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Discussion Paper no. [2025-06](#)

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JEL Classification: I31, J21, J22, N37, O10, Z13, Z18

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The Long Run Gender Origins of Entrepreneurship: Evidence from Australia's Convict History

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Abstract

This paper extends prior theory linking present-day sex ratios to present-day propensity for entrepreneurship among men backward in time to explore the long-run gender origins of entrepreneurship. We argue that present-day propensity for entrepreneurship among men will be higher in neighbourhoods which had historically high sex ratios. We propose that high sex ratios generate attitudes and behaviours that imprint into cultural norms about gender roles and that vertical transmission within families create hysteresis in the evolution of these gender norms. To empirically test the theory, we employ the transport of convicts to the British colonies of New South Wales and Van Diemen's Land in the eighteenth and nineteenth centuries as a natural experiment to examine the long-run effect of gender norms on entrepreneurship in present-day Australia. We use a representative longitudinal dataset for the Australian population that provides information on the neighbourhood in which the participant lives, which we merge with data on the sex ratio in historical counties from the mid-nineteenth century. We find that men who live in neighbourhoods which had high historical sex ratios have a higher propensity for entrepreneurship. We present evidence consistent with the vertical transmission of gender norms within families being the likely mechanism. Arguments for policies to promote female entrepreneurship are typically couched in terms of gender norms representing a barrier to more women starting their own business. We present evidence consistent with gender norms contributing to gender differences in rates of entrepreneurship by being a spur for higher male entrepreneurship rather than a barrier to female entrepreneurship.

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1. Introduction

It is well established that gender norms are important in influencing both entrepreneurial practice and observed patterns in entrepreneurship (Boddington, 2024). For instance, it is recognised that gender norms are an important reason why globally only one in three businesses are owned by women (GEM, 2023; Masterson, 2022; Meunier et al., 2022). There is at least implicit acknowledgment in much of the research on gender norms and entrepreneurship that the origins of gender norms lie in the past.¹ However, how exactly gender norms originated in the past, how they are transmitted from the past to the present or the mediators through which they affect entrepreneurship outcomes in the present have not been modelled.

In this paper we extend existing theory linking contemporaneous high sex ratios and high rates of entrepreneurship among men backward in time. Chang and Zhang (2015) put forward the argument that high sex ratios, in which there is an excess of men over women, will generate higher rates of entrepreneurship.² Their reasoning is that given the shortage of women, men will pursue entrepreneurship as an avenue to build wealth, in order to make them more competitive in the marriage market. We build on the argument in Chang and Zhang (2015) to theorise that an historical imbalance in the sex ratio in favour of men will increase present day propensity for entrepreneurship, well after the imbalance in the sex ratio has evened out.

Our theoretical argument rests on three pillars. First, historically the imbalance in the sex ratio will be a cause of higher historical levels of entrepreneurship as men engage in entrepreneurship to build wealth to compete in the marriage market. Second, high sex ratios create reinforcing gender norms in which (a) men and women will exhibit attitudes and behaviours "as if" there was strong competition among men for female partners; and (b) that men will pursue entrepreneurship in order to build wealth to make them more attractive in the marriage market. Third, these gender norms will persist long after the high sex ratio has dissipated. We contend that these gender norms will persist through vertical transmission across generations in local areas in which sex ratios were historically high. We also theorise that the transmission of gender norms will be attenuated in local areas which have experienced inward immigration and are more ethnically diverse because people moving into these local areas will bring their own cultural values and will not share in the learned values, rooted in high historical sex ratios, that have been passed down through generations.

We empirically test our theory employing a natural experiment couched in Australia's convict past. Grosjean and Khattar (2019, p. 724) state: "An ideal natural experiment [to examine the long run effects of a high sex ratio] would consist of placing more men than women on an isolated island, with these men and women being of a similar cultural background and operating within the same institutional environment, and then observe outcomes over time". This is exactly what happened in Australia in the eighteenth and nineteenth centuries. Australia was

¹ For example, feminist scholarship on gender norms and entrepreneurship, typically, at least implicitly, posits that gender norms that create barriers to females becoming entrepreneurs have their origins in historical, often deep seated, inequities between the sexes (e.g., Boddington, 2024; Brush et al., 2009; Henry & Marlow, 2014; Muntean & Ozkazanc-Pan, 2015).

² In earlier unpublished work, Du and Wei (2011) and Wei and Zhang (2011b) propose similar arguments.

discovered in 1770 and was first settled by the British in 1788. Between 1788 and 1868, the British transported approximately 157,000 convicts to the colonies of New South Wales and Van Diemen's Land, which was renamed Tasmania in 1856.³ About 85 per cent of these convicts were men (Hughes, 1987). These convicts represented the first European settlers of Australia, with convicts, emancipists and their children representing 80 per cent of the European population in the fledgling colonies until the 1840s (Ward, 1958).⁴

To examine the effect of these historical sex ratios on spatial differences in propensity for entrepreneurship between communities in present-day Australia we use 22 waves of Household Income Labor Dynamics Australia (HILDA). First administered in 2001, HILDA is a representative household longitudinal dataset that contains data on whether participants are self-employed and the correlates of self-employment in each wave. We use the restricted version of HILDA that provides information on the postcode in which the participant lives. We map the sex ratio in historical counties in New South Wales and Van Diemen's Land in the mid-nineteenth century to the equivalent postcode in the present-day Australian states of New South Wales and Tasmania. We use this information to examine how the historical sex ratio in the postcode in which the person lives, affects present-day propensity for entrepreneurship.⁵

Establishing causality between historical sex ratios and propensity for entrepreneurship is not straight forward because historical sex ratios are likely to be endogenous. To overcome this problem, we present reduced form estimates in which we regress whether the individual is self-employed across waves of HILDA directly on the convict sex ratio. Our results are also robust to using convict sex ratios as an instrumental variable (IV) for the historical population sex ratio.⁶ To account for the fact that convict settlement across historical counties was not random, we control for historical employment shares, mineral deposits and geographical formation.

We make three principal contributions. First, we contribute to the literature on gender norms and entrepreneurship by providing theory, and evidence, on the historical origins of gender norms and showing how historical shocks that generate imbalances in the sex ratio can influence present-day entrepreneurship, through persistence in these norms. This provides an historical perspective on how gender norms come to be embedded in social relationships.

Second, we respond to calls to pay more attention to history in entrepreneurship research (see, e.g., Aldrich, 2012; Perchard et al., 2017; Wadhvani, 2016; Wadhvani & Decker, 2017;

³ During this period New South Wales and Van Diemen's Land were British colonies. Australia came into existence as a federation in 1901. New South Wales and Tasmania were two of the six foundation states.

⁴ It is now recognized that indigenous Australians/first nations peoples settled in Australia 65,000 years ago and had their own economy and society at the time of European settlement by the British, but indigenous Australians were not counted in the census until 1971, following a referendum to change the Constitution in 1967.

⁵ First introduced in 1967, the postcode is broadly analogous to a zip code in the United States and is used by Australia Post to deliver mail. There are 515 postcodes in New South Wales and Tasmania. While postcodes vary in size reflecting differences in population density, they are a good proxy for a local community or neighbourhood, given that they generally equate with a suburb in a large city, a regional city or a town or a few smaller towns in close geographical proximity and surrounding areas in regional Australia.

⁶ The convict sex ratio is the ratio of male to female convicts. The historical (population) sex ratio is the ratio of males to females for the total colonial population, consisting of emancipists, colonial administrators, free settlers and Caucasians born in the colonies, in addition to convicts (Baranov et al., 2023).

Wadhvani et al., 2020). Despite an ‘historic turn’ in organisation studies (Clark & Rowlinson, 2004) in which entrepreneurship and other management scholars have started to pay more attention to historical reasoning and methods, with a few exceptions (Alegre & Berbegal-Mirabent, 2015; Decker et al., 2020; Fredin, 2017), progress in incorporating the role of historical context and path dependency into entrepreneurship research has been relatively slow. A particular gap in historical approaches to entrepreneurship is that there is very little research that seeks to show how events in the past directly influence entrepreneurship outcomes in the present or explore the potential mechanisms through which this occurs.

Third, we contribute to a broader literature in economics and sociology that seeks to explore the deep historical roots of gender norms and how historical shocks influence present-day socioeconomic outcomes through persistence in gender norms (Alesina et al., 2013; Baranov et al., 2023; Bazzi et al., 2024; Gay, 2023; Grosjean & Khattar, 2019; Teso, 2019). To this point, this literature has focused on outcomes such as female labour force participation, female empowerment and female participation in the political process. We extend this literature to examine how historical imbalances in the sex ratio affect entrepreneurship.

Extending theory, and giving evidence, on how historical imbalances in the sex ratio can influence propensity for entrepreneurship in the long run is important given its practical and ongoing relevance to modern societies. While the specific shock that we consider - the transport of convicts to a newly settled country - is unlikely to ever be repeated, other shocks have the potential to generate exogenous changes in the sex ratio with long-run implications for entrepreneurship. Studies have explored the exogenous shock that the World Wars had on the sex ratio on various long-run socioeconomic outcomes (Boehnke & Gay, 2022; Brainerd, 2017; Gay, 2023). Warfare and gendered genocide that continue to exist in modern societies have the potential to create imbalances in the sex ratio with implications for gender norms and patterns of entrepreneurship. Advances in reproductive technologies have the potential to alter the sex ratio with long-run implications for the propensity for entrepreneurship. Ultrasound and amniocentesis technologies have been linked to the high sex ratio in Asian countries, such as China, India and South Korea, since the 1970s (Das Gupta et al., 2003; Guilmoto, 2009) and to the high sex ratio among children born of immigrants from these countries in the United States (Almond & Edlund, 2008). Government policies to curtail population growth also have the potential to generate exogenous variation in the sex ratio with long-term implications for entrepreneurship. The best-known example is the One Child Policy in China, which created an excess of men (Ebenstein, 2010). Other examples are conditional cash transfer programmes, such as Devi Rupak or Janani Suraksha Yojna in India, which provide financial incentives to couples to have less children or have daughters (Anukriti, 2018; Javadekar & Saxena, 2021).

2. Theoretical framework

2.1. High present-day sex ratios increase propensity for entrepreneurship among men

Figure 1 represents the existing theoretical framework proposed by Chang and Zhang (2015), which posits that an increase in the present-day sex ratio causes an increase in the present-day propensity for entrepreneurship among men. In communities with high sex ratios there is strong competition among men for female partners, causing a squeeze in the marriage market (Becker, 1973). In response, men adopt measures to make themselves more attractive to potential mates and, hence, improve their prospects of finding a wife. Several studies suggest that wealth is a predictor of male success in the marriage market (see, e.g., Chu et al., 2020). Chang and Zhang (2015) theorise that high sex ratios specifically encourage males to favour entrepreneurship, instead of other labour market options, such as salaried employment, to build wealth and obtain a competitive advantage over their rivals for female partners in the marriage market

The reason that men favour entrepreneurship over other labour market options as a vehicle to build wealth quickly in a tight marriage market is that returns to being a successful entrepreneur are generally higher than returns to salaried employment (Levine & Rubinstein, 2017; Manso, 2016). Gentry and Hubbard (2000) find that entrepreneurs have a substantial share of household wealth and income in the United States and that this share increases throughout the income and wealth distribution. Figure 2 suggests that for male participants in HILDA, in present-day Australia that income from opportunity entrepreneurship is higher than paid employment. In Figures 3 and 4, we show how the returns to opportunity entrepreneurship and paid employment for men differ across income and wealth deciles. The divergence in income and wealth to labour market options is being driven by differences in the top three income deciles. The potential to build considerable wealth through opportunity entrepreneurship sends a strong signal to men facing a marriage squeeze that they could improve their marriage prospects by starting their own business venture, despite the risk of failure. This applies *a fortiori* for men who have little to lose in terms of opportunity cost even if they fail.

2.2. High historical sex ratios increase present-day male propensity for entrepreneurship through the vertical transmission of cultural norms about gender roles

Existing theory, represented in Figure 1, offers an explanation for why present-day high sex ratios can cause an increase in present-day rates of opportunity entrepreneurship among men. The driving mechanism in Figure 1 is the imbalance in the contemporary sex ratio, that leads men to choose a labour market option, opportunity entrepreneurship, that is designed to increase wealth and make them more attractive to prospective female partners. Existing theory, though, does not offer an explanation for the long-run gender origins of entrepreneurship. It is completely silent on how an historical imbalance in the sex ratio that has since evened out could cause an increase in the present-day propensity for opportunity entrepreneurship among men and the potential role of gender norms in facilitating this process.

In Figure 5, we extend existing theory back in time to provide a theoretical framework for explaining how an imbalance in the sex ratio in the past could contribute to a higher rate of

opportunity entrepreneurship among men, but not women, in the present. Because the proposed mechanism through which this occurs suggests that higher historical sex ratios should contribute to higher present-day male entrepreneurship, but not female entrepreneurship, our theoretical extension of Figure 1 backward in time, provides a framework for understanding the long-run origins of present-day gender differences in rates of entrepreneurship.

In Figure 5a we propose that propensity for entrepreneurship among men in the present will be higher in local areas which had historically high sex ratios, even after those sex ratios have dissipated. The first part of this theoretical argument posits that higher sex ratios in the past will cause higher rates of opportunity entrepreneurship among men in the past, contemporaneous with the imbalance in the sex ratio. The reasoning behind this first step is analogous to the argument underpinning Figure 1. Higher sex ratios in the past cause a squeeze in the marriage market in the past and men choose opportunity entrepreneurship over paid employment as a way to increase wealth to improve their prospects of finding a female partner. The theory predicts that higher sex ratios have no effect on female entrepreneurship, because it is men, and not women, that face the squeeze in the marriage market.

Short-term demographic characteristics, such as an imbalance in the sex ratio, can have long-run consequences for economic outcomes if their effect on attitudes and behaviours imprint into cultural norms about gender roles. A growing literature suggests that cultural norms can persist long after the circumstances that gave rise to them in the first place have ceased to exist (Alesina et al., 2013; Grosjean & Khattar, 2019; Hansen et al., 2015; Xue, 2016)

In Figure 5b we theorise that the link between higher sex ratios in the past and higher propensity for opportunity entrepreneurship among men in the present will be via the transmission of cultural gender norms. In theorising that cultural gender norms represent the transmission mechanism between historical sex ratios and present-day propensity for entrepreneurship we employ abductive reasoning, which seeks the simplest and most logical conclusion from a set of observations (Decker et al., 2020; Wadhvani & Decker, 2017). We adopt this approach because the evolution of gender norms is not directly observable over such a long period.

