Childless Aristocrats. Fertility, Inheritance, and Persistent Inequality in Britain (1650–1882)*

Paula Gobbi† Marc Goñi‡

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Abstract

This paper studies the interaction between inheritance schemes, fertility, and inequality over the very long run. While a high fertility in the elite is typically associated with lower wealth concentration, we show that this is not necessarily true for the extensive margin of fertility. We study the case of Britain, where inheritance was governed by marriage settlements, a *de facto* entailment of the land that had to be renewed every generation. Using genealogical evidence for 20,000 peers and peers' offspring between 1650 and 1882, we show that families signing a settlement were 12.5 percentage points more likely to have children, thus ensuring dynasty continuation. To establish causality we use variation within lineage and estimate an instrumental variables model exploiting the birth order of the heir. We then propose a model to highlight the mechanisms behind this reduced form effect. The model provides three sets of results: first, we rationalize the existence and the persistence of inheritance schemes that tie the hands of future generations with inter-generational hyperbolic discounting. Second, we argue that settlements can affect fertility choices on the extensive margin due to inter-generational preferences: a household who is subject to a settlement—and thus cannot break the family estate—is more likely to produce an heir in order to enjoy the utility of passing him a large inheritance. Third, the model rationalizes a positive relation between the extensive margin of fertility and inequality: settlements contributed to inequality not only by entailing the land, but also by ensuring the survival of dynasties at the top of the distribution. We argue that this is important to understand the pattern of persistent inequality in landownership in England since the Norman conquest.

Keywords: Childlessness, Inheritance, Inequality, Settlement, Inter-generational discounting.
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†National Fund for Scientific Research (Belgium) and IRES, Université catholique de Louvain and CEPR
‡Department of Economics, University of Vienna

The rich get richer and the poor get - children!—F. Scott Fitzgerald, *The Great Gatsby*

1 Introduction

Inequality is highly persistent. Clark et al. (2014) argues that "movement on the social ladder has changed little over the last 8 centuries." Neither the Protestant Reformation, the Industrial Revolution, nor the rise of the welfare state in the twentieth century seem to have had much effect on social mobility, particularly at the top of the wealth distribution—the richest families have always been the same.[1] Why is inequality so persistent? One important factor is inheritance. For example, the increase in top inequality in the second half of the twentieth century (Piketty and Saez 2006) is associated with an increase in the percentage of national income accounted by bequests (Piketty 2011).

However, inheritance *per se* cannot explain everything. One important factor mediating the effect of inheritance on inequality is demographics. Typically, economist have argued that a fertility and inequality are negatively associated (Deaton and Paxson 1997; Kremer and Chen 2002; de la Croix and Doepke 2003). With low fertility, bequests are divided among less children and thus family wealth remains concentrated in a few hands. But other effects might be at place. A high fertility ensured the continuity of a family lineage, and therefore that wealth could remain in one family. The relation between fertility and inequality, hence, might be different in the intensive margin— the decision of how many children to have—and extensive margin— the decision whether to have children or not. A second limitation in the way economists deal with inheritance is related to inter-generational discounting: the classic overlapping generations model of bequests assumes exponential discounting across generations (Barro 1974). That is, it assumes that preferences are time consistent across generations. This is hard to reconcile with many inheritance schemes that tie the hands of proprietors, such as trusts, fee tails (United States), entails

[1]The persistence of inequality is particularly striking when it comes to landownership. After the Norman conquest of England in 1066, one-third of the land was given to Norman noblemen (Domesday book). Around 1880, fewer than 5,000 landowners—many of them, descendants of these Norman noblemen—owned more than 50 percent of all land (Cannadine 1990). Nowadays, less than 1 percent of the population still owns 70 percent of the land (Cahill 2002).

(Scotland), *majorat* (France), *mayorazgo* (Spain), or *ordynacja* (Poland).

In this paper, we analyze a unique historical setting and show that the relation between top-inequality and the extensive margin of fertility can be positive, especially in the presence of inheritance schemes that tie the hands of proprietors. In nineteenth century Britain, around 50 families "held the lion's share of land, wealth, and political power in the world's greatest empire" (Cannadine 1990). These were the British peerage. Their position at the top of the distribution, however, was not always guaranteed. Around 1600, between 30 and 40 percent of all married women in the peerage were childless. This was of course a threat for the continuity of noble family lineages and therefore the maintenance of land and wealth within these families. We show that the introduction of settlements—a *de facto* entailment of the land that restricted the heir's freedom to sell parts of the family estate—crucially moved the peerage to a higher fertility regime. By 1850, childlessness rates among peers' daughters decreased to 10 percent, the level for the general population (de la Croix, Schneider, and Weisdorf 2017). Settlements, thus, contributed to the persistence of inequality not only by entailing the land, but also by ensuring the survival of dynasties at the top of the distribution.

To estimate the effect of settlements on childlessness, we exploit the demographic aspect of settlements. Most settlements were signed upon the marriage of the eldest son, whom limited his interest in the estate to that of a life-tenant, ensuring that the family estate would descend unbroken to the heir born of this marriage (Habakkuk 1950). For the marriage settlement to operate as a *de facto* entailment, the settlement had to be renewed by each generation at the time of the marriage of the heir. Thus, it was crucial for the father to survive to the marriage of his eldest son (Bonfield 1979). Linking demographic information across generations for about 1,500 peers and their offspring from 1650 to 1882, we find that heirs marrying before their fathers' dead—that is, heirs subject to a settlement—where 15 percentage points less likely to be childless. To establish causality, we exploit exogenous variation in the probability of a heir marrying after the father's death coming from the birth order of the heir. All the effects are identified based on variation among members of the same family, capturing the genetic similarities of these related individuals, as well as their cultural and socio-economic proximity. Furthermore, the results are robust to the inclusion of controls over spouses' age at marriage, socio-economic status, and socio-economic

and demographic conditions during their lifetime, as partly captured by birth year and marriage decade fixed effects.

The second main contribution of this paper is to show that imperfect altruism[2] across generations can (1) rationalize the widespread use of settlements in the nobility and (2) explain its effects on fertility. We develop a simple model of household decisions where three generations of the same dynasty decide sequentially over consumption and fertility. These decisions affect future generations as they reduce the amount of family wealth that is passed down in the form of bequests. We depart from the classic bequests models by assuming that individuals have quasi-hyperbolic discount function towards future generations and that altruism is higher towards direct descendants than towards distant relatives. The first assumption implies that individuals are present-biased as they value their current consumption over that of the next generations. At the same time, they do not value their children's well-being significantly more than that of the future generations, namely their grandsons. As preferences are not consistent across generations, fathers have an incentive to restrict their son's freedom to manage the family estate with a settlement. In other words, hyperbolic discounting across generations—as opposed to the exponential discounts typically assumed—rationalizes the existence of settlements and, more generally, of inheritance rules that tie the hands of proprietors. To our knowledge, we are the first to explain inheritance schemes with hyperbolic discounting preferences.

Furthermore, our model suggests that inter-generational altruism can explain why settlements reduced the rate of childlessness. The idea is that a household head who, being subject to a settlement, cannot sell parts of the family estate, may decide to have children, as he prefers the large inheritance to go to their offspring rather than to a distant relative. Formally, we model settlements as a commitment device that allows the father to decide all bequests of future generations. In this model, the father can influence the fertility decisions of his son by settling a larger endowment for the third generation, namely the grandson. As a result, the family dynasty is less likely to die out than in a benchmark model where every generation decides the

[2] Phelps and Pollak (1968) define perfect altruism as the situation when "each generation's preference for their own consumption relative to the next generation's consumption is no different from their preference for any future generation's consumption relative to the succeeding generation" (p. 185). Here we will use imperfect altruism to refer to time discounts that are not consistent across generations; i.e., when, say, the father values the well-being of his grandson relatively more than what his son will do.

bequests of the next generation (i.e., a model without settlements). This effect is stronger the more hyperbolic the discount function is, suggesting that this particular time-preference may explain the reduced-form effect of settlements on fertility that we document in the empirical analysis.

This paper relates to several strands of the literature. First, we challenge the common wisdom that fertility and inequality are negatively associated. Deaton and Paxson (1997) conclude that lower rates of population growth can contribute to wealth concentration by increasing within cohort inequality in settings as diverse as in the USA, Britain, Taiwan, or Thailand. Similarly, Kremer and Chen (2002) and de la Croix and Doepke (2003) find that inequality is associated with fertility differentials between the rich and the poor. We show that on the extensive margin—i.e., on the decision whether to have children or not—the relationship between fertility and inequality can be the opposite. High fertility ensures the continuation of a family lineage and, hence, that wealth remains concentrated in their hands. This is particularly relevant for the top of the wealth distribution. The literature on demographic economics has already shown that childlessness—the opposite of the extensive margin of fertility—can respond differently to economic changes than the intensive margin of fertility. Aaronson, Lange, and Mazumder (2014) show that the Rosenwald Rural Schools Initiative decreased the intensive margin of fertility (number of children) but increased motherhood rates. Similarly, Baudin, de la Croix, and Gobbi (2015) show that motherhood rates and completed fertility can show a negative relationship for low-educated women. Brée and de la Croix (2016) show that an increase in materialism, women's empowerment, and the returns to education can explain the increase in childlessness in Rouen between 1640 and 1792. Finally, de la Croix, Schneider, and Weisdorf (2017) show that, once the extensive margin of fertility is accounted for, the middle-classes had higher reproductive success than the upper-classes in early-modern England.

Second, our paper also contributes to the study of time preferences. In particular, hyperbolic discounting has been used widely to explain savings decisions (Laibson, Repetto, and Tobacman 1998; Diamond and Kőszegi 2003), addictive behavior (Gruber and Kőszegi 2001), or fertility (Wrede 2011; Wigniolle 2013) *of individuals*. Our contribution is to apply the idea of hyperbolic discounting *across generations*, in line with the seminal paper by Phelps and Pollak (1968). We argue that, in opposition to exponential discounting, hyperbolic discounting across generations is consistent with

many inheritance schemes that “tied the hands” of proprietors. Furthermore, we show that models of bequests assuming exponential discounting are not only inconsistent with such inheritance rules, but also that this type of discounting may ignore important effects of inheritance on the extensive margin of fertility.

