. The dependent variable in Columns 1 to 2 is an individual's response to the statement "*it is better for everyone involved if the man earns the money and the woman takes care of the home and children*." Response categories range from 1 (strongly disagree) to 7 (strongly agree) (mean: 4.47), which we recoded so that a higher value indicates more progressive attitudes. 'Geographic controls' are a postal area's centroid's latitude and longitude. 'Minerals and land type' is the presence and type of mineral deposit (minor coal; minor other; major coal; major copper; major gold; major mineral sands; major others) and land formation (plains and plateaus; hills and ridges; low plateaus and low hills; mountains), which are provided by Geoscience Australia. 'Historic controls' are: the historical county population, as well as the proportion of residents working historically in agriculture, domestic service, manufacturing, mining, government services and learned professions. 'Individual controls' are: relationship status (married or de facto), age, whether one was born in Australia and whether one has education beyond year 12. 'Present-day postal area controls' in Columns 1, 2, 6 and 7 are the number of men to women in a postal area and whether a postal area is urban. 'Present-day postal area controls' in remaining Columns are the same with an additional control of the average vocational tertiary education of a postal area. 'Male labor force participation' refers to the 2011 MLFP as reported in the 2011 Census. 'Men in high-ranking occupations' refers to the proportion of employed men employed as managers or professionals. Standard errors are reported in parentheses and have been corrected for heteroskedasticity and for clustering at the historical county level. Results are robust to using robust standard errors. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 4: Long-run effects: historical sex ratios and time use – OLS results

	1	2	3	4	5	6
	Time spent with children		**Time spent in housework and household errands**		**Feel rushed**	**Have spare time**
Historical sex ratio	0.027	-0.129	0.082	0.088	-0.000	-0.013
	(0.095)	(0.158)	(0.122)	(0.123)	(0.004)	(0.009)
Female	5.312***	11.774***	10.304***	10.182***	0.241***	-0.230***
	(0.204)	(0.492)	(0.428)	(0.409)	(0.011)	(0.014)
Female * Historical sex ratio	-0.221***	-0.416*	0.083	0.072	-0.013***	0.011**
	(0.080)	(0.209)	(0.191)	(0.187)	(0.004)	(0.005)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes	Yes	Yes
Observations	29,869	10,538	30,700	29,689	42,915	43,020
R-squared	0.121	0.211	0.218	0.218	0.095	0.073
Mean dep. var.	6.303	17.866	15.128	15.643	2.234	1.173

Notes: The table reports OLS estimates. All regressions are with a constant and HILDA wave fixed effects. The level of observation is an individual in a postal area, matched to a historic county. 'Geographic controls', 'Individual controls', 'Present-day postal area controls', 'Historical controls' and 'Minerals and land type' controls are as in Table 3. For each item, the first column considers the whole sample and the second column considers only individuals with non-zero values for the task. "Time spent with children" includes: playing with children, helping them with personal care, teaching, coaching, or actively supervising them and getting them to daycare, school, or other activities. "Housework and household errands" includes: preparing meals, washing dishes, cleaning house, washing clothes, ironing, sewing, shopping, banking, paying bills, and keeping financial records. "Feel rushed" are answers to the following question: "*How often to you feel rushed or pressed for time?*". Answers are coded from 1 (never) to 5 (almost always). "Have spare time" are answers to the following question: "*How often to you have spare time that you don't know what to do with?*". Answers are coded from 1 (never) to 5 (almost always). Standard errors are reported in parentheses and have been corrected for heteroskedasticity and for clustering at the historical county level.