Specifically, in Figure 5b, we propose that historical sex ratios will imprint into cultural gender norms and that these norms will be vertically transmitted through generations in households residing in locations which had high historical sex ratios. A large literature on cultural gender norms suggests that such norms are passed on from parents to children. Norms are transmitted via children listening to the attitudes that their parents express, watching how their parents interact, being influenced by their parents' values and learning from the behaviours that their parents exhibit (Bisin & Verdier, 2001; Fernández, 2013; Fernández et al., 2004). Fathers act as role models for their sons (Tamis-LeMonda, 2004). In our context, particularly salient is sons seeking to emulate fathers who are entrepreneurs. In this respect, Lindquist et al. (2015) find that sons of entrepreneurs are much more likely to become entrepreneurs themselves.

The vertical transmission of cultural gender norms from one generation to the next within the household generates strong hysteresis in the persistence of those norms in which an evolutionary stable long-run equilibrium develops (see, e.g., Alesina et al., 2013; Baranov et

al., 2023; Grosjean & Khattar, 2019). In this long-run equilibrium, men and women exhibit behaviours and express values consistent with cultural gender norms emanating from historically high sex ratios, even when those imbalances have long dissipated.

Grosjean and Khattar (2019) point out that cultural change has the characteristics of a collective action problem and that the higher the cost of deviating from a stable long-run equilibrium outcome, the less likely it will be that cultural change will occur once strong hysteresis in cultural norms are established. In particular, Grosjean and Khattar (2019) note that the specific nature of the marriage market generates feedback mechanisms that reinforce cultural gender norms. Once men have found a proven strategy to increase their prospects of finding a partner, such as building wealth through pursuing entrepreneurship, experimenting with alternative strategies is likely to be suboptimal, particularly if it leads to delay in a market that is characterised by high search costs and in which time is of the essence.

To examine whether cultural gender norms are a transmission mechanism, we use a standard lineage-based approach to empirically test how individuals transmit historical legacies across generations (see, e.g., Gay, 2023; Michalopoulos et al., 2019; Nunn & Wantchekon, 2011; Teso, 2019). Individual level information on whether the parents of the participant in HILDA were born in Australia is available in that dataset. The lineage-based approach to examining the transmission of gender norms involves treating whether the parents of male participants in HILDA were born in Australia as a moderator of the relationship between historical sex ratios and present-day entrepreneurship among men. This empirical approach to assessing the vertical transmission of cultural gender norms within families has been used in other studies that have examined the effect of historical imbalances in the sex ratio on other present-day outcomes using HILDA (Awawaoryi Churchill et al, 2024; Baranov et al 2023; Grosjean & Khattar, 2019). The expectation is that the moderating effect will strengthen the direct relationship between the historical sex ratio and present-day entrepreneurship among men because parents who are born in Australia will pass on shared values about gender roles, which are deeply rooted in Australia's colonial past. In contrast, participants whose parents were born outside Australia will not have had cultural gender norms, reflected in attitudes and behaviours, passed down to them from their parents (Baranov et al., 2023; Grosjean & Khattar, 2019).

These arguments suggest the following hypotheses:

H1: The present-day propensity for entrepreneurship among men will be higher in local communities which had historically high sex ratios, even after those sex ratios have dissipated.

H2: intergenerational continuity will moderate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. Reflecting the vertical transmission of gender norms within the household through children listening to the attitudes that their parents express, and learning from the behaviours and values that their parents exhibit, the effects of historical sex ratios on the present-day propensity for entrepreneurship among men will be stronger for men whose parents were born in Australia.

2.3. The vertical transmission of cultural gender norms will be weakened by demographic cultural heterogeneity as new families move into the area bringing their own values.

The idea that vertical transmission of cultural norms within the household will generate strong hysteresis in the evolution of such norms rests on persistence in cultural homogeneity over time in neighbourhoods that had historically high sex ratios. In tightknit local communities, cultural gender norms are inherently sticky and self-reinforcing because shared values will not only be passed down within families, but be reinforced through interaction with others in the local community who have the same cultural norms about gender norms stemming from historical imbalances in the sex ratio passed down to them from their parents.

In Figure 5b, we theorise that demographic cultural heterogeneity will attenuate the direct effect of historical sex ratios on present-day entrepreneurship among men. As measures of demographic cultural heterogeneity in the neighbourhood we use indicators of the extent of ethnic diversity in the postcode and whether the participant in HILDA moved to that postcode from either elsewhere in Australia or overseas. We treat both measures as moderators and interact each of them with the historical sex ratio in alternative specifications.

We expect that both greater ethnic diversity in the postcode and if the participant moved into the postcode to weaken the vertical transmission of local cultural gender norms for two reasons. First inward immigration and greater ethnic diversity increases the probability of co-mingling among different ethnic groups; thus, increasing opportunities for interethnic marriages. This introduces greater cultural heterogeneity in the local geographic area as people from outside the postcode bring their own cultural values about gender roles, which do not stem from historically high sex ratios which are specific to that local area. Individuals will update how they This will expose individuals whose families have lived in that geographic area to other cultural values, which attenuates the evolution of local cultural norms (Belloc & Bowles, 2013; Friedman-Sokuler & Senik, 2020; Schmitz & Weinhardt, 2019). Second, an increase in inward immigration and greater ethnic diversity, is likely to increase the share of the population that are less familiar with shared historical stories and traditions that underpin gender norms and are less likely to uphold such norms or pass them on across generations.

These arguments suggest the following hypothesis:

H3: Cultural homogeneity will moderate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. The effects of historical sex ratios on present-day propensity for entrepreneurship among men will be attenuated in local areas which have experienced more internal migration and in local areas in which the ethnic composition of the population is more diverse, both of which disrupt intergenerational continuity and weaken the vertical transmission of gender norms within the household.

2.4. Attitudes and behaviours reflecting gender norms emanating from historical sex ratios mediate the relationship between historical sex ratios and present-day entrepreneurship

Cultural gender norms emanating from historically high sex ratios that are inherently sticky will be manifest not only in men exhibiting higher propensity for entrepreneurship, but in other attitudes and behaviours consistent with there being historically an excess of men over women. In Figure 5c we theorise that these present-day attitudes and behaviours will mediate the relationship between historical high sex ratios and present-day propensity for entrepreneurship among men. Below, we discuss parental investment in sons, risk preferences, savings rates, social capital and spousal satisfaction as specific instances of present-day attitudes and behaviours that stem from historically high sex ratios that we theorise are potential mediators between historical sex ratios and present-day entrepreneurship.

We select these specific variables as potential mediators because there is both theory, and empirical evidence, to suggest that an imbalance in the sex ratio can cause a change in these variables and that, in turn, these variables have been shown to be antecedents of the propensity for entrepreneurship. We reason that historical imbalances in the sex ratio will cause a change in these variables in the past which will imprint as cultural gender norms. These cultural gender norms will become persistent and affect present-day changes in outcomes for these variables through intergenerational transmission within families, consistent with our earlier argument for how historical sex ratios influence present day propensity for entrepreneurship among men.

Parental investment in sons

When there is an excess of men, we theorise that parents will invest more in their sons to increase their labour market prospects and make them more attractive in the marriage market. Empirical evidence from the One Child Policy, which created an excess of men in China, suggests that parents to invest more in their sons in such circumstances (Guo et al., 2022). One might question the generalizability of this outcome from the One Child Policy to other contexts. With the One Child Policy a strong son preference culture, combined with the fact that parents only had one child to spend their money on, were important motivating factors. These cultural practices and restrictions on the number of offspring were not the driving forces in historical colonies, such as New South Wales and Van Diemen's Land, in the eighteenth and nineteenth centuries. However, these societies were still deeply patriarchal, in which sons were more likely to be supported than daughters, who, it was expected, would get married (Deacon, 1985).

Once the imbalance in the sex ratio acts as a catalyst to kickstart parental investment in their sons, a self-reinforcing cascading effect is generated, in which the transmission of parental privilege from one generation to the next becomes a cultural norm. Sons brought up in more supportive environments are more likely to provide nurturing environments for their own children (Masten & Coatsworth, 1998). Parental support, including investment in their son's human capital, is a predictor of propensity for entrepreneurship and whether the individual proves to be a successful entrepreneur (Schmitt-Rodermund, 2004; Unger et al., 2011).

H4: Present-day parental investment in sons will mediate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. In local areas with high historical sex ratios, present-day levels of parental investment in sons will be higher and higher rates of parental investment in sons will contribute towards there being higher present-day propensity for entrepreneurship among men.

Savings

Wei and Zhang (2011a) and Du and Wei (2013) argue that a high sex ratio will trigger a competitive savings motive, in which men save more in order to accumulate wealth and make themselves more attractive partners in the marriage market. They present evidence from the One Child Policy in China that is consistent with their argument. Even after imbalances in sex ratios even out, persistence in savings within households can occur through both the intergenerational transfer of wealth (Kotlikoff, 1988) and through learned behaviour in which children mimic the motives of their parents (Bauer et al., 2014). Higher rates of savings, including housing wealth, ease the liquidity constraint facing budding entrepreneurs and increase the propensity for entrepreneurship (Black et al., 1996; Hurst & Lusardi, 2004).

H5: Present-day savings will mediate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. In local areas with high historical sex ratios, present-day savings will be higher and higher savings will contribute towards there being higher present-day propensity for entrepreneurship among men.

Risk preferences

Intense competition among men for female partners induces men to take additional risks (Baranov et al., 2023), including making more risky financial investments (Li et al., 2022) with a view to getting a competitive advantage over their rivals. Similar to savings behaviour, risk-taking behaviour can become sticky across generations, making it persistent after the sex ratio evens out, because sons mimic the practices of their parents. While the empirical evidence is not unanimous, recent studies suggest that individuals who exhibit higher preference for risk are more likely to become entrepreneurs (see, e.g., Chanda & Unel, 2021).

H6: Risk preferences will mediate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. In local areas with high historical sex ratios preference for risk will be higher and higher risk preference will be a cause of higher present-day propensity for entrepreneurship among men.

Spousal satisfaction

In local areas in which historical sex ratios were high, there is a higher incidence of monogamous committed relationships (Grosjean & Khattar, 2019), lower rates of divorce and higher levels of spousal satisfaction (Grosjean & Brooks, 2017). The intuition is that in a tight marriage market in which women have more choice of men, they are better placed to choose a partner who is more compatible, more committed and ultimately with whom they are likely to be more satisfied. Over time, the behaviours and values that underpin long-term committed,

monogamous relationships becomes a reinforcing norm. Spousal emotional and moral support for new business ventures, along with a strong marital relationship, are important predictors of entrepreneurship (Craft et al., 2015; Danes et al., 2010; Forster & Pollack, 2014).

H7: Spousal satisfaction will mediate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. In local areas with high historical sex ratios, spousal satisfaction will be higher and higher spousal satisfaction be a cause of higher present-day propensity for entrepreneurship among men.

Social Capital

A high sex ratio, in which large numbers of men interact, can produce a masculine culture, which can be a double-edged sword. Masculinity can be manifest in negative attitudes and behaviours, such as bullying, health avoidance, violence towards women and other antisocial behaviour (Baranov et al., 2023). However, as discussed in Awaworyi Churchill et al. (2024c) it can also generate social capital forged through mateship, defined as “the bond between equal partners or close friends; comradeship [and] comradeship as an ideal” (Moore et al., 2016, pp. 938-939). Masculine values, reflected in social bonds and social trust between men, can be vertically transmitted across generations in the form of masculine norms (Baranov et al., 2023). This can occur vertically in the household through learned values, as well as through shared remembrance of male comradeship, such as mateship forged in times of war and at other times of adversity (Awaworyi Churchill et al., 2024c). Associations formed to promote masculine values, such as sporting clubs and Returned Services League (RSL) clubs can be important sources of social capital and avenues to build professional connections to help nascent business ventures. Several studies have found that social capital is an important antecedent of propensity for entrepreneurship (see, e.g., Davidsson & Honig, 2003; Kwon et al., 2013).

H8. Present-day social capital will mediate the relationship between historical sex ratios and present-day propensity for entrepreneurship among men. in local areas with high historical sex ratios, social capital will be higher and higher social capital will be a cause of higher present-day propensity for entrepreneurship among men.

3. Australia's colonial convict heritage as a natural experiment

Prior to the American War of Independence, Britain transported convicts to the North American colonies between 1615 and 1776. However, after the United States declared independence from British rule, the British needed a new destination to send convicts. Australia, which had been discovered by the British in 1770, was conceived as a penal settlement. Between first settlement in 1788 and 1868, the British transported 132,308 male convicts and 24,960 female convicts to the colonies of New South Wales and Van Dieman's Land. These convicts constituted the majority of the early settlers with very few free settlers migrating to the colonies prior to 1840. Most of the free settlers were men seeking economic opportunities in agriculture and mining (Hughes, 1987). There was a surge in free immigrants in the 1850s and 1860s, coinciding with the Victorian Gold Rush, but most of those attracted to the gold fields were men, reinforcing the high sex ratio (Packer, 1953).

On arrival, most of the convicts were assigned to work in different locations, as opposed to being housed in prisons. This created spatial disparities in convict settlement (Hughes, 1987; McLean, 2012). When released, the convicts typically settled in the local areas in which they had been assigned. Figure 6 depicts the convict sex ratio in mid-nineteenth century historical counties in New South Wales and Van Diemen's Land mapped to present day postcodes. Figure 6 highlights that there was a clear imbalance in the historical sex ratio in favour of men, with variation across local areas depending on levels of convict settlement

The stylized depiction of the marriage prospects of single men looking for a wife in the eighteenth and first half of the nineteenth centuries in New South Wales and Van Diemen's Land was close to the predictions of the theoretical framework. Historical accounts reference female convicts and free female settlers arriving in the colonies to multitudes of men looking for a partner (Burkett, 2019; Gothard, 2002; Hammerton, 2007). Concerned about the potential for imbalances in the sex ratio to result in crime, and in particular sexual crimes and homosexuality, at different points in the nineteenth century the colonial authorities sponsored women of marrying age to migrate to Australia, often publicising in the marketing material that that it would be easy for them to find a husband (Burkett, 2019; Smithers, 2021).