Our results also shed new light on the dynamics of inequality over the very long run. Using historical tax records, Piketty and Saez (2006) find that income inequality has increased dramatically over the last decades. This trend is especially significant for English-speaking countries like the United States or the United Kingdom. Miles (1993), Mitch (1993), and Long and Ferrie (2013) suggest that this is not a new phenomena. Already by the nineteenth century rates of occupational mobility were low in Britain. Similarly, Clark and Cummins (2015) analyze a sample of people with rare surnames, showing that social mobility has changed little since the middle ages, despite changes such as the Industrial revolution, the extension of the franchise, or the provision of public education. We argue that the interaction between inheritance schemes and fertility behavior settled the conditions for the persistence of wealth inequality over the long-run. Settlements contributed to the persistence of inequality not only by entailing the land, but also by ensuring the survival of dynasties at the top of the distribution.

Finally, this paper is important because it adds to our understanding of elites. When sufficiently powerful, elites may support policies that are pernicious to economic growth (Acemoglu 2008). A crucial factor explaining the persistence of elites is the intergenerational transmission of wealth. Bertocchi (2006) shows that primogeniture reinforced the concentration of landownership, consolidating aristocratic political systems. We add to this literature by showing how the interaction between inheritance schemes and demographic helped to consolidate the wealth and power of the British peerage. This paper is not the first to study the persistence of British peerage. Allen (2009) suggests that the aristocratic lifestyle was, in fact, a commitment device to ensure control over public offices. Goni (2016) emphasizes the role of marriage and the meeting technology embedded in the London Season. Marcassa, Pouyet, and Trégouët (2017) show that stringent dowry rules matter to explain the degree of assortativeness among the English and German nobilities. Two sets of studies are most related to our work. On the one hand, Habakkuk (1950), Bonfield (1979), and English and Saville (1983) describe marriage settlements and discuss whether they contributed or

not towards landownership concentration. On the other hand, Hollingsworth (1964) provided detailed descriptive statistics on the demography of the British peerage.

The article proceeds as follows. Section 2 portrays marriage settlements in the British nobility and describes the data. Section 3 describes historical trends in childlessness and presents reduced form estimates on the effect of settlements. In Section 4, we develop a model for the reproduction choices of British peers that highlights the mechanisms behind the reduced-form effect of settlements on childlessness, and that rationalizes the existence of settlements. Finally, Section 5 concludes.

2 Institutional Setting and Data

2.1 Settlements

How did settlements came into being? Before 1650, settlements were exclusively used to settle a provision for the wife in case she became a widow. In detail, one could not use settlements to entail the land because they were easy to break. A landowner who had settled his land, for example, could easily sell parts of the family estate because nobody was there to defend the interest of his under-aged or even unborn son, who was the beneficiary, that is, the one supposed to receive the estate untouched (Habakkuk 1994: p. 7).

This changed during the interregnum period with the introduction of the figure of the *trustee*, who was precisely in charge of defending the interest of this under-aged or unborn son. Why were *trustees*, and more generally, settlements developed during the Interregnum period? After the Civil War, both Royalist and Parlamentarist landowners were afraid of expropriation in case events turned the tide in favor of the opposing side. Settlements ensured their family estates would not be lost. Note that when a landowner signed a settlement, the beneficiary of his estate was no longer him but his heir, most likely an under-aged kid or even an unborn son who had obviously not taken sides in the war, and thus who could not be expropriated (Habakkuk 1994: p. 12).

Although the threat of expropriation eventually disappeared after 1650, settlements

became widely used by the aristocracy both to entail the land and to fix a provision for the widow and for the younger children of the couple. Quoting Habakkuk (1950),

> “[...] about one-half of the land of England was held under strict settlement in the mid-eighteenth century”.

(Bonfield 1983) finds that most settlements during the period 1660-1740 were of the form of the strict settlement (Table 1).

The standard settlement worked in the following way: Settlements were typically signed upon the marriage of the eldest son. With the settlement, he limited his interest in the estate to that of a life-tenant, ensuring that the family estate would descend unbroken to the heir born of this marriage (Habakkuk 1950). In order to convince his son to make such a sacrifice, the father usually transferred him an income to support his household until he inherited the estate. Although settlements were only valid for a generation, *de facto* they operated as a permanent entailment of the land, as settlement were renewed by each generation. For the marriage settlement to operate in this fashion, however, it was crucial for the father to survive to the marriage of his eldest son (Bonfield 1979). In the empirical analysis we will exploit this demographic aspect of settlements to identify its effects on fertility.

In the negotiation of settlements, the wife’s family also had an interest, particularly regarding the allowances settled for her in case she became a wife, and for the younger children of the couple. This tension is illustrated by the following example:

> In 1673 Sir Henry Finch [gentry], negotiating for a bride for his eldest son, was pressed by her guardian to execute such a settlement as shall leave the young man but a tenant for life”. He resisted, and pointed out that ”most settlements in England which make the young man tenant for life, proceed rather from his father than from the wife’s friends (Habakkuk 1994: p. 14).

Allowances toke the form of charges on the estate (Habakkuk 1994: p. 17). This practice gained weight overtime, and by the end of the eighteenth century it had become common (Habakkuk 1994: p. 16). Although we recognize the importance of allowances in the negotiation of settlements, we abstract from this motivation and

focus on settlements as a legal instrument to entail the land and ensure the continuity and the integrity of family estates.

Importantly, settlements were prevalent in England, but not in Scotland. There, land could be entailed *ad perpetuum*. What frustrated the attempts to introduce a similar form of permanent entailment in England is not clear. Habakkuk (1994: p. 18) suggests that the reasons may be purely legal and not related to any specific demographic aspect of these countries. In detail, he suggests that the strong bias of English Common Law judges for the free alienability of land prevented the establishment of such permanent entails in England. In the empirical analysis, we will exploit this divergence between England and Scotland as a robustness check: Since the wives of Scottish peers were not subject to settlemets, we should not observe any effect of our proxy—that is, marrying after inheritance—on fertility.

Settlements came to an end with the Settled Land Act in 1882. In the midst of a great debate in Britain about landownership concentration (Bateman 1883), Parliament established that settlements could not prevent the life tenant to sell parts of the land. To be able to sell the land, the life-tenant was required to obtain the best possible price from the sell, and to settle the profits from the sell —that is, the money had to pass down untouched to the next generation.

2.2 Data

Our demographic data on the British peerage is from Hollingsworth (1964). In this subsection, we describe the original sources used by Hollingsworth to collect this information, as well as the process of matching parents to offspring that we undertook for this project.

Demographic data on the British peerage

The Hollingsworth (1964) genealogical database on the British peerage is constructed with information from various Peerage records, the family histories of the aristocracy of Britain and Ireland.[3] For the sake of illustration, Figure 1 shows the entry for

[3]The principal sources used by Hollingsworth where Cokayne's *Complete Peerage* (1913), Collins' *Peerage of England* (all editions from 1710 to 1812), Lodge's *Peerage of Ireland* (1754 and 1789), Douglas' *Scots Peerage* (1904-14), Burke's, Lodge's and Debrett's *Peerages* (different editions be-

Charles Lyttelton, 8th Viscount Cobham from Cokayne's *Complete Peerage*. The entry contains abundant genealogical material. In detail, the entry states that he was born in 1842 and married at age 35 to Mary Susan Caroline Cavendish, who was 11 years younger. They had seven children together. Charles George Lyttelton died aged 79 and was succeeded to the barony by his eldest son, John.

Hollingsworth collected all of this genealogical material for all peers who died between 1603 and 1938 (primary universe) and their offspring (secondary universe). The Hollingsworth (2001) database is the end product of digitizing the original 30,000 handwritten original index sheets by the Cambridge Group for the History of Population and Social Structure. In its current form, the data comprise approximately 26,000 individuals.

Each entry provides the date of birth, marriage, and death of each individual, as well as a variable indicating its accuracy. It also provides information on social status, title, whether he/she was heir-apparent at age 15, and the status of the highest-ranked parent.[4] If the individual married, we also know the spouses' date of birth, date of death, and social status. The entry also lists the name and the date of birth of the children born to this marriage. For individuals that married more than once, or individuals that had illegitimate children, we also know how many children they had in total. Figure 2 illustrates how a digitized entry looks like.

Matching parents to children

Unfortunately, the entries from the Hollingsworth (2001) dataset are not linked across generations. To resolve this issue, we manually matched each entry database to their father's entry. For individuals whose father could not be found in the database we tried to match them with their mothers.

In detail, we first match non-heirs (i.e., peers' daughters and younger sons) to their parents. To do so, we exploit a particularity of the Hollingsworth (2001) database. An entry corresponding to an heir is typically identified with a reference number

tween 1825 and 1961), and Burke's *Extinct Peerage* (1866 and 1883). See Hollingsworth (1964), appendix I for details on the method of compilation of the data.

[4]Social status is presented in five categories: (1) duke, earl, or marquis, (2) baron or viscount, (3) baronet, (4) knight, and (5) commoner. The entries state whether a title is an English, Scottish, or Irish peerage.

which is a multiple of 20 or 50. The reference number of the entries corresponding to her daughters and younger sons (if any) are typically consecutive numbers of the father's reference number. Thus, we match a entry C (children) to entry P (parent) if entry P is identified with a reference number that is a multiple of 10 and entry C is identified with a consecutive reference number.

The matching of heirs is less trivial. In the first iteration, we match entries C and P if entry P corresponds to a male, and the surname, name, date of birth, and accuracy in entry C coincides with the surname of the individual and the name, date of birth, and accuracy of any of the children listed in entry P. We then restrict the sample to unmatched individuals, and repeat the procedure considering female P entries only. For the remaining unmatched individuals, we consider a similar matching procedure based on birth date and accuracy (iteration 2), first name and birth date (iteration 3), and unique birth dates—that is, restricting the sample to individuals born on a date where no other peer or peer's offspring was born—(iteration 4). At each iteration, we check double matches mannually using information from `thepeerage.com`, an online genealogical survey of the peerage of Britain.

The validity of the matching is essential to the credibility of this exercise. For this reason, we perform several manual checks. First, we use `thepeerage.com` to check manually if individuals matched to their mother do not have siblings who were matched to their father. Second, we calculate the distance between father's and children's surnames for individuals matched in iterations 2 to 4. To do so, we use the Levenshtein distance algorithm, which measures the minimum number of single-character edits required to change one surname into the other. We then use `thepeerage.com` to check manually the matches with a Levenshtein distance above 1.