Table 5: Long-run effects: historical sex ratios, gender role attitudes and female labor supply – 2SLS results

	1	2	3	4
	Panel A: Second stage - 2 SLS			
	Progressive attitude	**FLFP**	**Hours worked (log)**	**Women in high-ranking occupations**
Historical sex ratio	-0.103**	0.247	-0.074***	-0.545**
	(0.047)	(0.317)	(0.013)	(0.207)
	[0.048]	[0.322]	[0.013]	[0.210]
State FE	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Individual controls	Yes	-	Yes	-
Present-day postal area controls	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes
Men labor force participation	No	Yes	No	No
Men in high-ranking occupations	No	No	No	Yes
Wild cluster bootstrap P-value	0.056	0.594	0.002	0.018
Observations	13,833	483	4,903	483
R-squared	0.165	0.820	0.064	0.806
	5	6	7	8
	Panel B: First stage - 2 SLS			
	Historical sex ratio			
Historical sex ratio among convicts	0.029***	0.033***	0.036***	0.033***
	(0.007)	(0.006)	(0.001)	(0.006)
	[0.007]	[0.006]	[0.001]	[0.006]
State FE	Yes	Yes	Yes	Yes
Geographic controls	Yes	-	Yes	-
Individual controls	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes
Men labor force participation	No	Yes	No	No
Men in high-ranking occupations	No	No	No	Yes
F-stat	18.82	34.42	12.30	34.17
Wild cluster bootstrap P-value	0.000	0.000	0.018	0.000
Observations	13,833	483	4,903	483
R-squared	0.844	0.822	0.855	0.822

Table 5 (cont'd): Long-run effects: historical sex ratios, gender role attitudes and female labor supply – 2SLS results

	9	10	11	12
	Panel C: OLS			
	Progressive attitude	**FLFP**	**Hours worked (log)**	**Women in high-ranking occupations**
Historical sex ratio	-0.075***	0.137	-0.029***	-0.544**
	(0.021)	(0.165)	(0.009)	(0.217)
	[0.021]	[0.168]	[0.009]	[0.221]
State FE	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Individual controls	Yes	-	Yes	-
Present-day postal area controls	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes
Men labor force participation	No	Yes	No	No
Men in high-ranking occupations	No	No	No	Yes
Wild cluster bootstrap P-value	0.004	0.494	0.002	0.048
Observations	13,833	483	4,903	483
R-squared	0.166	0.820	0.063	0.809
	13	14	15	16
	Panel D: Reduced form			
	Progressive attitude	**FLFP**	**Hours worked (log)**	**Women in high-ranking occupations**
Historical sex ratio among convicts	-0.003**	0.008	-0.003***	-0.018**
	(0.001)	(0.011)	(0.000)	(0.007)
	[0.001]	[0.011]	[0.000]	[0.007]
State FE	Yes	Yes	Yes	Yes
Geographic controls	Yes	-	Yes	-
Individual controls	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes
Men labor force participation	No	Yes	No	No
Men in high-ranking occupations	No	No	No	Yes
F-stat	-	-	-	-
Wild cluster bootstrap P-value	0.056	0.594	0.002	0.018
Observations	13,833	483	4,903	483
R-squared	0.165	0.820	0.064	0.806

Notes: See Table 3 for the list of controls. 'Individual controls' also include gender. The historical county population has been excluded from the set of "Historical controls" because of a multicollinearity issue with the total number of convicts in a county ("Number of convicts"). Standard errors in parentheses have been corrected for heteroskedasticity and for clustering at the historical county level. Number of clusters (historical counties): 28 for estimation with HILDA data (Progressive attitude and hours worked (log)) and 31 for estimation with the Census (FLFP and women in high-ranking occupations). Standard errors in square brackets are bias-corrected cluster-robust to adjust for the small number of clusters (see Cameron and Miller 2015). The reported P-values at the bottom of Table 5 have been corrected by the Wild cluster bootstrap method by Cameron, Gelbach and Miller (2008) based on a 1,000 replications. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 6: Long-run effects for females: historical sex ratios and time use – 2SLS results:

	1	2	3	4	5	6
	Panel A: Second stage - 2 SLS					
	Time spent with children		**Time spent in housework and household errands**		**Feel rushed**	**Have spare time**
Historical sex ratio	-0.432	-0.711	-0.171	-0.309	-0.065***	0.093***
	(0.556)	(1.324)	(0.781)	(0.776)	(0.013)	(0.030)
	[0.567]	[1.350]	[0.797]	[0.792]	[0.013]	[0.031]
State FE	Yes	Yes	Yes	Yes		
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes	Yes	Yes
Wild cluster bootstrap P-value	0.620	0.638	0.876	0.826	0.002	0.096
Observations	5,278	1,831	5,422	5,305	7,558	7,571
R-squared	0.113	0.187	0.160	0.161	0.094	0.061
	7	8	9	10	11	12
	Panel B: First stage - 2 SLS					
	Historical sex ratio					
Historical sex ratio among convicts	0.032***	0.030***	0.033***	0.033***	0.031***	0.031***
	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)
	[0.009]	[0.008]	[0.009]	[0.009]	[0.008]	[0.008]
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	13.03	41.29	12.71	13.06	14.19	14.24
Wild cluster bootstrap P-value	0.002	0.000	0.004	0.010	0.000	0.000
Observations	5,278	5,102	5,422	5,305	7,558	7,571
R-squared	0.840	0.855	0.841	0.841	0.843	0.844

Table 6 (cont'd): Long-run effects for females: historical sex ratios and time use – 2SLS results

	13	14	15	16	17	18
	Panel C: OLS					
	Time spent with children		**Time spent in housework and household errands**		**Feel rushed**	**Have spare time**
Historical sex ratio	-0.351	-0.644	-0.148	-0.010	-0.036**	0.019*
	(0.331)	(0.496)	(0.592)	(0.025)	(0.013)	(0.011)
	[0.338]	[0.506]	[0.604]	[0.026]	[0.013]	[0.011]
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes	Yes	Yes
Wild cluster bootstrap P-value	0.498	0.302	0.750	0.768	0.12	0.114
Observations	5,278	1,831	5,422	5,305	7,558	7,571
R-squared	0.113	0.188	0.785	0.161	0.095	0.059
	19	20	21	22	23	24
	Panel D: Reduced form					
	Time spent with children		**Time spent in housework and household errands**		**Feel rushed**	**Have spare time**
Historical sex ratio among convicts	-0.014	-0.021	-0.006	-0.161	-0.002***	0.003***
	(0.018)	(0.039)	(0.026)	(0.354)	(0.000)	(0.001)
	[0.018]	[0.040]	[0.027]	[0.361]	[0.000]	[0.001]
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes
Minerals and land type	Yes	Yes	Yes	Yes	Yes	Yes
Number of convicts	Yes	Yes	Yes	Yes	Yes	Yes
Wild cluster bootstrap P-value	0.620	0.638	0.876	0.826	0.002	0.096
Observations	5,278	1,831	5,422	5,305	7,558	7,571
R-squared	0.113	0.187	0.160	0.161	0.094	0.061

Notes: Sample of females only. See Table 3 for the list of controls. The historical county population has been excluded from the set of "Historical controls" because of a multicollinearity issue with the total number of convicts in a county ("Number of convicts"). Standard errors in parentheses have been corrected for heteroskedasticity and for clustering at the historical county level. Number of clusters (historical counties): 25. Standard errors in square brackets are bias-corrected cluster-robust to adjust for the small number of clusters (see Cameron and Miller 2015). The reported P-values at the bottom of Table 6 have been corrected by the Wild cluster bootstrap method by Cameron, Gelbach and Miller (2008) based on a 1,000 replications. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