Initially, Britain intended New South Wales and Van Diemen's Land to be a self-sustaining prison, which seems antithetical to the development of entrepreneurship (Butlin, 1953). However, military officers from the New South Wales Corp., the first of which arrived on the Second Fleet in 1790, were engaged in private enterprise, importing goods on the convict ships (Abbot, 1969; Butlin, 1985; Johns & van der Eng, 2010). The military officers engaged convicts and emancipists as agents to sell these imported goods, “so that they themselves did not harm their gentlemanly status” (Johns & van der Eng, 2010, p. 815). This provided an opportunity for the early convicts and emancipists to accumulate wealth. Many used this capital to branch out on their own to set up their own businesses (Johns & van der Eng, 2010).

Because the private sector was embryonic, opportunities for social advancement and to build wealth through paid employment was limited or near non-existent. Thus, many emancipists saw entrepreneurship as a way to improve their chances of finding a wife. Under Lachlan Macquarie, who served as New South Wales fifth Governor from 1810-1821, emancipist entrepreneurship was seen as the main vehicle to promote economic development (Johns & van der Eng, 2010). Karskens (2013, p. 8) points out: “In the first decade of the nineteenth century, [emancipist entrepreneurship] far outstripped the government economy and [Sydney] was studded with warehouses and shops, all jockeying to be closest to the water, wharves and ships”. Despite the paucity of business records from the eighteenth and nineteenth centuries, several case studies suggest that entrepreneurship was a favoured route to build wealth among men in the colonies (Aveling, 1992; Graham, 2020; Johns & van der Eng, 2010; Ville, 1998). The prospects for convicts and emancipists in the marriage market heavily depended on wealth and social status (Almenberg & Dreber, 2009). Entrepreneurship was seen as the vehicle to accomplish this as quickly as possible. Ville (1998, p. 19) suggests: “The desire for legitimacy, esteem and recognition combined with the denial of conventional routes of achievement acted

as a strong spur to reformed convicts. Business was probably considered more legitimate and respectable than in Britain and so provided a good route to social ascendancy”.

Social capital forged through mateship was clearly very important in making connections and building wealth through new business ventures in the convict period. Ward (1958) argued that mateship, had its origins in the social bonds that were forged between the overwhelmingly male population in the convict era and harsh frontier environment of the Australian bush in the nineteenth century. Building networks and social capital through inter-firm collaboration was particularly important in a colonial market “that was fraught with hazards and most of the population was composed of convicts” (Johns & Ville, 2012, p. 168). “[A] major issue for successful trading in the colony was the ability to command capital and to be credit worthy. This was difficult when markets and contacts were so far away [in Britain], and for ex-convicts, when reputation and good character were essential” (Johns & Ville, 2012, p. 171).

While the sex ratio was about 3 to 1 in the mid-nineteenth century, it has declined over time. Figure 7 plots the time series for the sex ratio, for Australia as a whole and New South Wales and Tasmania separately, between 1830 and 2021. The sex ratio continued to exceed one until about 1920, but evened out after that. Figure 8 is the present-day equivalent of Figure 6. It shows the sex ratios in the same locations as in Figure 6, but based on data from the 2021 census. The historical imbalance in the sex ratio apparent in Figure 6 no longer exists. This point is important to our set up because, to the extent that we observe that the propensity for entrepreneurship is higher in postcodes with higher historical sex ratios, it suggests that this will reflect gender norms. It rules out any possibility that spatial differences in present-day propensity for entrepreneurship simply reflect contemporary imbalances in the sex ratio.

We hypothesise that the vertical transmission of gender norms will be attenuated by immigration. Early settlement was ethnically homogenous and most immigration to Australia prior to World War II was from Britain (Moran, 2005). This situation started to gradually change after World War II with the partial relaxation of the White Australia Policy, which was fully dismantled by the Whitlam Labor government in the first half of the 1970s (Moran, 2005). Now Australia has an ethnically diverse population, particularly around Sydney (Collins & Kunz, 2009) where a lot of the initial convict settlement took place.

4. Research methods

4.1. Data and sample

We rely on data from restricted Release 22 of the HILDA survey for individual-level present-day data on self-employment and its correlates. The HILDA survey is a nationally representative household longitudinal survey that collects information on the socioeconomic and labour market activity of households in Australia (see Wooden et al., 2024). The annual survey, which commenced in 2001 contains 22 annual waves in Release 22. Given the focus

of our study is on how the historical sex ratio affects whether men pursue entrepreneurship, in the main analysis, we restrict our analysis to male participants in HILDA.⁷

In our main analysis, we rely on a sample of 27,424 observations (4,025 unique individuals) over the period 2001-2022. Figure A1 presents an overview of the number of male participants interviewed in each wave of HILDA over the 22-year period. There are very few instances of missing data in Release 22 of HILDA. This is because, prior to releasing the data, the HILDA survey team imputes values when complete responses are not available from participants, so Release 22 contains these imputed values. The imputation strategies that the HILDA team uses pre-release are described in Hayes and Watson (2009). Despite this, a small number of participants in the original sample contain missing values for one or more of the covariates (26 observations). In the main analysis we exclude these participants. As one of the robustness tests, we use the multiple imputation technique for the missing values to check the sensitivity of our results (Rubin, 1996) and find that the results remain unchanged.

4.2. Variables and measures

Outcome variable

Our outcome variable is propensity for opportunity entrepreneurship for each male participant in each wave of HILDA. The Global Entrepreneurship Monitor (GEM) introduced the concept of necessity and opportunity entrepreneurship in 2001 to differentiate between entrepreneurship that reflects voluntary pursuit of identified market or business opportunities and entrepreneurship that reflects necessity to engage in business opportunities in the absence of other viable employment opportunities (Raynolds et al., 2002). Opportunity entrepreneurs are those who choose to become entrepreneurs, rather than those who become self-employed because they have no other options. Opportunity entrepreneurship, hence, contrasts with necessity entrepreneurship, where individuals start businesses because they have no other means of earning a livelihood (Dencker et al., 2021; O'Donnell et al., 2024).

To measure entrepreneurship, we use a binary variable denoting whether the participant is self-employed (see, e.g., Awaworyi Churchill et al., 2023a; Awaworyi Churchill et al., 2021; Estrin et al., 2024; Hessels et al., 2020; Nikolaev et al., 2020; Van Praag et al., 2013). To ensure that we are not including necessity entrepreneurs, who are turning to self-employment because they are unemployed and have no other option, we define our outcome variable as those who were

⁷ HILDA has been used in at least four other recent studies that examine the antecedents of propensity for entrepreneurship in Australia, some of which also match data from HILDA with postcode-level variables. Awaworyi Churchill et al. (2023b) use 19 waves of HILDA to examine whether contemporary negative life events affect propensity for entrepreneurship, along with the moderating role of locus of control. Awaworyi Churchill et al. (2023a) use 19 waves of HILDA, which they match with crime rates at the postcode level. These authors examine how local crime rates affect propensity for entrepreneurship, together with the mediating role played by social capital. Awaworyi Churchill et al. (2024a) match 19 waves of HILDA with data on weather at the postcode level to examine the effect of weather shocks on propensity for entrepreneurship. Finally, Hayward et al. (2024) use 20 waves of HILDA, which they match with data on solar power installations at the postcode level, which they use as a proxy for community sustainability initiatives. These authors examine how solar power installations at the community level act as a spur for individual propensity for entrepreneurship and consider the role of potential and mobilized social capital as mediators of this relationship.

in paid employment in the previous wave, but are self-employed in the next wave. These individuals are more likely to be opportunity entrepreneurs who choose self-employment. This approach is consistent with how several studies have empirically modelled opportunity entrepreneurship (Awaworyi Churchill et al., 2023a; Block & Wagner, 2010; Estrin et al., 2024). In each wave of HILDA, participants were asked to indicate their employment status as either an “employee”, “employee of own business with other employees”, or “employee of own business without other employees”. Our measure of opportunity entrepreneurship is a binary variable set equal to one if a male participant was in paid employment in the previous period, but in the current period owns a business either with or without employees (Awaworyi Churchill et al., 2023a; Block & Wagner, 2010; Estrin et al., 2024).⁸

Historical convict and population sex ratio

Drawing on data from the earliest reliable colonial censuses, Grosjean and Khattar (2019) compile data on historical convict and population sex ratios in New South Wales and Van Diemen's Land, which we use in our study. The earliest reliable census for New South Wales was conducted in 1836, while the earliest census for Van Diemen's Land was conducted in 1842. In each census, data is available on both the convict sex ratio and the historical sex ratio in historical counties, which were the unit of observation for the historical census.⁹ The convict sex ratio is the ratio of male to female convicts in each historical county in the two colonies. The historical population sex ratio includes colonial administrators, emancipists, free settlers and Caucasians born in the colonies, in addition to convicts (Baranov et al., 2023).

The restricted Release version of HILDA, which we use, provides information on the postcode in which each participant lives. We use the shapefiles provided by Grosjean and Khattar (2019) to map the convict sex ratio and historical sex ratio from historical counties to their equivalent present-day postcodes. This allows us to match propensity for entrepreneurship and its individual-level correlates for each participant in HILDA residing in New South Wales, Tasmania and the Australian Capital Territory across the 22 available waves with the convict sex ratio and historical sex ratio in the postcode in which they live.¹⁰

Covariates

Covariates are of four types. The first are individual-level variables from HILDA that previous studies suggest are correlated with propensity for entrepreneurship: age, marital status, education status and country of origin. The second are time-varying present-day postcode covariates - the present-day sex ratio and the urbanization rate, which are collected from the

⁸ We identify an opportunity entrepreneur in a particular year based on their employment status in both the current year and the previous year. If they are self-employed this year after being employed last year, they would be classified as an opportunity entrepreneur. Furthermore, if they continue to be self-employed in subsequent years, maintaining their status as an opportunity entrepreneur, they would still be classified as such.

⁹ There were 34 historical counties across the two colonies of New South Wales and Van Diemen's Land. The average population of each country was approximately 4,500 people.

¹⁰ We include participants in HILDA from the Australian Capital Territory because it was part of New South Wales until 1911. In 2020, the population of New South Wales, Tasmania and the Australian Capital Territory combined, represented 36 per cent of Australia's population of 25.7 million.

2001, 2006, 2011, 2016 and 2021 censuses.¹¹ The third type of covariate are geographic characteristics at the postcode level - postcode centroid, land formation (plains and plateaus, mountains, other) and historical mineral deposits (major coal; major gold; other). The fourth type of covariate are a set of historical demographic and economic characteristics: historical county population mapped to the present day postcode, historical county convict population mapped to the present-day postcode and the historical share of the population employed in the main employment sectors (agriculture, mining, manufacturing, domestic services and professional occupations). Information on geographic and historical demographic and economic characteristics were collected by Grosjean and Khattar (2019) and we use their data.

Moderators

To examine vertical transmission of gender norms within the household, we follow the approach of studies that contrast the attitudes of individuals of different ancestries (Baranov et al., 2023; Grosjean & Khattar, 2019; Nunn & Wantchekon, 2011). The premise is that only parents who are born in Australia will pass on cultural gender norms rooted in Australia's colonial past (Baranov et al., 2023). We employ data on whether the parents of the participant in HILDA were born in Australia (Baranov et al., 2023; Grosjean & Khattar, 2019). To examine the potential attenuating role of migration on the vertical transmission of gender norms we consider two moderators. The first is ethnic diversity at the postcode level using data from the 2001, 2006, 2011, 2016 and 2021 censuses. We calculate ethnic diversity using the Herfindahl fractionalization index, which captures the probability that two randomly selected individuals in a given postcode belong to different ethnic groups (Greenberg, 1956). The second is a binary variable denoting whether the participant migrated across the HILDA survey. It captures whether the participant was new to a neighbourhood/postcode and may not be familiar with the norms, and share the values, that have been passed down in that local area.

Mediators

Parental investment: We measure parental investment in sons using the educational attainment of the father and mother. Parental education is positively correlated with investment in their children's cognitive and non-cognitive outcomes and ultimately earnings (Lee et al., 2024). The HILDA survey asks participants about how much schooling that their father/mother completed. We use a binary variable capturing the completion of year 12 to measure parental investment.

Savings: We measure savings as the difference in household wealth over time (Cobb-Clark et al., 2016) using data from the HILDA survey. Given that information on household wealth is reported in four-yearly intervals in the HILDA survey – i.e., in waves 2, 6, 10, 14, 18, and 22, our measure of savings is the difference in household wealth between each consecutive wave. Our measure of wealth or household total net worth is the sum of net financial and non-financial wealth. Net financial wealth is defined as “the sum of total interest earning assets in banks and other institutions, total stocks and mutual funds, and total other investments (life insurance,

¹¹ The Australian census is administered every five years. These were the four censuses that took place during the collection of the 22 annual waves of HILDA that we employ in the study.

trust funds, and collectibles), minus the total value of unsecured debt (including car loans)” (Cobb-Clark et al., 2016, p. 115). Non-financial wealth consists of four asset categories; namely, business equity, vehicles, real estate wealth and pensions.

Risk preference: Risk preference is measured using the Survey of Consumer Finances Risk assessment indicator (Brown & Van der Pol, 2015; Grable & Lytton, 1999; Hanna & Lindamood, 2004). The question in HILDA is: “Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash; i.e., cash used for savings or investment?” Responses are coded on a four-point scale: 1 = I take substantial financial risk expecting to earn substantial returns; 2 = I take above average financial risks expecting to earn above average returns; 3 = I take average financial risks expecting to earn average returns; and 4 = I am not willing to take any financial risks.¹² We reverse code responses such that higher values on the scale denote preference for greater risk.

Spousal satisfaction: We measure spousal satisfaction using information in the HILDA survey that asks participants how satisfied or dissatisfied that they are with their partner. Responses are coded on a 0-10 scale, where zero means “completely dissatisfied” and 10 means “completely satisfied”. Our measure of spousal satisfaction uses the 11-point scale.