Using this procedure, we match 98.25 percent of the 26,499 entries in the dataset to their parents. Only 2.22 percent of them are matches to the mother.

Table 2 presents descriptive statistics for the universe of peers and peers' offspring in the Hollingsworth dataset. On average, 26.3 percent of married peers and peers' sons remained childless. Those who were not had, on average, 4.7 children. Women married earlier than men (23 versus 29 years old) and lived longer (51 versus 47 years). For the sample of matched parents who had children, we can also compute the proportion whose last offspring was a girl. Around 50 percent of their last children was

a girl, indicating that on average parents did not stop having children after they had a son. Regarding socio-economic status, 18% of the individuals in the whole sample are heirs to a peerage, half of them from an English peerage. Finally, 23.6 percent of the individuals in the database married after the heir of the family inherited, that is, married with the estate not being re-settled. In the next section, we will use this proxy for marriage settlements to gauge their impact on childlessness and completed fertility.

3 The effect of settlements on fertility

3.1 Historical trends

Compared to the general population, the British aristocracy had more children but a considerably higher childlessness rate. Figure 3 plots the average fertility of mothers (left panel) and childlessness rates (right panel), for all peers' daughters first-marrying between ages 15 and 35 in 1600–1959. Dots illustrate the corresponding estimates for the general population.[5] The number of children born to aristocratic mothers reflects general trends in fertility. On average, mothers had between 4 and 5 children before the 1800s. The peerage experienced a demographic transition around 1810, eighty years earlier than the general population. This is consistent with previous findings regarding the fertility of the wealthy (Clark and Cummins 2009).

In contrast, marital childlessness rates among the aristocrats were astonishingly high. For example, around 1600 between 30 and 40 percent of all married women in the aristocracy were childless. In the general population, the corresponding rate was only around 10 percent. The rate of childlessness in the peerage was also high in comparison to other European nobilities. Table 3 shows that peers consistently display higher childlessness than the nobility of Hesse-Kassel (Germany) and, before 1700, than *ducs et pairs*—the highest ranked nobles in France.[6] Admittedly, peers had children out

[5] Estimates for the general population are from de la Croix, Schneider, and Weisdorf (2017), Galor (2011), Anderson (1998) and Wrigley and Schoeld (1997).

[6] These comparisons have to be taken with grain of salt. First, because of the limited number of observations in Lévy and Henry (1960) and Pedlow (1982). Second, because Lévy and Henry (1960) considers a sample of women marrying before 20, whose marriage did not break because one spouse died before reaching 45 years of age. We report results from a comparable sample. This sample,

of wedlock. Therefore, our childlessness rates might be an overestimate. However, illegitimate children did not inherit and therefore are not relevant for our analysis.[7]

The high rates of childlessness in the peerage around 1600 were of course a major threat for the continuity of noble family lineages and therefore, a threat to the concentration of wealth within these families. Around 1650, however, we observe a declining trend in childlessness in the aristocracy. By 1850, childlessness rates among peers' daughters decreased to 10 percent, the level for the general population (de la Croix, Schneider, and Weisdorf 2017). This declining trend coincides with the introduction of a particular inheritance scheme: settlements. In the next section we show that settlements crucially moved the British nobility to a higher fertility regime, and hence ensured the continuity of a family lineage and the concentration of wealth in their hands.

3.2 OLS estimates

Here we show that settlements reduced childlessness rates in the British peerage. Ideally, we would like to compare fertility outcomes in families that are subject to a settlement to the outcomes of similar families who have not signed it. Unfortunately, we do not know who signed a settlement and who did not. To resolve this issue, we exploit the demographic aspect of settlements. Most settlements were signed upon the marriage of the eldest son, whom limited his interest in the estate to that of a life-tenant and committed to provide an allowance for his siblings (Habakkuk 1950). In order to convince his son to make such a sacrifice, the father transfered him an income to support his household until he inherited the estate. For settlements to operate in this fashion, thus, it is crucial for the father to survive to the marriage of his eldest son (Bonfield 1979). In contrast, when heirs inherited before their wedding and, thus, were not subject to settlements they could freely dispose of the family estates, sell parts of it, and decide over the next generation's inheritance. We use the fact that a father survived (did not survive) until his heir's wedding as a proxy for the

however, may not be ideal. By considering such early marriages we are probably selecting women who married close relatives, which could also affect childlessness rates (Goñi 2014).

[7] Hollingsworth's dataset still provides some information on the number of illegitimate children. For example, James O'Hara, 2nd Baron Tyrawley and 1st Baron Kilmaine did not have any children with his wife, but had seven illegitimate children—including the famous Irish actress George Anne Bellamy.

presence (abscence) of a settlement. Formally, we estimate the effect of settlements on childlessness as follows:

$$\chi_{i,j,b,q} = \beta \cdot S_{i,j,b,d} + \mu_j + \mu_b + \mu_q + \mathbf{X}'_{i,j,b,q}\gamma + \epsilon_{i,j,b,q} \quad (1)$$

where χ equals one if individual i did not have any children and equals zero otherwise. Our proxy for the presence of a settlement, S, indicates if i's father survived until the wedding of his heir.[8] The coefficient β captures the association between settlements and childlessness. We account for a wide range of confounding factors that may also affect fertility. Following Galor and Klemp (2014), we include family fixed effects, μ_j, and cluster all standard errors by family. That is, we identify the effect of settlements on childlessness using variation in fertility among members of the same lineage. This will capture any genetic, cultural, religious, or socio-economic predisposition towards childlessness among these genetically related individuals. In addition, childlessness rates may be affected by the socio-economic and demographic conditions during one's lifetime. To capture this lifecycle effects, we include birth year fixed effects, μ_b, and dummies indicating the quarter-century in which the marriage took place, μ_q. Finally, the vector $\mathbf{X}$ includes a set of covariates that may also affect the probability of having children: social status of the spouses, wife's age at marriage, spouses' age at death, history of stillbirth in the husband's family, and the number of siblings for which the heir of the family had to provide for.

Table 4 presents the results of estimating Equation (1) for all peer heirs' wives who married between 1650 and 1882 using OLS.[9] There is a strong, significant association between the probability of being childless and settlements. In detail, signing a settlement (i.e., marrying before inheritance) is associated to a decrease in the probability of being childless by 4 to 8 percentage points. Results are robust to the inclusion of covariates that may also affect childlessness, like the social status of spouses, the wife's age at marriage, or the ratio of stillbirths to live births in the husbands family (columns 2 and 3). The precision of the model increases when we include family fixed

[8] Note that if i is the heir himself, then $S = 1$ when he married before his father's death. If i is not the heir of the family, then $S = 1$ when the family heir (i.e., i's eldest brother married before the family head's death (i.e., before i's father's death).

[9] Our preferred specification is a linear probability model. The reason is that it is more flexible in dealing with fixed effects—which in our case are crucial to control for genetic, cultural, or religious unobserved factors affecting fertility at the family level. However, our baseline results are robust to using non-linear econometric models such as probit or logit (results are available upon request).

effects to control for unobserved heterogeneity in terms of genetic preconditions, culture, or social-economic position, as well as when we control for life-cycle conditions by including birth year and marriage decade fixed effects (column 4).

Is the total number of births—that is, the extensive margin of fertility—also associated to settlements? Historical trends suggest that, in contrast to childlessness, the total number of births reflects general trends in fertility. Peers and commoners (who did not use settlements) present a comparable record for the number of births (see Figure 3). We should therefore expect settlements to play a minor role for the extensive margin of fertility beyond the effects over childlessness.

Table 5 confirms this. In detail, the table presents results of poisson regressions[10] of Equation (1)'s form, with the number of births as dependent variable. To fully explain away the effect of settlements on childlessness, we restrict the sample to couples having at least one children. Results suggest that an heir who signed a settlement produced a similar number of children than an heir who did not sign a settlement, conditional on having at least one child. In detail, our proxy for settlements—i.e., marrying before the heir inherits—is not significantly associated with he number of live births. The estimated coefficient is not only insignificant, but also small in magnitude. In a poisson regression, the coefficients may be interpreted as semi-elasticities. A coefficient of 0.036 (column 4) indicates that an heir signing a settlement is expected to give birth to 3.6 percent more children than what he would have if he had not signed a settlement. Given that, conditional on not being childless, the average number of births of an heir's wife is 5.2, this effect is equivalent to having 0.19 more children.

This result is robust to the inclusion of covariates that may also affect fertility, like the social status of spouses, the wife's age at marriage, or the ratio of stillbirths to live births in the husbands family (columns 2 and 3). Including family, birth year, or marriage decade fixed effects also does not alter results (column 4). Finally, the effect is not statistically different for comparable women who were not directly exposed to settlements: non-heirs' wives (column 5) and wives of Scottish peers (column 6), where entails were perpetual, i.e., they did not had to be renewed upon the heir's marriage (Habakkuk 1994: 6).

[10] Poisson regressions are the standard form of regression analysis used to model count data like the number of live births.

Altogether, the evidence indicates a strong correlation between settlements and childlessness, but not with the number of births. In other words, settlements are associated with the extensive margin of fertility, while the effect on the intensive margin is negligible. In the next subsection, we use exogenous variation in our proxy for settlements to estimate the causal effect of this legal instrument on childlessness rates.

3.3 IV estimates

In this subsection, we estimate the causal effect of settlements on childlessness using an instrumental variables approach. Whether a family signed a settlement or not depends on many factors, some of which might be endogenous to childlessness. Specifically, it could be that individuals with certain characteristics that are correlated to childlessness may choose not to sign a settlement by delaying marriage until their father dies. We exploit exogenous variation in our proxy for settlements—i.e., the probability of marrying before or after inheritance—coming from the birth order of heirs. Formally, our proxy for settlements, S, is treated as an endogenous variable and modeled as:

$$S_{i,q} = \sum_{n=2}^{15} \beta_n \mathbb{I}(r_{i,q} = n) + \beta_z Z_{i,q} + \mu_q + \mathbf{X}'_{i,q}\gamma + \epsilon_{i,d} \ , \tag{2}$$

where $S_{i,q}$ indicates if i's father survived until the wedding of his heir. That is, it is equal to one when i is likely to be subject to a settlement and equal to zero otherwise. Our principal instrument is $r_{i,q}$, the birth order of individual i. The indicator function $\mathbb{I}$ is equal to one when $r_{i,d} = n$ and zero otherwise. We also include the age at death of i's father, Z, which obviously affects S without regard to i's birth order. As in equation (1), μ_q are marriage quarter-century fixed effects; and $\mathbf{X}$ is a vector of covariates including social status of the spouses, wife's age at marriage, spouses' age at death, history of stillbirth in the husband's family, and the total number of siblings of the heir.