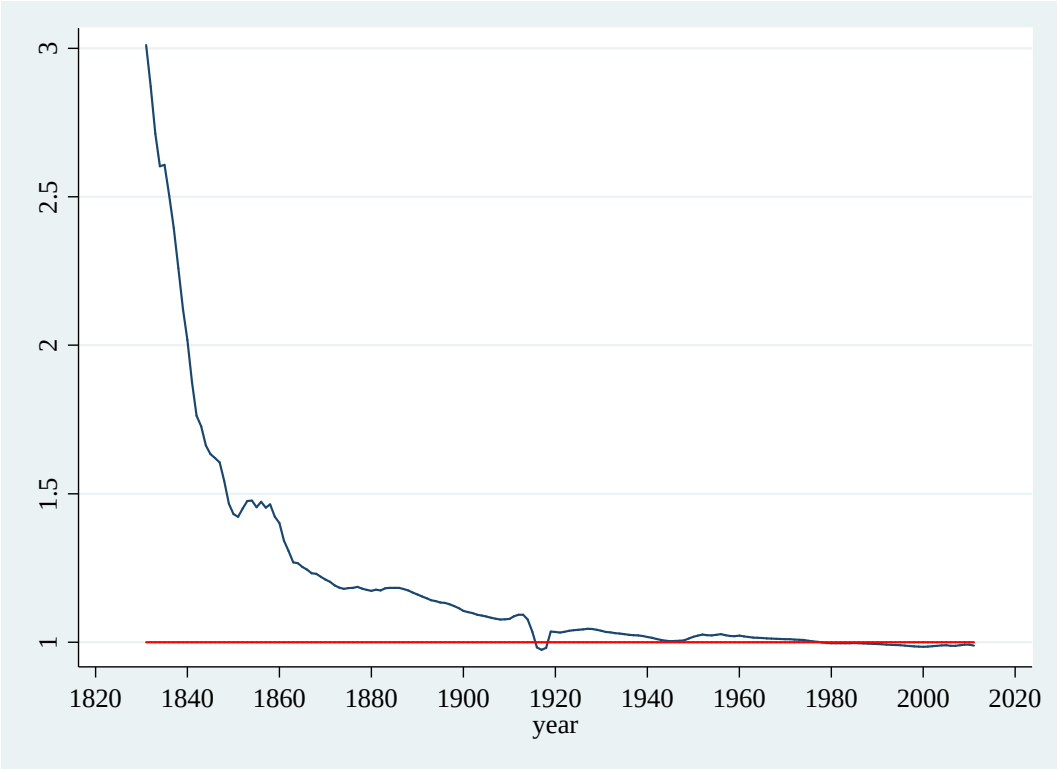
Table 7: Persistence: vertical cultural transmission, migration, and homogamy

	1	2	3	4	5	6
			Progressive attitude			
Historical sex ratio	0.024	0.014	0.053**	0.038*	0.069	0.067
	(0.018)	(0.015)	(0.026)	(0.021)	(0.047)	(0.050)
Australian parent	0.304***	0.302***				
	(0.061)	(0.060)				
Australian parent * Historical sex ratio	-0.060***	-0.059***				
	(0.022)	(0.021)				
Low migration			0.101*	0.102		
			(0.058)	(0.062)		
Low migration * Historical sex ratio			-0.078***	-0.074***		
			(0.025)	(0.019)		
High Homogamy					0.087	0.087
					(0.112)	(0.132)
High Homogamy * Historical sex ratio					-0.088*	-0.095*
					(0.048)	(0.051)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes
Present-day postal area controls	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	No	Yes	No	Yes	No	Yes
Minerals and land type	No	Yes	No	Yes	No	Yes
Observations	42,866	42,284	42,866	42,284	42,947	41,928
R-squared	0.167	0.169	0.166	0.168	0.167	0.168

Notes: The table reports OLS estimates. All regressions are with a constant and HILDA wave fixed effects. See Table 3 for the list of controls. 'Individual controls' also include gender. 'Low migration' refers to postal areas where the proportion of residents born in Australia is higher than the mean proportion of residents born in Australia as per the 2011 Census. 'Australian parent' is a dummy equal to one if respondent has an Australian father or an Australian mother (mean: 0.68). 'High migration' refers to postal areas where the proportion of residents born in Australia is lower than the median proportion of residents born in Australia as per the 2011 Census. Homogamy refers to the average proportion of people of Australian descent in the postal area who married someone also of Australian descent. 'Low Homogamy' are postal areas whose predicted level of homogamy lies below the median level of homogamy, which is 86%. 'High Homogamy' refers to postal areas whose predicted level of homogamy lies above the median. Homogamy is predicted by the sex ratio today, the degree of urbanization, income, education, shares of employment in 18 different industries and respondents' parents' countries of birth in the postal area. Standard errors are reported in parentheses and have been corrected for heteroskedasticity and for clustering at the historical county level (78 clusters). ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