Social capital: We measure social capital using a composite index of social capital that combines the dimensions of neighbourhood trust, community membership, neighbourhood support and collaboration. The composite indicator of social capital is based on a 6-item questionnaire, which is available in waves 6, 10, 14, 18 and 22 of the HILDA survey, collectively capturing different aspects of social cohesion and networks among neighbours (Awaworyi Churchill et al., 2023a; Clark & Lisowski, 2018). The first four items are based on responses to the question: “To what extent do you agree or disagree with the following statements about your neighbourhood? (1) This is a close-knit neighbourhood, (2) People in this neighbourhood can be trusted, (3) People in this neighbourhood generally do not get along with each other, and (4) People in this neighbourhood generally do not share the same values”. Responses are on a seven-point response scale, where one means “strongly disagree” and seven means “strongly agree”, with responses reverse coded for questions (3) and (4). The last two items are based on the question: “How common are the following things in your local neighbourhood? (1) Neighbours helping each other out, and (2) Neighbours doing things together”. Responses are coded on a five-point scale, where one means “never happens” and five means that it is “very common”. Consistent with the standard approach in the literature, the composite indicator of social capital is derived as the average of the six questions, such that increasing values of the scale represent higher levels of social capital (see, e.g., Awaworyi Churchill & Farrell, 2020; Awaworyi Churchill et al., 2023a; Clark & Lisowski, 2018).

Table 1 provides summary statistics of the main variables used in our analysis.

¹² For participants without any spare cash, they are asked to assume that they “had some spare cash that could be used for savings or investment” and responses are coded on the same scale.

In Appendix A we provide a step-by-step detailed breakdown of the all the decisions involved in the data preparation and more details on the unit of observation.

The analysis was performed using Stata (Standard edition 17.0).

4.3. Empirical Strategy

To estimate the long-terms effects of high sex ratios on the propensity for opportunity entrepreneurship among men, we employ the following empirical specification:

$$E_{ipcst} = \gamma_0 + \gamma_1 Ratio_{pcs} + \gamma_2 X_{pcs}^G + \gamma_3 X_{cs}^H + \gamma_4 T_{pcs}^C + \gamma_5 X_{ipcs}^C + \varphi_s + \delta_t + \varepsilon_{ipcst} \quad (1)$$

E_{ipcst} is the propensity for opportunity entrepreneurship for male i in each HILDA wave (t) in postcode p contained in historical county c , located in state s . $Ratio_{pcs}$ is the sex ratio measured as the ratio of males to females in postcode p contained in historical county c , located in state s . We alternatively use the historical sex ratio in the structural form estimation and convict sex ratio in the reduced form estimation, both are which from the 1836 (New South Wales) and 1842 (Van Diemen's Land) census to measure the sex ratio. X_{pcs}^G and X_{cs}^H denote vectors of time-invariant geographic and historic demographic and economic characteristics, respectively, that are likely to influence both the convict sex ratio and the propensity for opportunity entrepreneurship. T_{pcs}^C and X_{ipcs}^C denote vectors of present-day postcode level and individual level covariates that are likely to be correlated with propensity for opportunity entrepreneurship and the error term. φ_s are state fixed effects, δ_t are time fixed effects that correspond with the HILDA survey waves and ε_{ipcst} is the idiosyncratic error term.

γ_1 , which measures the effect of the historical sex ratio, measured as either the historical population sex ratio or the convict sex ratio in the reduced form, on propensity for opportunity entrepreneurship, is the main parameter of interest in Equation (1). There are several potential threats to identification, which we address in a range of complementary ways. The most common problem with estimating the impact of sex ratios on economic outcomes usually arises from spatial selection, whereby men and women sort across locations based on observable and unobservable characteristics that are correlated with the outcomes of interest. We do not have this problem because the convicts were assigned to specific locations and were not free to move. This feature implies that γ_1 , is not biased by self-selection into different locations.

A potential threat to identification is that the assignment of convicts to specific locations was not random, but was a function of labour needs in specific areas, if the convict was skilled and, if so, the specific skillset that the convict had, as well as differences in economic specialisation across regions (Meredith & Oxley, 2005). Nicholas (1988, p. 200) notes that “most skilled convict workers found themselves employed in the same jobs in Australia as they had held at home prior to conviction”. For example, if a convict had skills as a miner, he would be assigned to a mining region. The scarcity of female convicts meant that they were allocated as a priority to the largest landowners, who were most in need of domestic servants (Dillon, 2008; Reid,

2003). We address this potential endogeneity bias by controlling for land formation, latitude and longitude of each postcode's centroid, historical mineral deposits and the historical share of the population employed in specific sectors. Our identification strategy rests on the assumption that the spatial distribution of male and female convicts was as good as being random once we control for these historical economic and geographical factors influencing convict assignment (Baranov et al., 2023). Note that another potential threat to identification would be if convicts had been assigned to specific locations based on their general character and sentence length and if these traits were transmitted across generations. We are not able to control for these factors. The evidence, though, suggests this was not the case. For example, Meredith (1988, p. 15) emphasises that convicts were assigned according to economic needs and their skillset and not "with reference to their sentence, crime or general character".

Our preferred approach for estimating Equation (1) is to report the reduced form estimates in which we regress propensity for opportunity entrepreneurship among men on the convict sex ratio. The main reason for focusing on the reduced form estimates is that our theoretical framework suggests that the sex ratio should affect propensity for entrepreneurship among males through competition for women in the marriage market. If the primary mechanism of the unbalanced sex ratio on propensity for entrepreneurship is through competition for mating, it should operate among adults of reproductive age. The historical censuses do not break the population down by age, so it is not possible to calculate the sex ratio for adults of reproductive age. This makes the historical population sex ratio an imprecise measure of the main variable of interest. The advantage of focusing on the convict sex ratio as the main variable of interest is that most convicts were of marriageable age, so the convict sex ratio was a more precise measure of the sex ratio among adults of reproductive age (see Baranov et al., 2023).

As an alternative to presenting reduced form estimates, we estimate Equation (1) using the convict sex ratio as an IV for the historical population sex ratio. To be a valid IV, the convict sex ratio has to satisfy the relevance and exogeneity conditions. Because convicts made up most of the population at the time of the first colonial censuses, the instrument is relevant and demonstrates a strong correlation with the overall population sex ratio.¹³ To satisfy the exogeneity condition, the effect of the convict sex ratio on present-day propensity for entrepreneurship has to operate purely through the historical population sex ratio.

One potential threat to the exclusion restriction would be if convicts differed from the general population in ways that are likely to be transmitted to their present-day male descendants living in postcodes with historically high convict settlement, hence influencing propensity for entrepreneurship. For example, convicts might have higher than average discount rates (Åkerlund et al., 2016), making them less likely to save and, thus, lowering propensity for entrepreneurship. Alternatively, convicts might have higher preference for risk (Chevalier & Marie, 2024), therefore, increasing their likelihood of becoming entrepreneurs. These traits could persist in locations which had high convict settlement through the concept of a 'convict stain' – which is the notion that individuals descended from convicts are genetically

¹³ Grosjean and Khattar (2019) demonstrate that the correlation between: 1) the convict population and total population is 0.99, and 2) the convict sex ratio and total population sex ratio is 0.83.

predisposed to similar behaviours (Lambert, 2002). However, most historians now agree that the convicts transported to Australia did not exhibit traits that differed from the general population in Britain at the time. Most convicts were transported for relatively minor offences committed out of economic necessity and which reflected the harsh economic conditions that characterized Victorian England (Donnachie, 1986; Hughes, 1987; Nicholas, 1990).

As a further check, to ensure that our results do not simply reflect which postcodes had high historical convict settlement *per se*, as opposed to gender imbalance in convict settlement, in our vector of historical covariates, X_{CS}^H , we control for historical county convict population.

One might worry that present day propensity for entrepreneurship among men might be higher in areas that experienced greater early settlement and in which infrastructure and institutions were established early. Controlling for historical county convict population as well as the present-day urbanization rate seeks to alleviate this concern. Figure 8 shows that historical high sex ratios have dissipated in the present, meaning that present day sex ratios are unlikely to be biasing the estimates, but to rule out this possibility, we control for present-day sex ratios.

5. Results

5.1. Results for H1: High historical convict and population sex ratios increase present-day propensity for entrepreneurship among men

Table 2 reports baseline OLS results for the relationship between the historical population sex ratio and propensity for opportunity entrepreneurship.¹⁴ Column (1) is a parsimonious specification that excludes all covariates except for state and year fixed effects. Column (2) adds individual-level covariates, while Column (3) adds geographic controls to the individual-level covariates. In Column (4), estimates include all covariates and relevant fixed effects. The OLS results in Table 2 suggest that men who live in postcodes which had high historical sex ratios have a higher propensity for opportunity entrepreneurship. In the most comprehensive specification in Column (4), a standard deviation in the historical population sex ratio is associated with a 0.7 per cent increase in male propensity for opportunity entrepreneurship.

Table 3 presents the reduced form estimates for the effect of the convict sex ratio on the propensity for opportunity entrepreneurship across four columns, in which the specifications correspond to those in Table 2. The estimates show that the propensity for opportunity entrepreneurship among men is significantly higher in postcodes which had high convict sex ratios. In Column (4), a standard deviation increase in the convict sex ratio increases the propensity for opportunity entrepreneurship among men by 2.6 per cent.¹⁵

¹⁴ The full set of results that show coefficients on all control variables are reported in Table B1 in Appendix B.

¹⁵ In Table 3, we present HAC-robust standard errors corrected for potential spatial autocorrelation and Moran statistics (a spatial version of the Durbin-Watson statistic), together with related *p*-values. Both suggest that our results do not (partially) reflect spatial autocorrelation in the residuals (Kelly, 2019). We also examine the robustness of our results to endogeneity due to omitted variable bias using the Oster (2019) bounds analysis. Following the approach in Oster (2019), we calculate bounds using maximum $R^2=1.3 \times R^2$ with all standard controls. We define the bounded set by the effect in the main specification with all observable covariates and the

In Column (5) of Table 3, we perform a placebo test on the first hypothesis, in which instead of using a sample of male participants from HILDA, we use a sample of female participants. If the effect of convict sex ratios on propensity for entrepreneurship is operating through our proposed theoretical mechanism, one would expect the convict sex ratio to have no effect on the propensity for entrepreneurship among women, which is what we find.

Table 4 presents the IV results for effects of the historical sex ratio on the propensity for entrepreneurship among men where we instrument for the historical population sex ratio using the convict sex ratio. The first stage F-statistic across all specifications are greater than 104.7, which suggests that the convict sex ratio is not a weak IV (Lee et al., 2022). Consistent with expectations, in the first stage the convict sex ratio is positively associated with the historical sex ratio (Grosjean & Khattar, 2019). In each column, the point estimates on the historical population sex ratio are relatively larger in magnitude than those in Table 2, suggesting that the OLS estimates are biased downwards. In Column (4), where we control for all covariates and relevant fixed effects, the results suggest that a standard deviation in the historical population sex ratio increases the propensity for entrepreneurship among men by 3.5 per cent.¹⁶

Taken together, the results in Tables 2-4, provide support for our first hypothesis.¹⁷

5.2. Results for H2-H3: Persistence mechanisms

In Column (1) of Table 5 we augment Equation (1) and regress propensity for opportunity entrepreneurship on the convict sex ratio, a binary variable indicating whether the man's parents were born in Australia and the interaction between these two variables. The coefficient on the interaction term reflects whether the vertical transmission of gender norms within families is stronger in postcodes in which the historical convict sex ratio was higher. The results show that the effect of the convict sex ratio on propensity for entrepreneurship is relatively larger for men whose parents were born in Australia compared to men whose parents were not.

In Column (2) of Table 5, we examine whether ethnic diversity attenuates persistence in the evolution of cultural equilibria. To examine the role of ethnic diversity, we augment our main specification to include the fractionalisation index and its interaction with the convict sex ratio. The effect of the historical convict sex ratio is relatively smaller in magnitude for men who live in more ethnically diverse postcodes. In an alternative test to examine the attenuating effect of migration on the vertical transmission of gender norms, in Column (3) of Table 5, we interact a binary variable equal to one if the man migrated across postcodes. The effect of the convict sex ratio is relatively smaller in magnitude for internal migrants.

The results in Table 5 provide support for both hypotheses 2 and 3.

treatment effect, assuming observables are as important as unobservables. The results suggest that our estimates are relatively stable and robust to omitted variables bias. The full set of results for the reduced form estimates in Column (4) of Table 3, including all covariates, are reported in Table B1 in Appendix B.

¹⁶ The full set of results for Column (4) in Table 4 are provided in Table B1 in Appendix B.

¹⁷ In Table C1 in Appendix C, we examine the robustness of our preferred reduced form estimates in Table 3 to a suite of sensitivity checks, which are fully described in Appendix C. The results are robust in each case.

5.3. Results for H4-H8: Present-day attitudes and behaviours as mediators

Some of our proposed mediators, such as own savings and spousal satisfaction are endogenous, in the sense that there is likely to be reverse causality. For example, individuals with greater propensity for entrepreneurship might have higher savings or spousal satisfaction. Thus, it is important to employ a causal mediation method that is robust to the mediators being potentially endogenous. To examine the role of parental investment in sons, risk preferences, savings, spousal satisfaction and social capital as mediators through which the convict ratio influences propensity for entrepreneurship, we perform a causal mediation analysis (Liu et al., 2014). This mediation technique requires estimating two models: a model for the mediator conditional on treatment and covariates and a model for the outcome conditional on treatment and covariates. The mediation analyses determine the proportion of the total effect of the convict sex ratio on propensity for entrepreneurship that is mediated by each of the potential channels. This approach draws on the conventional practice of causal chains and therefore capture the sequence of effects that explain how an independent variable (sex ratios) influences a dependent variable (opportunity entrepreneurship) through a set of mediating variables (M).