The causal effect of settlements on childlessness is captured by coefficient β in:

$$\chi_{i,j,b,d} = \beta \hat{S}_{i,j,b,q} + \mu_j + \mu_b + \mu_q + \mathbf{X}'_{i,j,b,q}\gamma + \epsilon_{i,j,b,q} \ . \tag{3}$$

where $\hat{S}_{i,j,b,q}$ is the value of $S_{i,j,b,q}$ estimated from Equation (2), and μ_j and μ_b are, respectively, family and birth year fixed effects. To fit this model, we estimate the recursive equation system (2) and (3) by maximum likelihood.

Note that our main specification is a triangular IV model in which not all the covariates used in the first-stage are included in the second-stage.[11] In detail, we include father's age at death in the first-stage but do not consider it to affect childlessness in the second-stage. The implicit assumption is that father's age at death does not have a direct effect on childlessness other than affecting the probability of signing a settlement. This assumption would be violated, for example, if an early age at death of the father reflects poor health conditions that are transmitted intergenerationally. This scenario is unlikely for three reasons. First, we include the history of stillbirths in the second stage and estimate all the effects using family fixed effects. This captures any genetic predisposition towards childlessness among genetically related individuals. Conditional on these covariates, father's age at death likely does not affect childlessness. Second, we test the exogeneity of father's age at death formally by conducting Sargan-Hansen tests. Results suggest that, conditional on birth order being a valid instrument, father's age at death is exogenous to childlessness rates. Third, we present evidence suggesting that neither father's age at death nor birth order affect childlessness through channels other than settlements. In detail, we estimate the IV model for a comparable group of women who were not exposed to a settlement (because they married a non-heir or a Scottish peer) and show that the estimated effects converge to zero.

Table 6 presents the first-stage results. Relative to first-born heirs, later-born heirs have a smaller probability to marry before their father's death and, hence, to sign a settlement. For example, a second-born heir is 4 percentage points less likely to sign a settlement, a third-born heir 10 percentage points, and a seventh-born heir, 16.5 percentage points. The remaining covariates have expected signs. As the father lives longer, the probability of signing a settlement increases. In detail, every additional year of life of the father increases the probability of him being present at his heir's wedding by 2 percentage points. The probability of signing a settlement also increases with the husband's social status and decreases with wife's age at marriage. Finally,

[11] In Appendix C, Table 11, we estimate the same IV model including all covariates in the first stage and show that our main results are robust to this alternative specification.

the F-test is large enough to eliminate concerns about weak instruments.

Table 7 presents the OLS and IV estimates for the effect of settlements on childlessness. An heir marrying before his father's death and, thus, signing a settlement, was significantly less likely to be childless. The magnitude of the effect is large. IV estimates suggest that signing a settlement decreases by 14.7 percentage points the probability of being childless. Given that the average childlessness rate for heirs equals 17.6%, settlement increased by 83.5% the extensive margin of fertility among British heirs.

Note that the bias affecting the OLS results is an attenuation bias. One possible explanation is that if the father dies before the marriage of the heir, he is less likely to influence his son's choice of bride. In other words, the heir might enjoy more freedom when choosing his wife. If such marriages tend to have more children (e.g., because they are love matches rather than socially convenient marriages), this could explain the attenuation bias in our OLS specifications, corrected by the instrumental variables model.

Covariates have the expected signs. Heirs from larger families and heirs who live longer are less likely to be childless. Marrying an older wife significantly increases the probability of not having children, although the effect is much lower than that of settlements. In detail, to match the estimated effect of settlements on childlessness one would have to marry a wife aged 12 years younger.

The Sargan-Hansen test confirms the validity of our triangular IV specification. In detail, our specification includes father's age at death in the first-stage but does not consider it to affect childlessness in the second-stage. The implicit assumption is that father's age at death does not have a direct effect on childlessness other than affecting the probability of signing a settlement. We cannot reject the null hypothesis of the Sargan-Hansen test. That is, conditional on birth order being a valid instrument, father's age at death is exogenous to childlessness rates.

As with every IV approach, the identifying assumption is that the instrument is relevant and that the exclusion restriction is satisfied. First stage results confirm that the birth order of the heir is a relevant instrument for our proxy for settlements: in families where the heir is born after one or two daughters, the father is older and thus the likelihood that he survives until the heirs' wedding is smaller than if the heir

is his first-born child. Furthermore, F-stats are large enough to rule out concerns about weak instruments.

Next, we test the validity of the exclusion restriction, that is, that birth order of the heir only affects childlessness through the probability of signing a settlement. In detail, we estimate the instrumental variables system in Equations (2) and (3) with a comparable sample of women who should not be affected by settlements because (a) they did not marry an heir, or because (b) they married a Scottish heir. Unlike settlements in England and Ireland, Scottish entails were perpetual, i.e., they did not had to be renewed upon the heir's marriage (Habakkuk 1994: 6). If the exclusion restriction is satisfied—that is, if the birth order of the heir only affects childlessness through our proxy for settlements—we should find no effect for these populations.

Table 8 presents the results of the test of the exclusion restriction. The effect of marrying before inheritance (our proxy for settlements) on childlessness is much smaller and not significantly different from zero for peers' daughters who did not marry heirs (col. 2).[12] In other words, for those who did not inherit the family estates, our proxy rightly indicates that settlements did not affect their choice of having children. A Wald test confirms that the estimated coefficients are significantly different from the baseline effect for the sample of heirs' wives (col. 1).

We find similar results when we compare women who married English or Irish peers (col. 3) to those that married Scottish peers (col. 4), and thus, who had not to renew entailments (the Scottish equivalent to a settlement) every generation. Signing a settlement decreases the probability of being childless by 16 percentage points in the case of women who married English or Irish peers. In the case of wives of Scottish peers the coefficient is not significantly different from zero. The Wald test rejects that the effect is the same for wives of English or Irish peers and for wives of Scottish peers. Note that, compared to the results in columns (1) and (2), the Wald test is weaker. This may be the result of the measurement error: on the one hand, there are fewer Scottish peers, so the regression is estimated with fewer observations. On the other hand, Scottish peers typically held land and titles in England too, so some of them might have been subject to settlements.

[12] Note that in this case the instrument is the birth order of the family heir, that is, the birth order of the husband's older brother.

Altogether, the evidence indicates that settlements played a crucial role in reducing childless. Heirs born after several daughters were exogenusly less likely to marry before their father died. That is, they were exogenously less likely to sign a settlement, and thus, could freely dispose of the family estates, sell parts of it, and decide over the next generation's inheritance. As a result, their rates of childlessness were high. In contrast, first-born heirs were exogenously more likely to be subject to a settlement. The empirical results suggest that this reduced their childlessness rate.

3.4 Robustness: settlements signed at heir's majority.

This section shows that our results are robust to alternative specifications for our proxy of settlements. So far, we assumed that a settlement was signed if the family head survived until the wedding of his heir. This proxy hinges on settlements being signed on the wedding day of the heir. Although there is ample evidence that this was the common practice, Habakkuk (1950) suggests that a some settlements were signed when the heir turned 21, the age of majority. Habakkuk argues that

> the father might find it advantageous to bargain with his eldest son before a marriage was in immediate prospect to avoid the pressure of the bride's family. (Habakkuk 1950: p. 26).

In other words, settlements signed when the heir turned 21 would only reflect the objective of entailing of the family estates. In contrast, settlements signed at the marriage of the heir may also reflect the interests of the bride's family bargaining for larger family provisions.

Here, we show that our results are robust to assuming that settlements were signed at the heir's majority. Tables 9 and 10 present our main results using an alternative proxy for settlements. We assume that a settlement was signed if the heir turned 21 before the family head died. As with the benchmark proxy, we find that signing a settlement decreases the probability to be childless by 8 to 15 percentage points. The magnitude of the IV coefficient (column 2) is not significantly different to that of Table 7. As before, we find that the bias affecting the OLS results is an attenuation bias. Our previous conjecture—that is, that if the father dies before the marriage of the heir he is less likely to influence the heir's choice of the bride—is also valid here.

The reason is that the average age at marriage was 28.7, significantly above the age of majority.

As before, we find that birth order is a valid instrument. Specifically, first-stage results in Table 10 suggest that birth order is a relevant instrument: First-born heirs are more likely to turn 21 before their father's death than later-born heirs. F-stats are also large enough to rule out concerns about weak instruments.

Columns 3 and 4 in Table 7 suggest that the exclusion restriction also holds for this alternative proxy. The childlessness rates of women who were not exposed to settlements because they married a non-heir or a Scottish heir were not affected by the fact that the family head survived until his heir's majority or not. Furthermore, Wald tests reject the null hypothesis that the effects are the same for the sample of women marrying heirs and the sample of women marrying non-heir or Scottish heirs. In other words, our instruments do not seem to have a direct effect on childlessness other than by affecting the probability of signing a settlement.

Finally, column 5 suggests that our alternative proxy for settlements is not associated with the intensive margin of fertility, that is, the number of births by mothers.

Overall, our main conclusions are robust to adjusting our proxy for settlements to the possibility that these were signed at the heir's majority. Moreover, note that settlements signed at the heir's majority were not influenced by the interest of the bride's family as much as settlements signed at the marriage of the heir. Therefore, these results suggest that the effect of settlements on childlessness is the result of family interests to entail of land, and not the result of the bride's family interest in setting family provisions.

4 A model of fertility and bequests

This section presents a simple theoretical framework with two main objectives: first, to highlight the mechanisms behind the reduced-form effect of settlements on fertility documented in Section 3. Second, the model rationalizes the existence of settlements, or, more generally, of inheritance rules that tie the hands of proprietors.