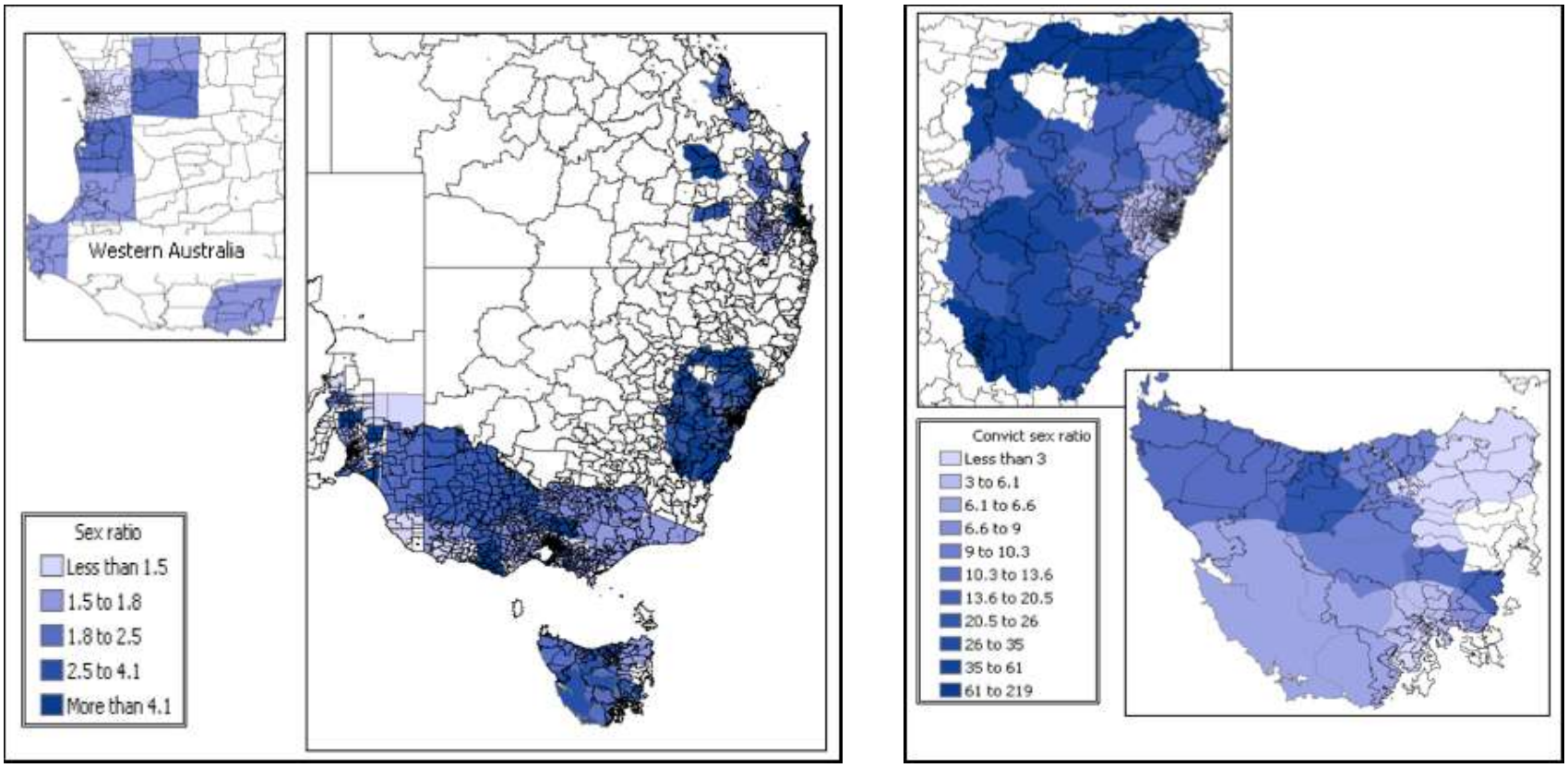
FIGURES

Figure 1: Sex ratio in Australia: number of men to every woman, 1830-2011



Source: Australian Bureau of Statistics

Figure 2: Sex ratios in mid 19th century Australia: in the whole population (Left Panel) and among the subset of convicts (Right Panel)



Notes: The maps only show the parts of Australia for which Census data is available for the period of study. Left Panel: Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania, Victoria, and Western Australia. Right Panel: Australian Capital Territory, New South Wales, Tasmania.
Source: Australian Historical Census