The results in Table 6 show evidence of partial mediation and suggest that the convict ratio increases the propensity for entrepreneurship through each of the mediators. Specifically, the observed direct effects in Table 6 reinforce the direct positive effect of the convict sex ratio on the probability of moving from paid employment to self-employment. Turning to the indirect effects, the convict sex ratio increases the probability of self-employment through savings (indirect effect of 0.00001 with $p < 0.001$), spousal satisfaction (indirect effect of 0.00001 with $p < 0.05$), social capital (indirect effect of 0.00029 with $p < 0.05$), risk preferences (indirect effect of 0.00006 with $p < 0.001$), and parental investment (indirect effect of 0.00001 with $p < 0.001$). Thus, by increasing savings, spousal satisfaction, social capital and parental investment, the convict sex ratio increases the probability of moving from paid employment to self-employment. Further, by making people more risk loving, the historical convict sex ratio increases the probability of moving from paid employment to self-employment. The results in Table 6 support the conclusion that parental investment in sons, risk preferences, savings, spousal satisfaction and social capital are mediators through which the convict ratio influences propensity for entrepreneurship among men, consistent with hypotheses 4-8.

A stylized fact is that having an entrepreneur parent greatly increases the likelihood that a child will become an entrepreneur (Colombier & Masclet, 2008; Dunn & Holtz-Eakin, 2000; Lindquist et al., 2015; Sørensen, 2007). This suggests an alternative mechanism linking the historical sex ratio to present-day entrepreneurship: the direct passing of entrepreneurial genes, skills, role modelling, and wealth from the first generation of male entrepreneurs, who were thrust into this role by the marriage squeeze in the convict era, to their descendants. This mechanism differs from the cultural gender norms mechanism stemming from imbalanced sex ratios in that it can affect both sons and daughters. However, our empirical result shows that the historical sex ratio does not appear to increase the probability of female entrepreneurship (see Column 5 of Table 3), suggesting that we can rule out this alternative explanation.

6. Discussion

6.1. Linking historical sex ratios to present day propensity for entrepreneurship

Our theoretical contribution is to extend prior theory on how contemporaneous imbalances in the sex ratio affect propensity for entrepreneurship among men (Chang & Zhang, 2015) backward in history. We treat historical imbalance in the sex ratio as a generator of highly persistent gender norms, through which an historical shock to the sex ratio can shape modern spatial patterns in entrepreneurship. Recent studies have called for historical context to be considered a source of new theorising in entrepreneurship research (Wadhvani, 2016; Wadhvani & Decker, 2017). In linking Australia's convict period with present-day spatial patterns in entrepreneurship, we seek to use a major historical event in the settlement of Australia – the transport of convicts from Britain to the colonies of New South Wales and Van Diemen's Land – to both conceptualise and evaluate theory (Maclean et al., 2016).

The fact that most of the convicts who were transported to the colonies were men and that the system of convict assignment created regional differences in the sex ratio in the eighteenth and nineteenth centuries, provided us the context to conceptualise a theory as to how these spatial patterns could impact present day entrepreneurship, despite having long disappeared. The historical natural experiment, in which we match data on the historical sex ratio from the convict period with present-day longitudinal data on individual propensity for entrepreneurship, provides a rigorous empirical framework to evaluate that theory.

6.2. Extending historical approaches to entrepreneurship research

In their introduction to a special issue in the *Strategic Entrepreneurship Journal* on 'historical approaches to entrepreneurship research', Wadhvani et al. (2020) propose a synthesising framework for integrating history into entrepreneurship theory. The three elements of their framework are context, time and the mechanism of change. We seek to engage with each of these elements in extending historical approaches to entrepreneurship research.

Context: Perchard et al. (2017, p. 906) state that context "lie[s] at the heart of historical perspective and methods. For without a full appreciation of the historical context in which social actors operate, and how that changes, these lose their ability to reflect the dynamics of social processes and the implicit (and explicit) value of history". We treat historical context as front and square. The gendered transportation of convicts is not simply an historical backdrop to our study, but is central to our theory that present day propensity for entrepreneurship is embedded in social relationships, forged in the past, which influence the present through persistence in gender norms, as well as the natural experiment that we use to test that theory.

Time: Until recently, most entrepreneurship research largely ignored the role of time and temporality (McMullen & Dimov, 2013). Time is central to our work. In terms of theory, the evolution of sticky cultural norms necessarily takes decades, perhaps centuries (North, 1994). In the story that we tell, attitudes and behaviours emanating from high sex ratios are vertically transmitted in the household which generates strong hysteresis in cultural norms. This only

occurs over the course of generations. The course from high historical sex ratios to present-day entrepreneurship is not linear, but reflects a path dependent process in which persistence in cultural norms are subject to buffering from demographic changes, such as migration and change in the ethnic composition of the population, which take place over a long period of time. Empirically, testing these theoretical arguments requires data spanning centuries.

Mechanisms of change: We contribute to understanding of how historical context shapes entrepreneurial action through exploring the moderators and mediators. To examine whether gender norms are a transmission mechanism, we use a standard lineage-based approach grounded in the notion that only parents who are born in Australia will pass on gender norms, which are deep rooted in Australia's colonial past. We also theorise, and provide evidence, on how cultural norms emanating from high sex ratios affect the decisions of men as to whether to pursue entrepreneurship through the extent to which parents invest in their sons, savings levels, appetite for risk, social capital and satisfaction with one's spouse in the present.

The focus of most historical research in entrepreneurship has been on what we can learn from the past to better inform the present. Wadhvani et al. (2020) identify five such approaches: socio-economic history, cultural history, microhistory, comparative history and historical case studies. The common thread in each approach is seeking to draw implications or lessons for contemporary entrepreneurship research from studying entrepreneurship in the past. This is different to studying how what happens in the past can directly shape entrepreneurship in the present. This represents a missed opportunity in historical approaches to entrepreneurship research. Scholars in other disciplines, such as economics and sociology, are increasingly providing theory and evidence linking events in the past directly to present-day outcomes. These studies typically theorise, and provide evidence, on the factors that mediate the historical event and the present-day outcome and the potential persistence mechanisms (see, e.g., Alesina et al., 2013; Baranov et al., 2023; Bazzi et al., 2024; Grosjean & Khatat, 2019; Voigtländer & Voth, 2015). We build on these developments in other disciplines to provide an additional historical approach to entrepreneurship research to those identified by Wadhvani et al. (2020) and show how historical context can be used to shed light on present day entrepreneurship.

There are parallels between what we do and a recent literature that studies how early life events affect propensity for entrepreneurship later in life. These studies consider major historical events such as the Chinese Great Famine (see, e.g., Cheng et al., 2021; Yi et al., 2022), the Cultural Revolution (Hayward et al., 2022) or the Vietnam War (Awaworyi Churchill et al., 2021) as triggers for early life adversity. The difference between these studies and what we do is that their focus is on historical events that occurred after the individual was born and they examine how these events altered their life trajectories. We focus on an event that occurred well before the participants in our study were born and examine the role that gender norms, emanating from that event, can play as the mechanism linking the past with the present.

6.3. Evidence on the origins of gender norms in entrepreneurship research

Existing research notes that men are more likely to be entrepreneurs than women in most countries (Baughn et al., 2006; Feldmann et al., 2022; Jennings & Brush, 2013). Several studies

attribute this outcome to gender norms (Boddington, 2024; Feldmann et al., 2022; Muntean & Ozkazanc-Pan, 2015). However, in much of this research, the origins of these gender norms are treated as a black box. Even studies, such as Boddington (2024) and Muntean and Ozkazanc-Pan (2015), which contain detailed theorising about how gender norms shape entrepreneurship, are largely silent on the historical origins of those gender norms and do not explicitly model them. This stands in contrast to other disciplines in which gender norms have been traced to traditional agricultural practices (Alesina et al., 2013); the harsh conditions associated with living in frontier settlements (Bazzi et al., 2024) demographic shocks tied to World War I (Gay, 2023) and the transatlantic slave trade (Teso, 2019). These studies then show how, through the evolution of persistence in gender norms, these historical origins contribute to gender inequality in a range of economic, political and social outcomes, including the gendered allocation of household work, civic participation and female participation in the workforce (Alesina et al., 2013; Bazzi et al., 2024; Gay, 2023; Grosjean & Khattar, 2019; Teso, 2019). We extend this literature on the historical origins of gender inequality to provide evidence on the long-run gender origins of the propensity for entrepreneurship.

There are four other studies that specifically use Australia's convict history to examine how historical sex ratios affect contemporary outcomes. Grosjean and Khattar (2019) examine the effect of historical sex ratios traced back to the convict period on modern-day female labour participation rates. Baranov et al. (2023) use Australia's male-biased convict population as a natural experiment to document the historical roots and contemporary consequences of masculinity norms – beliefs about the appropriate conduct of men. These authors show that in locations which had higher sex ratios, centuries later, men were more likely to volunteer to go to war. There were also higher rates of male violence and higher rates of male suicide and other forms of preventable male mortality in such locations. Awaworyi Churchill et al. (2024c) trace the origins of male bonding (mateship) in the Australian psyche to male-biased sex ratios in the convict era and show how this relates to local variations in modern-day social capital. These authors examine how the effect of historical sex ratios on the geographical distribution of social capital was reinforced in the World Wars and transmitted via shared remembrance, reflected in variation in the geographical distribution of local war memorials. Finally, Awaworyi Churchill et al. (2024b) examine how historical sex ratios, dating back to the convict period, affect the bargaining power of women in the household and, consequently, women's ability to influence community sustainability initiatives. Specifically, they find that community sustainability initiatives are higher in postcodes that have higher historical sex ratios.

We extend these studies to show that the propensity for entrepreneurship among men in modern-day Australia can also be traced back to the convict period. In doing so, we extend and build on these studies in at least two ways. The first way in which we differ is that, in contrast with Grosjean and Khattar (2019) and Awaworyi Churchill et al. (2024b), who focus on how historical sex ratios affect the bargaining power of women, we consider how historical sex ratios affect the economic incentives facing men. Second, in contrast to Baranov et al. (2023) who, like us, also focus on economic outcomes for men, we show that the outcomes need not be negative or result in anti-social behaviour. Rather, we show that high sex ratios stemming from the convict period can be a positive spur to new economic activity.

6.4. Are our results generalizable to other countries and contexts?

Given that our results are based on a unique historical experiment in Australia, one might be concerned about whether they are generalizable to other countries and contexts. The unique historical experiment stems from the gender imbalance in convicts transported to the colonies and the system of convict assignment, which facilitated empirical identification of the relationship between historical sex ratios and present-day entrepreneurship. The imbalance in the sex ratio in the founding population of Australia, though, is not that unusual. Other ‘new world’ countries experienced similar historical imbalances. For example, the frontier settlements in the United States in the nineteenth century also had high sex ratios (Schacht & Smith, 2017). Bazzi et al. (2024) show that these historical high sex ratios continued to affect female labour force participation rates in the United States in the twenty-first century via the transmission of gender norms. While it is an empirical question, spatial differences in the historical sex ratio could contribute to present day differences in propensity for entrepreneurship between men and women in the United States (Langowitz & Minniti, 2007).

In other parts of the world, such as China, India and the Middle East, some combination of government policies, cultural practices, such as son preference, selective abortion and migration have created skewed sex ratios in the marriage market, which potentially have implications for observed gender differences in entrepreneurship. Several studies suggest that skewed sex ratios in China resulting from the One Child Policy have had behavioural consequences tied to a tight marriage market, such as increased investment in sons (Guo et al., 2022) and higher savings rates (Wei & Zhang, 2011a). These behavioural responses are antecedents for higher rates of entrepreneurship. Chang and Zhang (2015) provide direct evidence that competition among men for partners in a tight marriage market was a cause of higher rates of entrepreneurship in Taiwan in the decades following the removal of a military ban on soldiers getting married at the end of the 1950s. Wei and Zhang (2011b) find that new private venture formation in China is higher in provinces with higher sex ratios.

The proviso on interpreting our findings as having application beyond Australia is that they rest on how gender norms are transmitted across generations. The extent to which our results are applicable to other contexts depends on the extent to which cultural norms evolve in a similar way. While concepts such as mateship, which we have argued underpins social capital as a mediator between historical sex ratios and entrepreneurship, is not unique to Australia, it has a quite specific role in defining the Australian male psyche. This role can be traced back to the convict period and the path dependent evolution of gender norms around mateship is likely specific to significant defining moments in Australian history, such as Australia's involvement in the World Wars, and how these helped forge a sense of Australian identity (Ward, 1958).

Australia is also an individualistic country. In collectivist countries, such as China, hysteresis in culturally gender norms is likely to take less time to form, be more sticky and be harder to break down. If anything, though, this suggests that in collectivist cultures, there might be a stronger relationship between historical events that act as a generator of gender norms and present-day outcomes, but this is speculative in the absence of further research.

6.5. Implications for practice

Our results suggest that policies are needed to promote female entrepreneurship in regions (and countries) with high sex ratios or historically high sex ratios because the gender imbalance will contribute to higher rates of entrepreneurship among men. Arguments for policies to promote female entrepreneurship, couched around gender norms, are typically posited in terms of gender norms being a barrier to more females starting their own business. We show that gender norms can contribute to gender differences in rates of entrepreneurship by being a catalyst for increased male entrepreneurship rather than a barrier to female entrepreneurship. Specifically, consistent with theoretical expectations, we find that high historical sex ratios do not cause higher present-day propensity for entrepreneurship among women (see Column 5 of Table 3).

6.6. Limitations and suggestions for future research

The main limitation of the study is that data availability prevents us from telling a richer empirical story about the transmission of gender norms. Consistent with previous studies, we use whether the parent of the participant was born in Australia to examine vertical transmission of gender norms in families. We speculate about how these gender norms are transmitted from parent to child, but we do not have the data to explore the exact processes at work. We are not able to examine other potential mechanisms, such as horizontal transmission in schools. It is conceivable, even likely, that gender norms evolve through peer-to-peer transmission in schools when individuals are at a young, impressionable age (Baranov et al., 2023). We do not have data in HILDA to examine this channel. We have proposed attitudes and behaviours that theoretically are likely to emanate from high sex ratios and be antecedents of entrepreneurship, as mediators, but we cannot rule out other potential channels for which we do not have data. This is a common problem in papers studying shocks that occurred centuries ago, reflecting the complexity of history. As Pierce and Snyder (2020) note in their study of the effects of the African slave trade on modern ownership structures, “definitively isolating the mechanisms through which the slave trade continued to influence ownership across centuries is impossible”.

We have examined the role of demographic change as one buffer on gender norms. Future research could examine other factors that potentially change the persistence in cultural norms, such as policy innovations and technological change (Bazzi et al., 2024). More research is needed to understand the mechanism underpinning the transmission of gender norms in other contexts and countries in general, but particularly in collectivist cultures.