4.1 Setup

We assume a three-period sequential move game played by three generations $i = \{1, 2, 3\}$ of the same dynasty. For simplicity, one can think of these as the father, the son, and the grandson. Each generation makes decisions regarding consumption, x_i, and fertility, $n_i = \{0, 1\}$. We model fertility as a binary choice and assume that there is no uncertainty regarding having an heir.[13] If a generation decides not to have children, we assume that the dynasty dies out after this generation.

The three generations belong to a dynasty endowed with wealth K. Think, for example, of landholdings. This endowment is used to subsidize consumption. Therefore, the consumption of generation i today affects future generations by reducing their endowments.

The decisions of each generation, thus, crucially depend on how the dynasty wealth K is passed down from one generation to the next. This, in turn, depends on the degree of altruism towards future generations and on inheritance rules. We depart from the classic bequests models by assuming hyperbolic discounting towards future generations. This means that individuals are present biased as they value their consumption x_i over that of the next generations x_{i+1}. At the same time, they do not value their children's well-being significantly more than that of the future generations, namely their grandsons.

As for inheritance rules, we will consider two models: a benchmark case where each generation decides the bequests to the next generation, and a model with commitment where the first generation decides the bequests of the following two generations. The latter case is meant to represent settlements, which ensured the father some control over the inheritance that his grandson would receive. More generally, it represents any inheritance scheme that ties the hands of proprietors (e.g. trusts).

[13]Alternatively, Li and Pantano (2014) propose a dynamic framework of fertility choices in order to account for sex selection. From our sample, sex selection does not seem to be an issue among the British Nobility. An important concern is that families might stop having children once they conceive an heir. This does not seem to happen as on average 49% of last births within families are girls (see Table 2 for details).

4.2 Model without commitment

Consider a model in which each generation decides over consumption, fertility, and the bequests for the next generation. Generation 1 derives utility from his consumption but also from the consumption of the following two generations in case the dynasty continues. We assume that the dynasty becomes extinct if any generation decides not to have children, and otherwise it dies out after generation 3.

Formally, the utility of generation 1 is

$$v_1(x_1, x_2, x_3, n_1, n_2) = u(x_1) + n_1 \cdot \left[\beta\delta\ u(x_2) + n_2 \cdot \beta\delta^2\ u(x_3)\right], \tag{4}$$

where x_i and $n_i = \{0, 1\}$ are the consumption and fertility of generation $i = \{1, 2, 3\}$.

We assume that generation 1 has a quasi-hyperbolic discount function towards future generations. This discount function has two components: First, $\delta \in [0, 1]$ is the discount rate for future generations. In other words, generation 1 is present-biased, that is, he values his consumption more than that of the next two generations. At the same time, he uses an additional discount factor β to discount all the future consumptions compared to his own. This additional discount factor therefore captures his dynastic preferences.

Consider Figure 4. For low values of β, generation 1 has a strong dynastic preference, in the sense that he values the consumption of his grandson and his son similarly. For high values of β, the discount function tends to the exponential discount function, implying that an individual values the consumption of his grandson much less than that of his son.

Hyperbolic discounting is important in this model because it provides the rational for settlements. Under exponential discounting ($\beta = 1$) generation 1's preference for his own consumption x_1 relative to his son's consumption x_2 is no different from his son's preference for his own consumption x_2 relative to the succeeding generation's consumption x_3. In other words, preferences are time consistent across generations. This is hard to reconcile with inheritance schemes that tied the hands of proprietors, such as entails or settlements. In contrast, under hyperbolic discounting ($\beta < 1$) individuals value the well-being of their grandchildren relatively more than their son will do, and hence, they have an incentive to restrict their son's freedom to manage

the family estate with a settlement.

Generation 1 is subject to the following budget constraint. He needs to allocate the family wealth, K, to his own consumption, and the bequests to the next generation, k_2. Formally,

$$K = x_1 + k_2. \tag{5}$$

Generation 2, the son, faces a similar problem. He derives utility from his consumption, x_2, and from the consumption of generation 3 in case he decides to have children. His utility is therefore represented as

$$v_2(x_2, x_3, n_2) = u(x_2) + n_2 \cdot \beta\delta \ u(x_3). \tag{6}$$

His budget constraint is similar to that of generation 1. He needs to allocate the bequest he receives from his father, k_2, to his own consumption, and the bequests to the next generation. Formally,

$$k_2 = x_2 + k_3. \tag{7}$$

Finally, generation 3—the grandson—faces a trivial problem. The dynasty will die out after him, so he only values his own consumption:

$$v_3 = u(x_3). \tag{8}$$

As there is no intrinsic utility from having children, he will consume all his endowment, that is, the bequests he receives from previous generations, k_3.

Since we have a sequential move game with perfect information and finite time, we use subgame perfect equilibrium (SPE) as the solution concept.

Definition 1 (SPE without commitment) *The SPE of the sequential game in which each generation decides over the bequests for the next generation is a strategy profile* $\{k_2, k_3, x_1, x_2, x_3, n_1, n_2, n_3\}$ *where* $\{k_2, x_1, n_1\}$ *maximize* v_1 *subject to (5),* $\{k_3, x_2, n_2\}$ *maximize* v_2 *subject to (7), and* $\{x_3, n_3\}$ *maximize* v_3 *subject to* $x_3 = k_3$*.*

We solve the model described in (4)-(8) by backward induction. Proposition 1 summarizes the optimal decisions regarding consumption and bequests conditional on

fertility choices. Hereafter, we assume log-utility for simplicity; i.e. $u(x_i) = \ln x_i$.

Proposition 1 (Consumption and bequests without commitment) *Suppose that each generation decides over the bequests for the next generation. In any SPE:*

(a) *If $n_1 = 0$, generation 1 consumes all the dynasty wealth, $x_1 = K$.*

(b) *If $n_1 = 1$ and $n_2 = 0$, generation 1 consumes $x_1^* := \dfrac{K}{1+\beta\delta}$, generation 2 consumes $x_2^* := \dfrac{\beta\delta K}{1+\beta\delta}$, and generation 1 gives a bequest $k_2^* := x_2^*$.*

(c) *If $n_1 = 1$ and $n_2 = 1$, generation 1 consumes $x_1^{**} := \dfrac{K}{1+\beta\delta+\beta\delta^2}$, generation 2 consumes $x_2^{**} := \dfrac{1+\delta}{1+\beta\delta}\,\dfrac{\beta\delta K}{1+\beta\delta+\beta\delta^2}$, generation 3 consumes $x_3^{**} := \dfrac{\beta(1+\delta)}{1+\beta\delta}\,\dfrac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}$, and generations 1 and 2 give a bequest $k_2^{**}{:=}K - x_1^{**}$ and $k_3^{**}{:=}x_3^{**}$ respectively.*

Proof: See Appendix B.1. ■

Given these optimal levels of consumption $K, x_1^*, x_2^*, x_1^{**}$, and x_2^{**}, we derive the optimal fertility choices for each generation by comparing the indirect utilities of having children and being childless. Proposition 2 characterizes these fertility decisions.

Proposition 2 (Fertility without commitment) *Suppose each generation decides over the bequests for the next generation. In any SPE:*

(a) *Generation 3 never has children, $n_3 = 0$.*

(b) *Generation 2 has children, $n_2 = 1$, if and only if:*

$$f(k_2, \beta, \delta) := v_2\left(x_2{=}\frac{k_2}{1+\beta\delta}, x_3{=}\frac{\beta\delta k_2}{1+\beta\delta}, n_2{=}1\right) - v_2(x_2{=}k_2, x_3{=}0, n_2{=}0) > 0,$$

where $f_{k_2} > 0$.

(c) *Generation 1 has children, $n_1 = 1$, if and only if:*

$$g(K, \beta, \delta) := v_1(x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0) - v_1(x_1{=}K, x_2{=}0, x_3{=}0, n_1{=}0, n_2{=}0) > 0 \quad \textit{when } f(k_2^*, \beta, \delta) < 0,$$

or

$$h(K,\beta,\delta) := v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) \\ - v_1(x_1{=}K, x_2{=}0, x_3{=}0, n_1{=}0, n_2{=}0) > 0 \quad \textit{when } f(k_2^{**},\beta,\delta) > 0$$

where $g_K, h_K > 0$.

Proof: See Appendix B.2. ■

Each generation will have children if and only if his indirect utility of doing so exceeds the indirect utility of being childless. The gains of having children for generation 2 are captured by the function f, where $x_2 = \frac{k_2}{1+\beta\delta}$ and $k_3 = x_3 = \frac{\beta\delta k_2}{1+\beta\delta}$ are the optimal consumption and bequest decisions when he has children, and $x_2 = k_2$ and $k_3 = 0$ are the corresponding optimal decisions when he is childless.[14] Importantly, f depends positively on his wealth, k_2. That is, the larger the bequest k_2 that generation 2 receives from his father, the more likely he is to have children.

In addition to wealth, the gains from having children for generation 1 also depend on whether he anticipates to have a grandson or not. Specifically, function g captures the difference in indirect utilities from having children or not when the dynasty dies out after generation 2; i.e., when $f < 0$. Function h captures the corresponding difference for the case in which the dynasty continues until generation 3; i.e., when $f > 0$.

Proposition 3 describes the conditions for the three possible SPE without commitment: a high-fertility SPE in which generations 1 and 2 have children, a low-fertility SPE in which only generation 1 has children, and a no-fertility SPE in which generation 1 is childless.

Proposition 3 (SPE without commitment) *Suppose each generation decides over the bequests for the next generation. Then,*

(*i*) *A high-fertility strategy* $\{k_2^{**}, k_3^{**}, x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1, n_3{=}0\}$ *is the SPE if:*

(*a*) $f(k_2^{**},\beta,\delta) \geq 0$*;* $h(K,\beta,\delta) > 0$*; and*

[14] To define f we characterize the indirect utility of being childless as $v_2(x_2 = k_2, x_3 = 0, n_2 = 0)$. This is a slight abuse of notation, as $n_2 = 0$ implies that the third generation does not exist. Hence, x_3 is not zero but undefined. Since the utility carried by future generations is multiplied by n_i this is inconsequential. The same applies for the indirect utility of being childless of generation 1.