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Table 1: Summary statistics

Variable	Obs.	Mean	Median	Std. dev.	Min	Max
<i>Panel A: Historical data</i>						
Historical sex ratio	27,424	2.550	1.452	1.769	1.263	10.750
Convict sex ratio	27,424	15.998	-0.475	24.268	1.270	219.000
Historical population (1000 s)	27,424	20,139.240	15,061.000	16,673.520	311.000	36,797.000
Number of convicts (1000 s)	27,424	5.130	1.978	3.940	0.037	9.079
<i>Panel B: HILDA survey</i>						
<i>Self-employment variables:</i>						
Self-employed	27,424	0.165	0.000	0.371	0.000	1.000
Employer	25,371	0.104	0.000	0.305	0.000	1.000
Employee of own business	24,798	0.083	0.000	0.276	0.000	1.000
<i>Control variables:</i>						
Marital status						
Single	27,424	0.312	0.000	0.463	0.000	1.000
Married	27,424	0.518	1.000	0.500	0.000	1.000
Cohabiting	27,424	0.170	0.000	0.376	0.000	1.000
Education						
Year 11 and below	27,424	0.312	0.000	0.463	0.000	1.000
Year 12	27,424	0.518	0.000	0.500	0.000	1.000
Vocational/Certificate	27,424	0.170	0.000	0.376	0.000	1.000
Degree	27,424	0.307	0.000	0.461	0.000	1.000
Age	27,424	39.625	39.000	13.843	15.000	87.000
Country of origin						
Australia	27,424	0.750	1.000	0.433	0.000	1.000
Other English-speaking country	27,424	0.092	0.000	0.289	0.000	1.000
Other non-English-speaking country	27,424	0.158	0.000	0.365	0.000	1.000

Table 2: Historical sex ratios and self-employment – Baseline (OLS) results

	Self-employment			
	Baseline	+ Individual controls	+ Geographic controls	+ Historical controls
	(1)	(2)	(3)	(4)
Historical sex ratio	0.009*** (0.002)	0.006** (0.002)	0.006** (0.003)	0.007** (0.003)
Individual control	No	Yes	Yes	Yes
Geographic controls	No	No	Yes	Yes
Historical controls	No	No	No	Yes
State and Year FEs	Yes	Yes	Yes	Yes
Observations	27,424	27,424	27,424	27,424

Notes: Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). Results with controls are presented in Table B1 (Appendix B). *** p<0.01, ** p<0.05, * p<0.1. p-values are based on 2-tailed tests.

Table 3: Historical sex ratios and self-employment – Reduced-form results

	Men				Women
	Baseline	+ Individual controls	+ Geographic controls	+ Historical controls	+ Historical controls
	(1)	(2)	(3)	(4)	(5)
Convict sex ratio	0.024** (0.010)	0.021** (0.010)	0.022* (0.012)	0.026** (0.012)	0.005 (0.009)
Spatial HAC <i>p</i> -value	0.048	0.058	0.060	0.038	0.520
Moran statistic <i>p</i> -value				0.436	0.551
Bounds on the treatment effect (Delta=1, Rmax=1.3*R)				[0.005, 0.035]	[-0.001, 0.006]
Individual control	No	Yes	Yes	Yes	Yes
Geographic controls	No	No	Yes	Yes	Yes
Historical controls	No	No	No	Yes	Yes
State and Year FEs	Yes	Yes	Yes	Yes	Yes
Observations	27,424	27,424	27,424	27,424	25,490

Notes: Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). Results with controls are presented in Table B1 (Appendix B). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. *p*-values are based on 2-tailed tests.

Table 4: Historical sex ratios and self-employment – 2SLS results

	Self-employment			
	Baseline (1)	+ Individual controls (2)	+ Geographic controls (3)	+ Historical controls (4)
Historical sex ratio	0.022** (0.010)	0.020** (0.010)	0.025* (0.013)	0.035** (0.017)
<i>First stage (dependent variable is historical sex ratio)</i>				
Convict sex ratio	1.696*** (0.098)	1.647*** (0.096)	1.420*** (0.092)	1.168*** (0.078)
Kleibergen-Paap F statistic	297.500	291.958	237.410	225.628
Individual control	No	Yes	Yes	Yes
Geographic controls	No	No	Yes	Yes
Historical controls	No	No	No	Yes
State and Year FEs	Yes	Yes	Yes	Yes
Observations	27,424	27,424	27,424	27,424

Notes: Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). Results with controls are presented in Table B1 (Appendix B). *** p<0.01, ** p<0.05, * p<0.1. p-values are based on 2-tailed tests.

Table 5 Cultural persistence and the role of vertical transmission of gender norms

	(1)	(2)	(3)
Convict sex ratio	0.000 (0.005)	0.025* (0.013)	0.009** (0.004)
Australian parent	-0.050*** (0.005)		
Convict sex ratio*Australian parent	0.012** (0.006)		
Ethnic diversity		-0.037** (0.018)	
Convict sex ratio*Ethnic diversity		-0.039** (0.019)	
Migration			0.008* (0.005)
Convict sex ratio*Migration			0.021*** (0.005)
Individual control	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes
State and Year FEs	Yes	Yes	Yes
Mean of dependent var.	3.688	3.688	3.688
Observations	27,424	27,424	27,424

Notes: Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). *** p<0.01, ** p<0.05, * p<0.1. p-values are based on 2-tailed tests.

Table 6: Causal mediation analysis

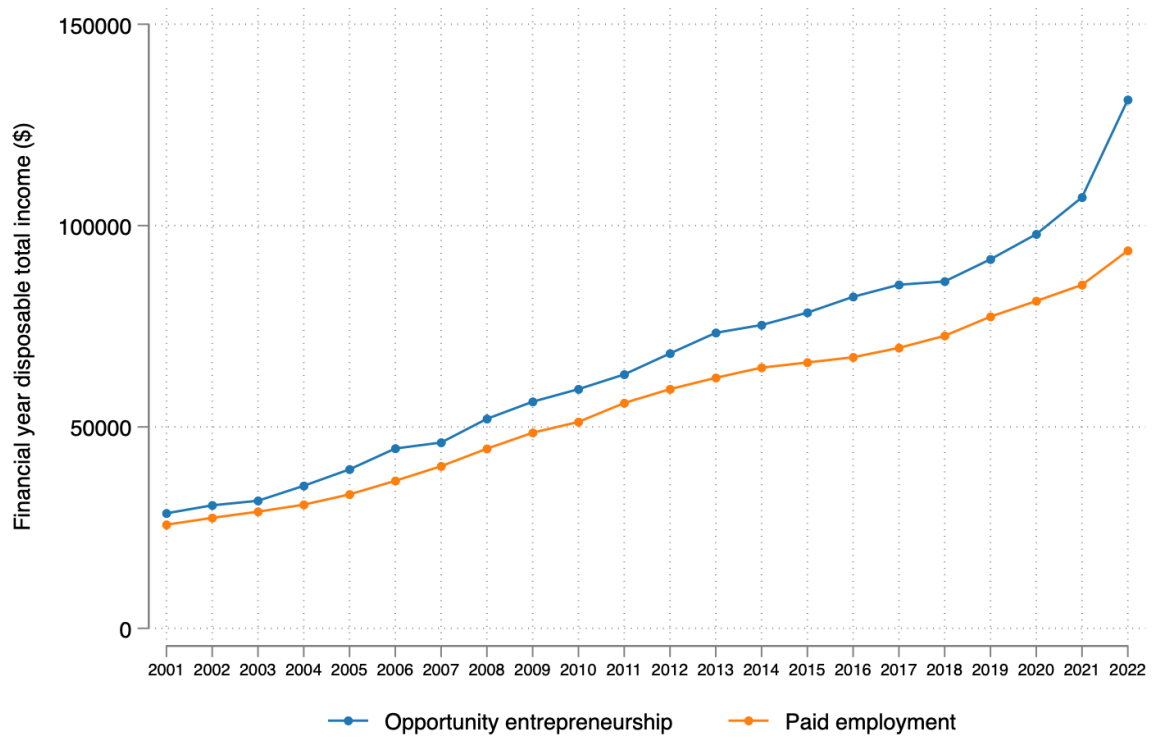
	Direct effect	Indirect effect
	(1)	(2)
Saving	0.0233*** (0.0090)	0.0001*** (0.0000)
Spousal satisfaction	0.0224*** (0.0042)	0.0001*** (0.0000)
Social capital	0.0254** (0.0046)	0.0019** (0.0004)
Risk preference	0.0286*** (0.0037)	0.0014*** (0.0003)
Parental investment	0.0266*** (0.0033)	0.0003*** (0.0001)
Individual control	Yes	Yes
Geographic controls	Yes	Yes
Historical controls	Yes	Yes
State and Year FEs	Yes	Yes

Notes: Results of reduced form. Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). *** p<0.01, ** p<0.05, * p<0.1. p-values are based on 2-tailed tests.

Figure 1: Existing Model of Sex Ratio and Entrepreneurship

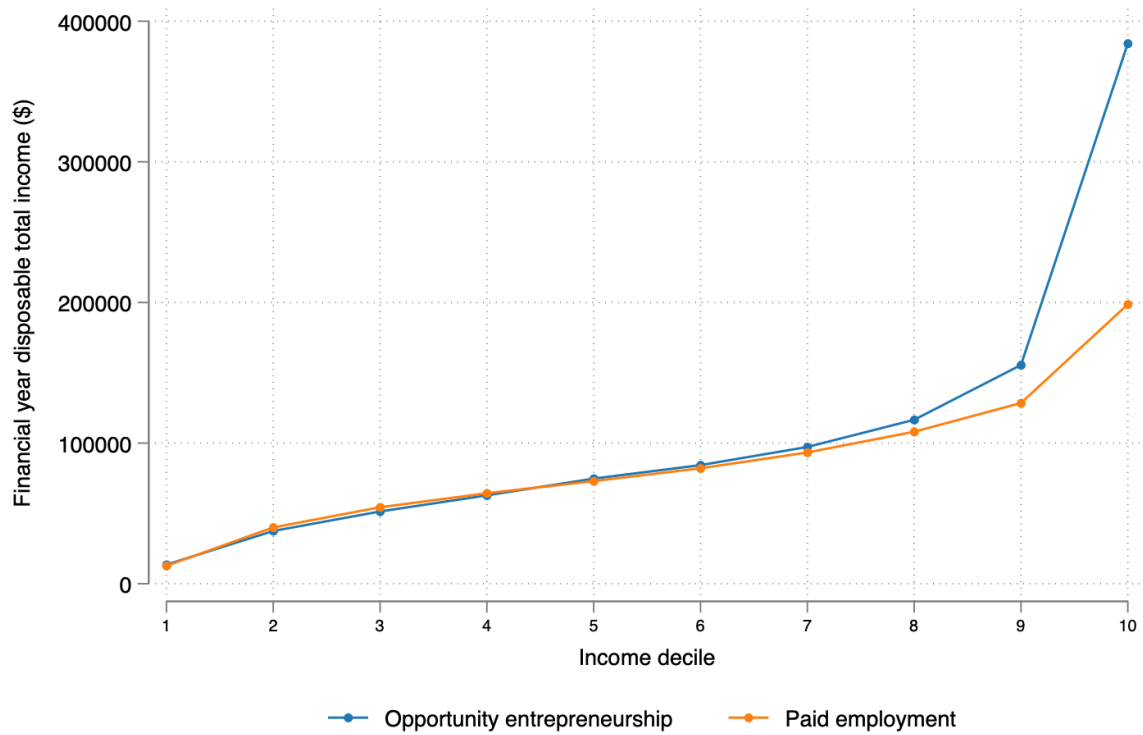


Figure 2: Income from male opportunity entrepreneurship and paid employment from 2001 to 2022 in Australia



Notes: Data from HILDA surveys, 2001–2022. Sample consists of male participants in HILDA.

Figure 3: Income from male opportunity entrepreneurship and paid employment by income decile in Australia in 2022



Notes: Data from HILDA survey 2022. Sample consists of male participants in HILDA.

Figure 4: Income from male opportunity entrepreneurship and paid employment by wealth decile in Australia in 2022

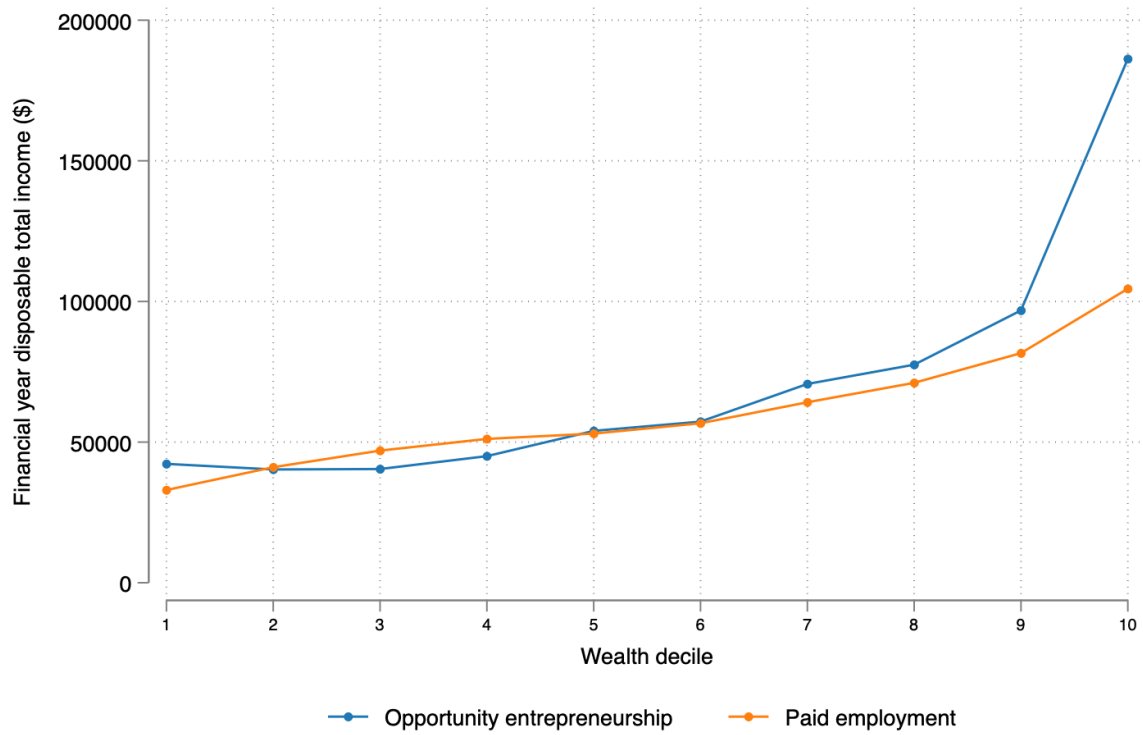


Figure 5a: Proposed Model of Sex Ratio and Entrepreneurship (Direct Effect)



Figure 5b: Proposed Model of Sex Ratio and Entrepreneurship (Moderated Effects)

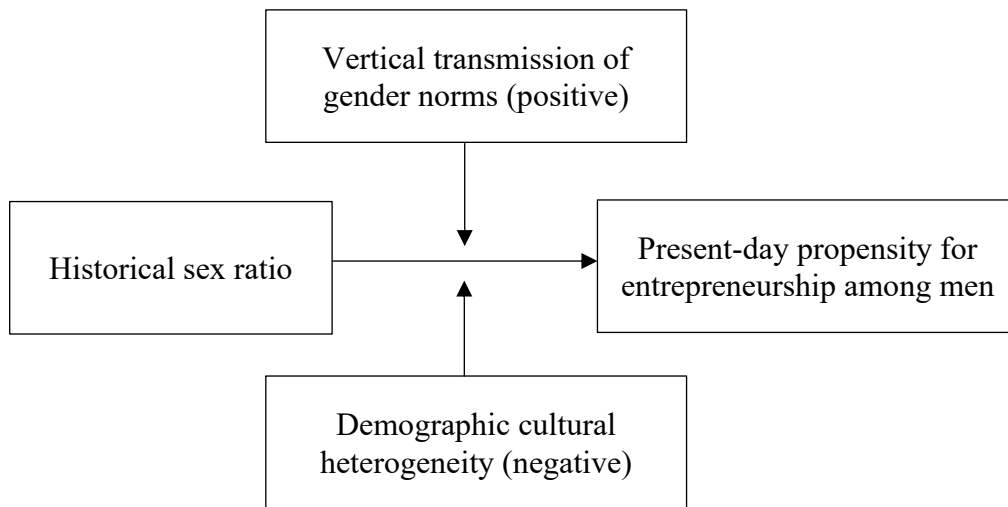
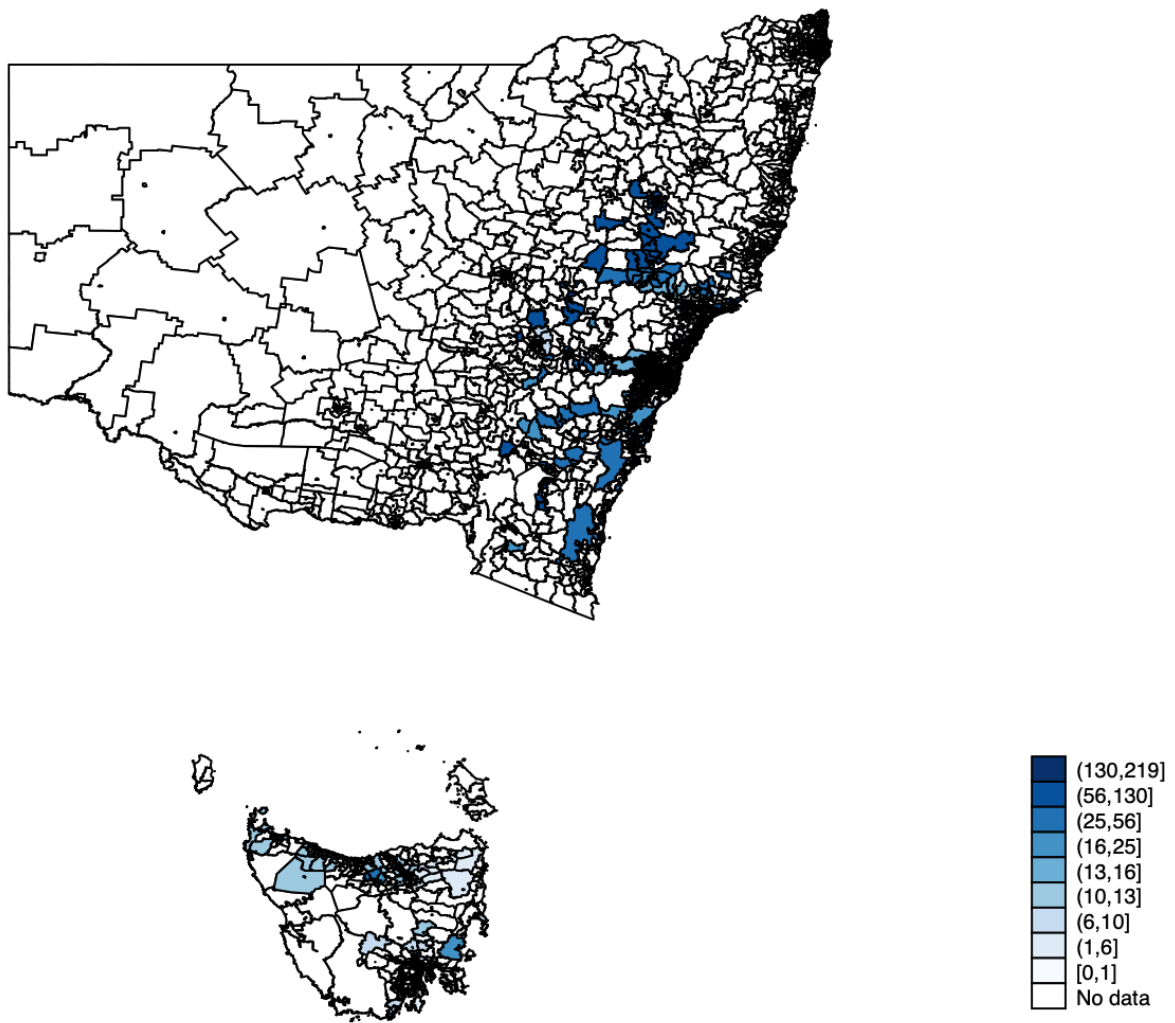


Figure 5c: Proposed Model of Sex Ratio and Entrepreneurship (Mediating Effects)



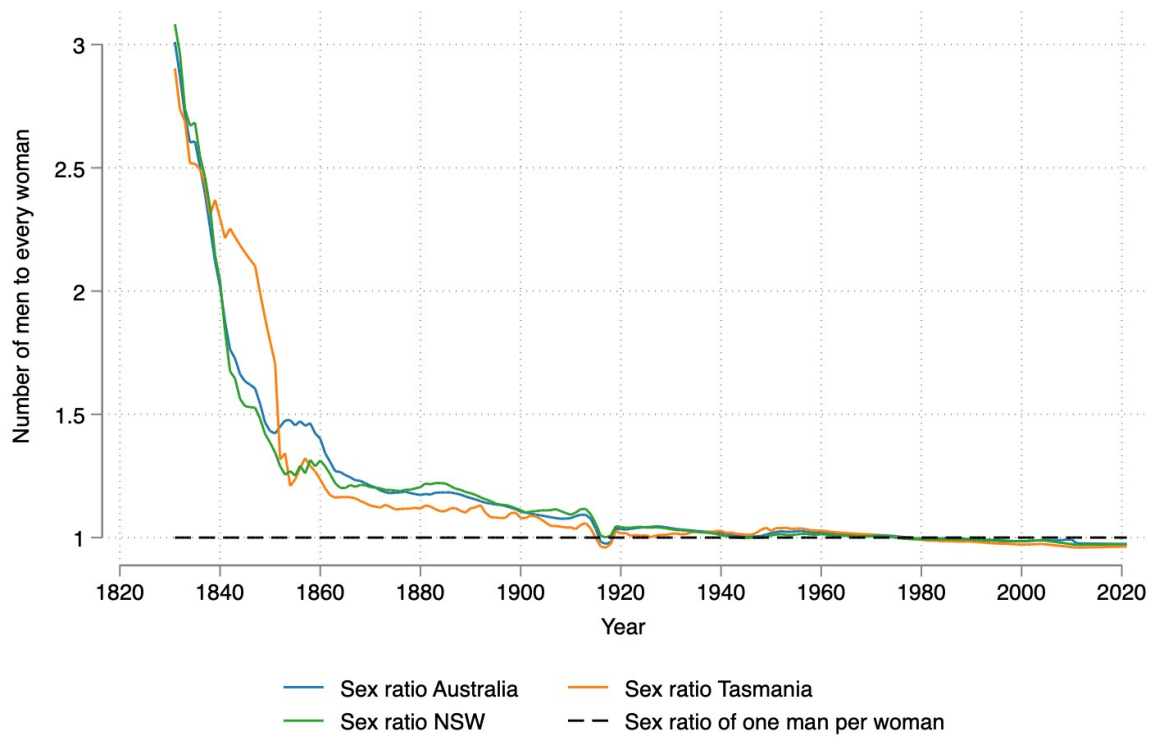
Figure 6: Convict sex ratios in mid-19th century New South Wales and Van Diemen's Land



Notes: The maps show the parts of New South Wales (including the Australian Capital Territory) and Van Diemen's Land (Tasmania) that had convict settlement. Boundaries depicted are for the 2016 Statistical Areas Level 1 (SA1), the smallest unit for the release of census data.

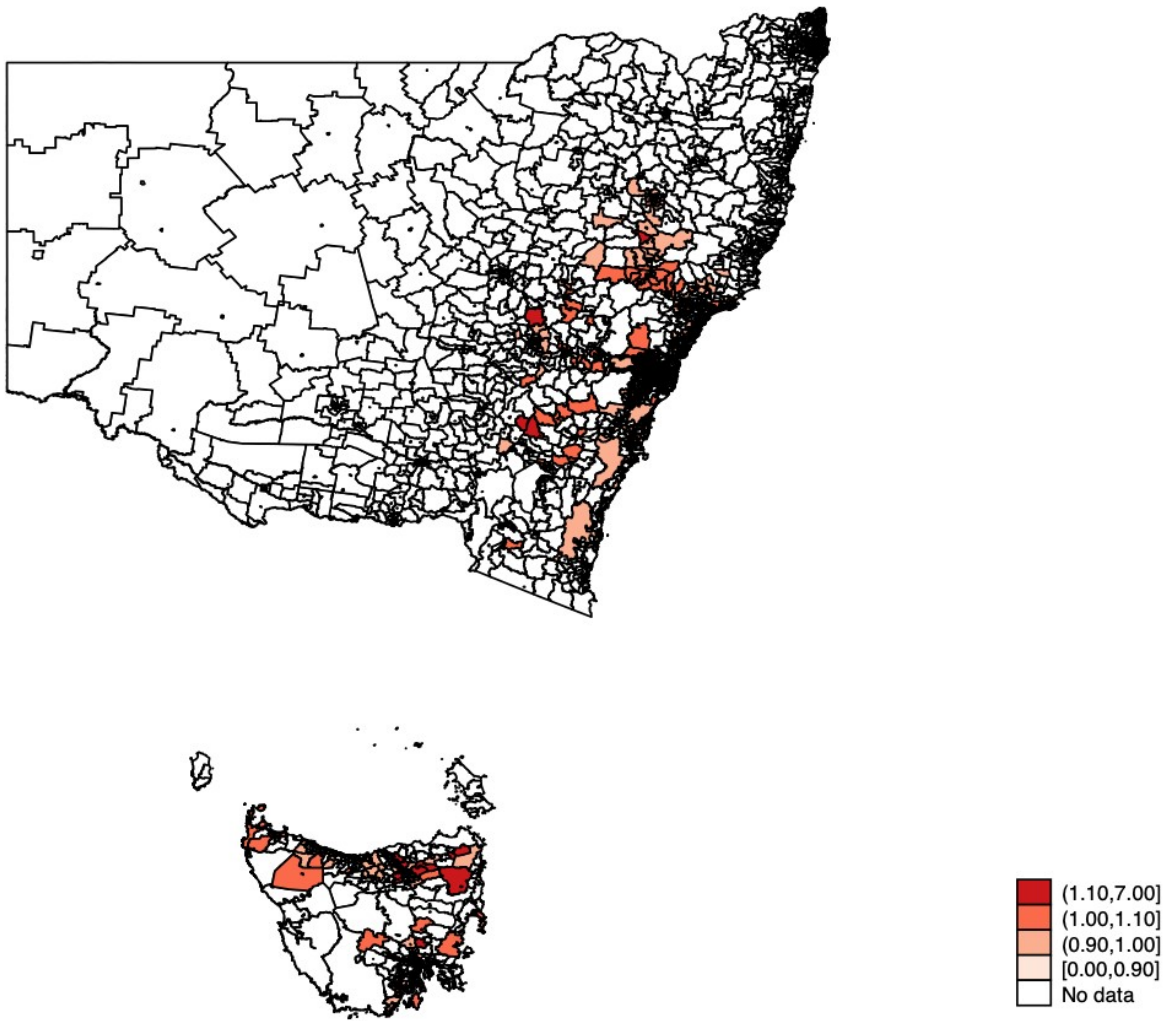
Source: Australian Historical Censuses and Volume 1 of the Australian Statistical Geography Standard.

Figure 7: Sex ratio in Australia: number of men to every woman, 1830–2021



Source: Australian Bureau of Statistics.

Figure 8: Sex ratios in New South Wales and Tasmania based on 2021 Census



Source: Australian Bureau of Statistics.

Appendix A: Step-by-step description of the decisions involved in the data preparation

Step 1: Timeframe for the present-day data on propensity for entrepreneurship and correlates.

The study employs 22 annual waves from Restricted Release 22 of HILDA, containing household-level data for participants over the period 2001 to 2022. Release 22 was the most recent release of HILDA at the time that the study was conducted.

Step 2: Selection of participants in the study

HILDA is a representative longitudinal survey of both Australian males and females. In our main analysis, we restrict participants to the male subsample from HILDA because the theory purports to predict propensity for entrepreneurship among males. In a falsification or placebo test, we use the female subsample to show that, consistent with the theory, that the historical sex ratio does not predict propensity for entrepreneurship among females.