(*b*) $v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) > v_1(x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0)$ *when* $f(k_2^*, \beta, \delta) < 0$ *and* $f(k_2^{**}, \beta, \delta) > 0$.

(*ii*) *A low-fertility strategy* $\{k_2^*, k_3{=}0, x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0, n_3{=}0\}$ *is the SPE if:*

(*a*) $f(k_2^*, \beta, \delta) < 0$; $g(K, \beta, \delta) > 0$; *and*

(*b*) $v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) \leq v_1(x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0)$ *when* $f(k_2^*, \beta, \delta) < 0$ *and* $f(k_2^{**}, \beta, \delta) > 0$.

(*iii*) *A no-fertility strategy* $\{k_2{=}k_3{=}0, x_1{=}K, x_2{=}x_3{=}0, n_1{=}n_2{=}n_3{=}0\}$ *is the SPE if* $g(K, \beta, \delta) \leq 0$ *and* $h(K, \beta, \delta) \leq 0$.

Proof: See Appendix B.3. ■

For each SPE, condition (a) guarantees that generation 1 and generation 2 take the optimal fertility decisions for a given k_2, k_3, x_1, x_2, x_3. Condition (b) ensures that generation 1 internalizes optimally that he can influence the fertility choices of the second generation. Specifically, note that for some parameter values, both $f(k_2^*, \beta, \delta) < 0$ and $f(k_2^{**}, \beta, \delta) > 0$ are satisfied. In other words, generation 1 can choose between an SPE in which he gives a low bequest k_2^* and generation 2 is childless and an SPE in which he gives a high bequest k_2^{**} and generation 2 has children. Condition (b) guarantees that generation 1 chooses his preferred SPE when these two are feasible.

How does intergenerational discounting affect fertility? For the sake of illustration, Figure 5 panel (a) shows how the two discount factors, β and δ, affect fertility choices for a given endowment K. Two comparative statics emerge: First, present-biased individuals are more likely to pursue a low-fertility or a no-fertility strategy. Intuitively, for low values of β and δ, that is, when individuals are present-biased, generation 1 prefers to consume all the dynasty's wealth and has no children. In contrast, when individuals value the consumption of future generations more, both generation 1 and 2 have children. Finally, for intermediate levels of β and δ, only generation 1 has children.

Second, for more hyperbolic discount functions a high-fertility strategy is the unique SPE. To see this we first need to define a measure capturing the degree of hyperbolism

of the discount function. Remember that the discount function has two elements: the discount rate for future generations, δ, and the discount rate for all the future consumptions, β. Note that, on the one hand, for low values of β (and δ) individuals are present biased. On the other hand, for low values of β preferences are more hyperbolic; i.e., an individual does not value the consumption of his son significantly more than that of his grandson. To disentangle the two effects of β, we consider combinations of β and δ with the same degree of present-biasedness; i.e., we keep $\beta \cdot \delta$ constant. These combinations are represented by the isolines in Figure 5. Along a given isoline, lower values of β capture more hyperbolic discount functions.[15]

Definition 2 (Hyperbolic discounting) *A discount function defined by $\{\beta, \delta\}$ is more hyperbolic than a discount function defined by $\{\beta', \delta'\}$ if $\beta \cdot \delta = \beta' \cdot \delta'$ and $\beta < \beta'$.*

Figure 5 panel (a) suggests that dynasties with more hyperbolic discounting—that is, dynasties with a lower β along a given isoline—are more likely to be in a high-fertility regime. Intuitively, when the first generation does not value the consumption of his son significantly more than that of his grandson he has a higher incentive to keep the dynasty alive. Hence, he sets a bequest for generation 2 high enough to ensure a positive fertility. Proposition 4 generalizes this result.

Proposition 4 (Comparative statics without commitment) *Suppose each generation decides over the bequests for the next generation. The conditions for a high-fertility SPE $\{k_2^{**}, k_3^{**}, x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1, n_3{=}0\}$ are more likely to be satisfied for more hyperbolic discount functions.*

Proof: See Appendix B.4. ■

In sum, present-biased individuals are less likely to have children. In contrast, individuals with a hyperbolic discount function have a higher incentive to keep the dynasty alive, and hence, give higher bequests to ensure that the next generation will have children. In the next two subsections, we solve a model in which generation 1 makes all the decisions regarding bequests and show that this commitment device can be used to increase the fertility of generation 2.

[15] Formally, let $\beta \cdot \delta = \Gamma$. Generation 1 discounts the consumption of the next two generations with Γ and $\frac{\Gamma^2}{\beta}$ respectively, where $\beta \in [\Gamma, 1]$. Keeping Γ constant, a lower β is associated with a more similar dicounting for the next two generations. That is, a lower β is associated with a more hyperbolic discount function.

4.3 Model with commitment

Consider a model where generation 1, the father, sets all bequests for future generations, namely k_2 and k_3. This commitment device closely resembles the strict settlement, which ensured the family head (e.g., the father) control over the inheritance that the next generation's heir (e.g., the grandson) would receive. More generally, it represents any inheritance scheme that ties the hands of proprietors (e.g., trusts).

Each generation decides over fertility and consumption but, in contrast to the previous model, generation 1 sets all bequests. Therefore, the constraints of generations 1 and 2 are now

$$K = x_1 + k_2 + k_3 \tag{9}$$

and

$$k_2 = x_2. \tag{10}$$

The decision problem of each generation is now characterized by equations (4), (6), (8), (9) and (10). Definition 3 characterizes the SPE of this game.

Definition 3 (SPE with commitment) *The SPE of the sequential game in which generation 1 decides over the bequests for the following two generations is a strategy profile* $\{k_2, k_3, x_1, x_2, x_3, n_1, n_2, n_3\}$ *where* $\{k_2, k_3, x_1, n_1\}$ *maximize* v_1 *subject to (9),* $\{x_2, n_2\}$ *maximize* v_2 *subject to (10), and* $\{x_3, n_3\}$ *maximize* v_3 *subject to* $x_3 = k_3$*.*

Proposition 5 summarizes the optimal decisions regarding consumption and bequests in this setting.

Proposition 5 (Consumption and bequests with commitment) *Suppose generation 1 decides over the bequests for the following two generations. In any SPE:*

(i) If $n_1 = 0$*, generation 1 consumes all the dynasty wealth,* $x_1 = K$*.*

(ii) If $n_1 = 1$ *and* $n_2 = 0$*, generations 1 and 2 consume* x_1^* *and* x_2^* *and generation 1 gives a bequest* $k_2 = x_2^*$ *as in the model without commitment.*

(iii) If $n_1 = 1$ *and* $n_2 = 1$*, generation 1 consumes* $x_{1c}^{**} := \dfrac{K}{1+\beta\delta+\beta\delta^2}$*, generation 2 consumes* $x_{2c}^{**} := \dfrac{\beta\delta K}{1+\beta\delta+\beta\delta^2}$*, generation 3 consumes* $x_{3c}^{**} := \dfrac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}$*,*

and generation 1 chooses $k_{2c}^{**} := x_{2c}^{**}$ *and* $k_{3c}^{**} := x_{3c}^{**}$ *as bequests.*

Proof: See Appendix B.5. ■

Proposition 5 suggests that the consumption and bequest decisions when $\{n_1 = 0\}$ and when $\{n_1 = 1,\ n_2 = 0\}$ are identical to the decisions from the model without commitment. In other words, the commitment device that allows generation 1 to set all bequests is only relevant when the dynasty does not die out, $n_1 = n_2 = 1$. In the latter case, note that $x_{2c}^{**} < x_2^{**}$ and $x_{3c}^{**} > x_3^{**}$. That is, generation 1 redistributes consumption from generation 2 to generation 3 by settling a larger bequest k_3 than the one generation 2 would have left in the model without commitment. Proposition 6 characterizes how this redistribution of family wealth affects fertility decisions.

Proposition 6 (Fertility with commitment) *Suppose that generation 1 decides over the bequests for the following two generations. In any SPE:*

(*i*) *Generation 3 never has children,* $n_3 = 0$*.*

(*ii*) *Generation 2 has children,* $n_2 = 1$*, if and only if:*

$$\mathcal{F}(k_3, \beta, \delta) := v_2(x_2{=}k_2, x_3{=}k_3, n_2{=}1) - v_2(x_2{=}k_2, x_3{=}0, n_2{=}0) > 0,$$

where $\mathcal{F}_{k_3} > 0$*.*

(*iii*) *Generation 1 has children,* $n_1 = 1$*, if and only if:*

$$g(K, \beta, \delta) := v_1(x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0) \\ - v_1(x_1{=}K, x_2{=}x_3{=}0, n_1{=}n_2{=}0) > 0$$

or

$$\mathcal{H}(K, \beta, \delta) := v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1{=}1, n_2{=}1) \\ - v_1(x_1{=}K, x_2{=}x_3{=}0, n_1{=}n_2{=}0) > 0 \text{ when } \mathcal{F}(k_{3c}^{**}, \beta, \delta) > 0,$$

where $g_K, \mathcal{H}_K > 0$*.*

Proof: See Appendix B.6. ■

The fertility choices for generation 2 change significantly when the generation 1 sets all bequests. The gains of having children are captured by the function $\mathcal{F}$ in the model

with commitment. In contrast to the model without commitment, here $\mathcal{F}$ does not depend on generation 2's endowment, k_2, but on the endowment that generation 1 settled for generation 3, k_3. For example, when generation 1 sets $k_3 = 0$, generation 2 will always prefer to be childless. Therefore, in the model with commitment generation 1 can influence the fertility choices of his son through by settling more wealth for the third generation.

Proposition 7 describes the conditions for the three possible SPE with commitment: a high-fertility SPE in which generations 1 and 2 have children, a low-fertility SPE in which only generation 1 has children, and a no-fertility SPE in which generations 1 is childless.