Figure A1 shows the number of male participants in each wave of HILDA. The spike between wave 10 and 11 reflects that a top-up (or refreshment) sample was added in 2011. In our main analysis, we treat the 22 waves of HILDA as an unbalanced panel and rely on the non-missing sample of 27,424 observations (4,025 unique individuals) over the period 2001-2022

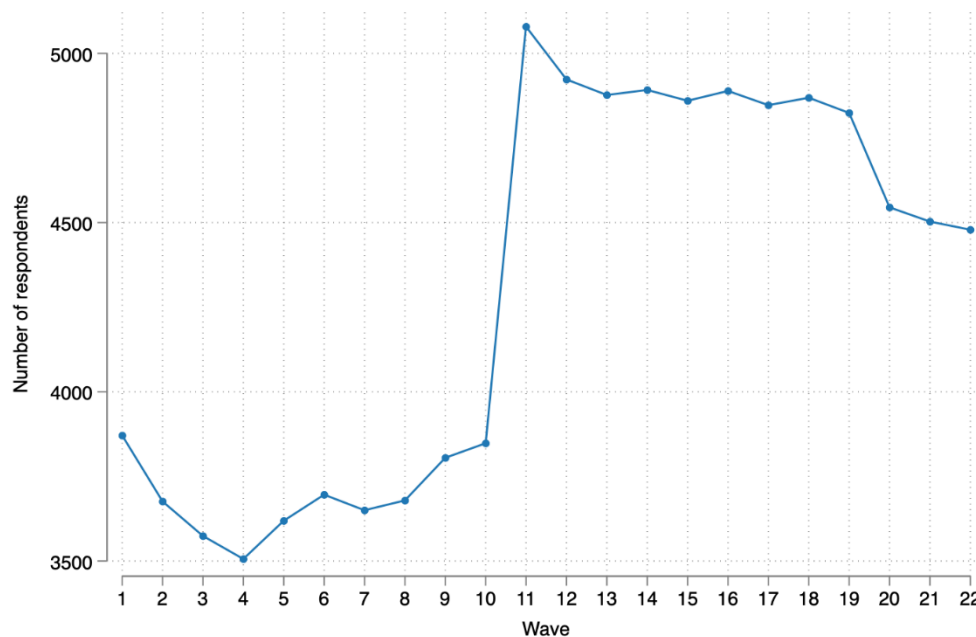


Figure A1: Number of male participants in each wave of HILDA

Step 3: Geographical coverage of the study

HILDA is a representative longitudinal survey of each of the six Australian states (Victoria, New South Wales, Queensland, South Australia, Western Australia, Tasmania) and two territories (Australian Capital Territory and Northern Territory). Our study is restricted to participants in HILDA living in New South Wales, the Australian Capital Territory and Tasmania. The reason for restricting participants to these three states/territory is that we need to match present-day data on propensity for entrepreneurship and its correlates with historical data on the convict sex ratio and New South Wales and Van Diemen's Land (later renamed Tasmania) were the two states with convict settlement. We include participants living in the Australian Capital Territory because historically – prior to 1911 – the Australian Capital Territory was part of New South Wales and was included in the 1836 census.

Step 4: Selection of the measure of the historical sex ratio

There are two ways in which we could measure the historical sex ratio: the convict sex ratio and the historical population sex ratio. The convict sex ratio is the ratio of male to female convicts. The historical population sex ratio is the ratio of males to females for the total colonial population, consisting of emancipists, colonial administrators, free settlers and Caucasians born in the colonies, in addition to convicts (Baranov et al., 2023)

In alternative specifications we use both measures. We use the historical population sex ratio in the structural form estimation, with the convict sex ratio as the instrumental variable for the historical population sex ratio in the 2SLS estimates. We use the convict sex ratio in the reduced form estimation. As we explain in the text, we prefer the estimates using the convict sex ratio because the theory predicts that males of marriageable age will be motivated by the high sex ratio to engage in entrepreneurship. We do not have data on the historical population sex ratio by age, so it is not possible to calculate the sex ratio for adults of reproductive age. This makes the historical population sex ratio an imprecise measure of the main variable of interest. The advantage of focusing on the convict sex ratio as the main variable of interest is that most convicts were of marriageable age, so the convict sex ratio was a more precise measure of the sex ratio among adults of reproductive age (see Baranov et al., 2023).

We use data on spatial patterns in the historical sex ratio from the earliest reliable census in New South Wales (incorporating the Australian Capital Territory) and Van Diemen's Land. For New South Wales, this was 1836. There was an earlier Census in New South Wales administered in 1833, but administrative boundaries were not formally mapped out until 1834. The first ever Census in Van Diemen's Land was in 1842. The unit of observation in these two censuses is the county. There were 19 counties in New South Wales in 1836 and 15 counties in Van Diemen's Land in 1842. We use data on the convict sex ratio and historical population sex ratio in each of these 34 counties from these two censuses. The data was originally collected by Grosjean and Khattar (2019) and Baranov et al (2023) and we use their data.

Step 5: Matching data on historical sex ratios from the 34 historical counties with present-day data on propensity for entrepreneurship and its correlates from HILDA.

Restricted Release 22 of HILDA contains data on the postcode in which each participant lives. There are 515 postcodes across New South Wales, the Australian Capital Territory and Tasmania. Using the shapefiles provided by Grosjean and Khattar (2019), we map data on the distribution of the historical sex ratio (for both the convict sex ratio and the historical population sex ratio) for each of the 34 historical counties to the 515 present-day postcodes.

Step 6: Selection of covariates

To minimize omitted variables bias as much as possible, we control for four types of covariates.

- (a) Individual level variables from HILDA.
- (b) Time-varying present-day postcode covariates (sex ratio and the urbanization rate).
- (c) Geographic characteristics (centroid, land formation, minerals) at the postcode level.
- (d) Historical demographic and economic characteristics: historical total population, historical convict population and the historical share of the population employed in the main employment sectors (agriculture, mining, manufacturing, domestic services and professional occupations).

The following table summarizes the unit of reporting, the observations in the original unit and the source for each of these four categories of covariates.

Covariate	Unit of Reporting	Observations in original unit	Source
(a) Individual level correlates	Participant	27,424	Release 22 of HILDA
(b) Present day population sex ratio and the urbanization rate in the neighbourhood in which the participant lives.	Postcode	515	2001, 2006, 2011, 2016, 2021 Commonwealth of Australia Census
(c) Geographic characteristics (centroid, land formation, minerals) in the neighbourhood in which the participant lives.	Postcode	515	Baranov et al. (2023). Original data sources are described in Online Appendix A of Baranov et al. (2023).
(d) Historical demographic and economic characteristics	Historical county (mapped to present-day postcode)	34	Grosjean and Khattar (2019). Historical data are originally from either the 1836 (New South Wales) or 1842 (Van Diemen's Land) Census as described in Section 3 of the online appendix to Grosjean and Khattar (2019).

HILDA contains a rich set of information on the characteristics of participants. The choice of individual-level characteristics, thus, denotes a standard set of covariates that previous studies have found to be correlated with propensity for entrepreneurship. The specific set of covariates selected for (b) to (d) was a function partly of data availability at the historical county/postcode level in the historical and modern censuses and the variables which previous studies, such as

Baranov et al (2023) and Grosjean and Khattar (2019), have highlighted as being important to control for in examining the effect of historical sex ratios on modern-day outcomes.

Step 7: Treatment of missing values

A small number of participants in the original sample contains missing values for one or more of the covariates (26 observations). In the main analysis we exclude these participants. In a robustness test, reported in Column (10) of Table C1, we use the multiple imputation technique for the missing values to check the sensitivity of our results (Rubin, 1996).

Step 8: Measuring persistence mechanisms

To examine the vertical transmission of cultural gender norms we use a standard lineage-based approach. The specific choice to use whether the parents of the participant were born in Australia as a moderator is based on what data is available in HILDA and how the vertical transmission of cultural gender norms has been measured in previous studies using HILDA. (Awaworyi Churchill et al, 2024; Baranov et al, 2023; Grosjean & Khattar, 2019).

As our main measure of demographic cultural heterogeneity we use ethnic diversity in the postcode depicted by the Herfindahl fractionalization index. The Herfindahl fractionalization index is a standard way to measure ethnic diversity. As an alternative, we use whether the participant in HILDA moved to that postcode from either elsewhere in Australia or overseas. This measure takes advantage of the availability of this information in HILDA. To measure the extent to which demographic cultural heterogeneity attenuates the vertical transmission of cultural gender norms, we interact each variable with the historical sex ratio. The decision to follow this approach follows the existing literature (see e.g., Baranov et al, 2023).

The following table summarizes the unit of reporting, the observations in the original unit and the source for the persistence mechanisms

Moderator	Unit of Reporting	Observations in original unit	Source
Parent born in Australia	Participant	27,424	Release 22 of HILDA
Herfindahl fractionalization index	Postcode	515	2001, 2006, 2011, 2016, 2021 Commonwealth of Australia Census
Migrant moved postcodes	Participant	27,424	Release 22 of HILDA

Step 9: Measuring mediators

The way in which we measure each mediator, as described in the text, is based on data availability/ how they are measured in HILDA. In each case, the exact way we measure the mediator is based on existing literature and/or standard constructs.

Appendix B

Table B1: Historical sex ratios and self-employment – Results with controls

	Self-employment		
	OLS (1)	2SLS (2)	Reduced form (3)
Historical sex ratio	0.007** (0.003)	0.035** (0.017)	0.026** (0.012)
Marital status (Ref: single)			
Cohabiting	0.017*** (0.006)	0.018 (0.015)	0.018 (0.015)
Married	0.011* (0.007)	0.012 (0.014)	0.012 (0.014)
Education (Ref: Year 11 and below)			
Year 12	0.003 (0.008)	0.003 (0.019)	0.002 (0.019)
Diploma / Certificate	0.022*** (0.006)	0.023 (0.019)	0.022 (0.019)
Degree	-0.022*** (0.007)	-0.023 (0.020)	-0.023 (0.020)
Age	0.006*** (0.000)	0.006*** (0.001)	0.006*** (0.001)
Country of origin (Ref: Australia)			
Other English-speaking country	0.013 (0.008)	0.012 (0.025)	0.012 (0.025)
Other non-English-speaking country	0.022*** (0.006)	0.024 (0.020)	0.022 (0.020)
Geographic controls	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes
State and Year FEs	Yes	Yes	Yes
Observations	27,424	27,424	27,424

Notes: Standard errors clustered at the individual level. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). *** p<0.01, ** p<0.05, * p<0.1.

Appendix C

In this section, we examine the robustness of our preferred reduced form estimates, reported in Column 4 of Table 3 to alternative methods and specifications. First, we examine the robustness of our results to clustering standard errors at the historical county level as opposed to the individual level. To do so, following Grosjean and Khattar (2019) we use bias-corrected standard errors by inflating the standard errors to adjust for the relatively small number of county clusters. The results, reported in Column (1) of Table C1 are robust.

Second, we examine the robustness of our results to non-linear effects of the convict sex ratio by taking the logarithmic transformation. The results, which are reported in Column (2) of Table C1, are consistent with the main reduced form results reported in Table 2.

Third, we examine the robustness of our results to the exclusion of potential outliers. In alternating models, we exclude historical counties with less than 100 women and either less than 300 people or more than 40,000 people. The results, which are reported in Columns (3) and (4) of Table C1, are consistent with the main reduced form results reported in Table 2.

Fourth, we examine the robustness of our results to propensity score matching. We follow Grosjean and Khattar (2019) and predict historical sex ratios as a function of historical employment shares in different sectors, geographic characteristics and the interaction between historical and geographic characteristics, and then condition on the predicted propensity score. The results, which are in Column (5) of Table C1, continue to remain robust.

In Column (6) of Table C1, we perform a placebo test in which we randomise the convict sex ratio across areas. The coefficient on the convict sex ratio is insignificant as expected.

Baranov et al (2023) find that an imbalance in the convict sex ratio give rise to masculinity norms that lead to more violence and higher present-day crime rates, which could have an adverse effect propensity for entrepreneurship. We control for neighbourhood crime using postcode level crime data from Awaworyi Churchill et al. (2023a). Note, that we do not have data on crime rates at the postcode level for Tasmania, so the sample size is smaller. The results, reported in Column (7) of Table C1, show that our main findings are robust.

It is possible that the oversupply of men itself in the 1830s and 1840s could have pushed some men, who failed to secure a paid job due to the severe competition in the labour market, to start their own business. This has nothing to do with the imbalanced sex ratio. In response to this concern, in Column (8) of Table C1, we directly control for the number of men in each county in the 1836 and 1842 census in addition to the convict sex ratio. The results are robust.

The main analysis does not exclude outliers. In Column (9) of Table C1, we examine the sensitivity of our results to removing extreme outliers. The convict sex ratio in our sample ranges from 1.270 to 219 with about 1 per cent of the sample having values larger than 100. Excluding these extreme values, the results remain consistent.

In the main analysis, we exclude a small number of participants with missing values for covariates. In the final column of Table C1 we use the multiple imputation technique for the missing values (Rubin, 1996) and find that the results remain unchanged.

Table C1: Robustness checks on reduced form results in Table 3

	Clustering at the county level	Non- linear effects	No county with <100 women, historically	No county with <300 or >40,000 people, historically	Propensity score matching	Random historical sex ratio	Controlling for the crime rate	Controlling for historical male population	Removing extreme sex ratio	Imputed for missing controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Convict sex ratio	0.026*** (0.009)	0.038** (0.018)	0.031** (0.012)	0.026*** (0.009)	0.026*** (0.005)	-0.012 (0.062)	0.026** (0.013)	0.027** (0.013)	0.016** (0.006)	0.026** (0.012)
Individual control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State and Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,424	27,424	27,084	27,424	26,613	27,424	24,683	27,424	27,226	27,450

Notes: Standard errors clustered at the individual level. Individual controls are age, educational levels, marital status, and country of origin. Geographic controls are at the postcode level and include the postcodes centroid and the minerals and land type of the postcode. Historic controls are the historical county population, convict population, as well as the presence and type of mineral deposit (major coal; major gold; other) and land formation (plains and plateaus, mountains, other). *** p<0.01, ** p<0.05, * p<0.1