Proposition 7 (SPE with commitment) *Suppose that generation 1 decides over the bequests for the following two generations. Then,*

(i) *A high-fertility strategy* $\{k^{**}_{2c}, k^{**}_{3c}, x^{**}_{1c}, x^{**}_{2c}, x^{**}_{3c}, n_1{=}1, n_2{=}1, n_3{=}0\}$ *is the SPE if:*

  (a) $\mathcal{F}(k^{**}_{3c}, \beta, \delta) \geq 0$; $\mathcal{H}(K, \beta, \delta) > 0$; *and*

  (b) $v_1(x^{**}_{1c}, x^{**}_{2c}, x^{**}_{3c}, n_1{=}1, n_2{=}1) > v_1(x^*_1, x^*_2, x_3{=}0, n_1{=}1, n_2{=}0)$,

(ii) *A low-fertility strategy* $\{k^*_2, k_3{=}0, x^*_1, x^*_2, x_3{=}0, n_1{=}1, n_2{=}0, n_3{=}0\}$ *is the SPE if:*

  (a) $g(K, \beta, \delta) > 0$, *and*

  (b) $v_1(x^{**}_{1c}, x^{**}_{2c}, x^{**}_{3c}, n_1{=}1, n_2{=}1) \leq v_1(x^*_1, x^*_2, x_3{=}0, n_1{=}1, n_2{=}0)$ *when* $\mathcal{F}(k^{**}_{3c}, \beta, \delta) > 0$,

(iii) *A no-fertility strategy* $\{k_2{=}k_3{=}0, x_1{=}K, x_2{=}x_3{=}0, n_1{=}n_2{=}n_3{=}0\}$ *is the SPE if* $g(K, \beta, \delta) \leq 0$ *and* $\mathcal{H}(K, \beta, \delta) \leq 0$.

Proof: See Appendix B.7. ■

For each SPE condition (a) guarantees that generation 1 and generation 2 take the optimal fertility decisions for a given k_2, k_3, x_1, x_2, x_3. Condition (b) ensures that generation 1 internalizes optimally that he can influence the fertility choices of generation 2. That is, that generation 1 chooses his preferred SPE when both the high-fertility SPE and the low-fertility SPE are feasible; i.e., when $\mathcal{F}(k^{**}_{3c}, \beta, \delta) > 0$.

As in the model without commitment, intergenerational discounting is crucial for fertility decisions. Specifically, present-biased individuals are more likely to be childless

and more hyperbolic discount functions are associated with high-fertility strategies. Figure 5 panel (b) illustrates these two effects for a given endowment K. For low values of β and δ, that is, when individuals are present-biased, a no-fertility strategy is the unique SPE. In contrast, dynasties with more hyperbolic discounting are more likely to be in a high-fertility regime. Note that each line represents a level set for $\beta \cdot \delta$ constant. That is, along a given isoline, the degree of present biasedness is constant and lower values of β are associated with a higher degree of hyperbolim. Dynasties with a lower β along a given isoline are more likely to be in a high-fertility regime. Intuitively, when the first generation has an hyperbolic discount function he does not value the consumption of his son significantly more than that of his grandson. Hence, he has a higher incentive to keep the dynasty alive. To achieve this, he settles a bequest for generation 3 high enough such that generation 2 prefers having children to being childless and loosing the utility from the settled bequest. Proposition 4 generalizes this result.

Proposition 8 (Comparative statics with commitment) *Suppose generation 1 decides over the bequests for the following two generations. The conditions for a high-fertility SPE* $\{k^{**}_{2c}, k^{**}_{3c}, x^{**}_{1c}, x^{**}_{2c}, x^{**}_{3c}, n_1{=}1, n_2{=}1, n_3{=}0\}$ *are more likely to be satisfied for more hyperbolic discount functions.*

Proof: See Appendix B.8. ■

4.4 Model comparison

This subsection compares fertility choices across models and derives welfare implications. Note that, in both models, generation 1 prefers the dynasty not to die out when he is not present biased and when he has a hyperbolic discount function towards future generations (Propositions 4 and 8). This objective, however, is achieved differently in the model without commitment than in the model with commitment. In the former, generation 1 can increase the fertility of generation 2 by giving him a higher bequest k_2 (Proposition 2). In contrast, in the model with commitment generation 1 influences the fertility choices of generation 2 by settling a bequest k_3 for the third generation (Proposition 6).

Which mechanism is more effective in moving the dynasty towards a high-fertility regime? For the sake of illustration, Figure 5 panel (c) compares fertility choices

across the two models. Specifically, the figure plots the three different SPE of the game (no-fertility, low-fertility, and high-fertility) for different values of the discount factors β and δ and a given K. Clearly, when generation 1 sets all bequests the high-fertility SPE is more prominent. In detail, the highlighted region in panel (c) represents the parameter region where the second generation does not have children in the model without commitment, but has children in the model with commitment. Proposition 9 generalizes this result.

Proposition 9 (The effect of settlements on fertility) *The set of parameter values that supports a high-fertility equilibrium in the model with commitment nests the corresponding set in the model without commitment.*

Proof: See Appendix B.9. ■

Intuitively, for any given bequest profile $\{k_2, k_3\}$, generation 2 has a lower incentive to deviate to a low-fertility strategy in the model with commitment than in the model without commitment. In the latter, generation 2 can choose to be childless and enjoy all his bequest k_2, which otherwise would be split between his own consumption and that of generation 3. In contrast, in the model with commitment, generation 2 cannot appropriate any of the bequest k_3 that generation 1 settled. If generation 2 deviates to a low fertility strategy, the dynasty dies out and k_3 is lost. Hence, generation 1 can increase the fertility of generation 2 more effectively in the model with commitment (i.e., by settling a high bequest k_3) than in the model without commitment (i.e., by giving generation 2 a high bequest k_2).

This result highlights the importance of settlements (or any inheritance scheme that ties the hands of proprietors) for fertility. Specifically, proposition 9 reproduces our empirical finding: individuals who signed a settlement with their father were more likely to have children than individuals who were not subject to a settlement. Furthermore, the proposition sheds light on the mechanism behind the reduced-form effect of settlements on fertility. When a father and a son sign a settlement, the latter cannot sell parts of the family estate. He may therefore have children, as he prefers the large, untouched inheritance to go to their offspring rather than it to be lost (or to go to a distant relative). In contrast, individuals who are not subject to a settlement can sell parts of the family estate, enjoy the dynastic wealth that was supposed to go down to the next generation, and decide to be childless to avoid the disutility of passing

down a diminished estate.

Importantly, commitment leads to a higher fertility only when discounting is hyperbolic. For example, figure 5 panel (c) suggests that when $\beta = 1$, that is, when discounting is exponential, the model with and without commitment produce identical fertility choices. Similarly, when individuals are highly present biased (low β and δ) or when they do not discount the future (high β and δ), fertility is identical across models. In contrast, when the dynasty exhibits hyperbolic discounting, a high-fertility regime is more likely in the model with commitment. To see this, note that each solid line in figure 5 represents an isoline for $\beta \cdot \delta$ constant. Along a given isoline, lower values of β are associated with a higher degree of hyperbolism. Clearly, a higher degree of hyperbolism leads to the parameter region where commitment is associated to high-fertility and no commitment to low fertility. Proposition 10 generalizes this result.

Proposition 10 (Settlements and hyperbolic discounting) *Fertility is larger in the model with commitment than in the model without commitment for more hyperbolic discount functions.*

Proof: See Appendix B.10. ■

Proposition 10 suggests that hyperbolic discounting across generations can explain the effect of settlements in reducing childlessness. When the family head has a hyperbolic discount function he does not value the well-being of his son relatively more than that of his grandson. In other words, he does not want the dynasty to die out in the next generation. Without commitment, he can only influence his son to give him grandchildren by giving him a large endowment k_2. In contrast, with commitment he can *force* him to have children more effectively by allocating a higher portion of the inheritance to his yet-to-be-born grandson.

Finally, we derive the welfare implications of the model with commitment compared to the benchmark case where each generation decides the bequests of the following generation. Specifically, we compare the utility of each generation across models in the parameter region where a high-fertility strategy is the SPE of the model with commitment and a low-fertility strategy is the SPE of the model without commitment. Proposition 11 summarizes the results.

Proposition 11 (Welfare) *In the parameter region where a high-fertility strategy is the SPE of the model with commitment and a low-fertility strategy is the SPE of the model without commitment, commitment is welfare improving. Specifically, all generations are better off; i.e.,* $v_3(x_{3c}^{**}) > v_3(x_3 = 0)$, $v_2(x_{2c}^{**}, x_{3c}^{**}, n_2{=}1) > v_2(x_2^{*}, x_3{=}0, n_2{=}0)$, *and* $v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1{=}1, n_2{=}1) > v_1(x_1^{*}, x_2^{*}, x_3{=}0, n_1{=}1, n_2{=}0)$.

Proof: See Appendix B.11. ■

In other words, commitment is welfare improving for dynasties with hyperbolic discounting. On the one hand, generation 1 will always prefer an arrangement in which he can decide the bequests of the following two generations, as this allows him to solve the problem of inter-generational time inconsistency. In the model with commitment he can settle a larger bequest to generation 3, while in the model without commitment generation 2 would choose a smaller bequest. On the other hand, generation 2 *ex ante* prefers the model with commitment as this guarantees that a larger share of the family wealth K will trickle down from generation 1; i.e., $k_{2c}^{**} + k_{3c}^{**} > k_2^{*}$. Finally, generation 3 obviously prefers the model with commitment as this guarantees him a larger bequest.

This result provides a rational for the widespread use of settlements in the aristocracy. On the one hand, the aristocracy is likely to have strong dynastic preferences. That is, it is likely to exhibit hyperbolic discounting across generations, and hence, improve its welfare with a commitment device that gives the family head (e.g., the father) some control over the inheritance that the next generation's heir (e.g., the grandson) will receive.[16] On the other hand, the fact that both generation 1 and generation 2 benefit, *ex ante*, from such a commitment explains why both the family head and the heir would accept signing a settlement upon the marriage of the latter.[17]

In sum, this stylized model provides two sets of interesting results. First, it shows that hyperbolic discounting across generations can explain why settlements reduced childlessness and moved the aristocracy to a high fertility regime. Second, hyperbolic

[16] From a societal point of view, however, the welfare implications are not clear as this mechanism can contribute to higher inequality.

[17] Admittedly, according to this model signing a settlement should occur before the heirs marriage, as this reduces the probability that the father dies before the wedding and, hence, that the settlement is not signed. Although our empirical results are robust to this possibility, it is certainly true that not all settlements were signed when the heir turned 21. This is explained by the interest of the bride's family in fixing allowances for the bride and the younger children of the marriage. In this paper, we have abstracted from the use of settlements as a device to fix family provisions.

discounting provides a rational for the widespread use of settlements in the aristocracy. These results are not specific to the case of the British aristocracy. Inheritance schemes that tie the hands of proprietors (e.g., trusts, fee tails, entails, etc.) are widely used today, particularly amongst the top one percent. This model shows that this is likely a byproduct of hyperbolic discounting across generations. Furthermore, these inheritance schemes may have important implications for the survival of dynasties at the top, and hence, for the persistence of inequality.

5 Conclusion

From 1650 to 1882, British peers could not freely dispose of their estates. Upon their marriage, peer heirs signed a settlement with their father in which they committed to pass down the family estate, unbroken, to the next generation. In this paper we show that such arrangements were crucial in reducing the high rates of childlessness in the British aristocracy. This ensured the continuation of family lineages and, thus, that wealth would remain concentrated in their hands. Using demographic evidence from about 1,500 wives of heirs to a peerage between 1650 and 1882, we show that heirs marrying after their fathers' death—that is, heirs that were subject to a settlement—where 15 percentage points more likely to have children. We address endogeneity concerns in the relation between our proxy for settlements and fertility. First, we show that results are robust to the inclusion of covariates that may also affect childlessness. Second, we estimate all the effects using variation within a lineage. That should capture any genetic, cultural, religious, or socio-economic predisposition towards childlessness. Finally, we estimate an instrumental variables model that uses exogenous variation in the probability of heirs marrying before the fathers' dead—that is, ou proxy for signing a settlement—coming from the birth order of the heir.

In the second part of the paper, we develop a model of household decisions where three generations of the same dynasty decide sequentially over consumption and fertility. We depart from the classic bequests models by assuming that individuals have quasi-hyperbolic discount function towards future generations and that altruism is higher towards direct descendants than towards distant relatives. As preferences are not consistent across generations, fathers have an incentive to restrict their son's freedom

to manage the family estate with a settlement. We then model settlements as a commitment device that allows the father to decide all bequests of future generations. In this model with commitment, we show that the father can influence the fertility decisions of his son by settling a larger endowment for the third generation, namely the grandson. As a result, the family dynasty is less likely to die out than in a model where every generation decides the bequests of the next generation. This effect is stronger for more hyperbolic discount functions, suggesting that this particular time-preference may explain the reduced-form effect of settlements on fertility that we document in the empirical analysis.

These results have two sets of implications: first, we argue that the benchmark model of bequests assuming exponential discounting (Barro 1974) is inconsistent with many inheritance rules that tie the hands of proprietors, and that this type of discounting may ignore important effects of such inheritance rules on fertility. Second, while economists typically think of fertility and inequality to be negatively related (Deaton and Paxson 1997; Kremer and Chen 2002; de la Croix and Doepke 2003), our results suggest that this relation may be the opposite on the extensive margin of fertility. Settlements contributed to inequality not only by entailing the land, but also by ensuring the survival of noble dynasties at the top of the distribution.

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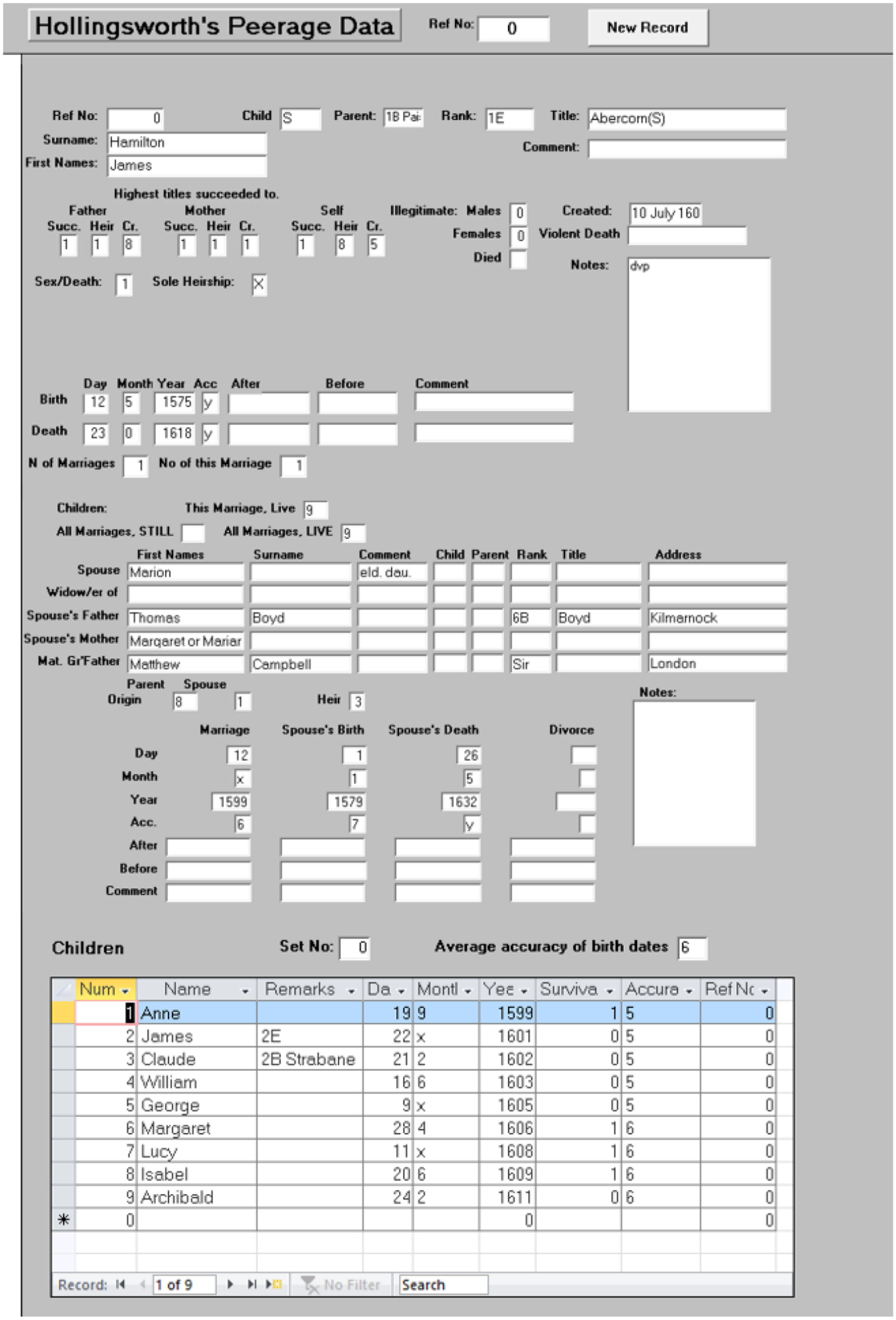
A Figures and Tables

Figure 1: Charles Lyttelton, 8th Viscount Cobham, Cokayne's *Complete Peerage* (1913).

VII. 1876. *5*. CHARLES GEORGE (LYTTELTON), LORD LYTTELTON, BARON OF FRANKLEY [1794] also BARON WESTCOTE OF BALLYMORE in the peerage of Ireland [1776] also *a Baronet* [1618], s. and h., by 1st wife, *b.* 27 Oct. 1842; ed. at Eton and at Trin. Coll., Cambridge; M.P. for East Worcestershire, 1868-74: *suc. to the peerage*, 18 April 1876; Land Commr., 1881-89; *suc.* as VISCOUNT COBHAM AND BARON COBHAM, on the death, 26 March 1889, of his distant cousin (the Duke of Buckingham and Chandos, Viscount Cobham, &c.), under the *spec. rem.* in the creation of that dignity, 23 May 1718. He *m.* 19 Oct. 1878, Mary Susan Caroline, 2d da. of William George (CAVENDISH), 2d BARON CHESHAM, by Henrietta Frances, da. of the Rt. Hon. William Saunders Sebright LASCELLES. She was *b.* 19 March 1853.

Figure 2: James Hamilton, 1st Earl of Abercorn, Hollingsworth database.



Hollingsworth's Peerage Data Ref No: 0 New Record

Ref No: 0 Child: S Parent: 1B Pai Rank: 1E Title: Abercorn(S)
Surname: Hamilton Comment:
First Names: James

Highest titles succeeded to.

	Father Succ.	Father Heir	Father Cr.	Mother Succ.	Mother Heir	Mother Cr.	Self Succ.	Self Heir	Self Cr.
	1	1	8	1	1	1	1	8	5

Illegitimate: Males 0 Females 0 Died
Created: 10 July 160
Violent Death:
Notes: dvp

Sex/Death: 1 Sole Heirship: X

	Day	Month	Year	Acc	After	Before	Comment
Birth	12	5	1575	y			
Death	23	0	1618	y			

N of Marriages 1 No of this Marriage 1

Children: This Marriage, Live 9
All Marriages, STILL All Marriages, LIVE 9

	First Names	Surname	Comment	Child	Parent	Rank	Title	Address
Spouse	Marion		eld. dau.					
Widow/er of								
Spouse's Father	Thomas	Boyd				6B	Boyd	Kilmarnock
Spouse's Mother	Margaret or Mariar							
Mat. Gr'Father	Matthew	Campbell				Sir		London

Origin: Parent 8 Spouse 1 Heir 3
Notes:

	Marriage	Spouse's Birth	Spouse's Death	Divorce
Day	12	1	26	
Month	x	1	5	
Year	1599	1579	1632	
Acc.	6	7	y	
After				
Before				
Comment				

Children Set No: 0 Average accuracy of birth dates 6

Num	Name	Remarks	Da	Montl	Yee	Surviva	Accura	Ref Nc
1	Anne		19	9	1599	1	5	0
2	James	2E	22	x	1601	0	5	0
3	Claude	2B Strabane	21	2	1602	0	5	0
4	William		16	6	1603	0	5	0
5	George		9	x	1605	0	5	0
6	Margaret		28	4	1606	1	6	0
7	Lucy		11	x	1608	1	6	0
8	Isabel		20	6	1609	1	6	0
9	Archibald		24	2	1611	0	6	0
* 0					0			0

Record: 1 of 9 No Filter Search

Figure 3: Childlessness rates and average births of mothers, by marriage decade.

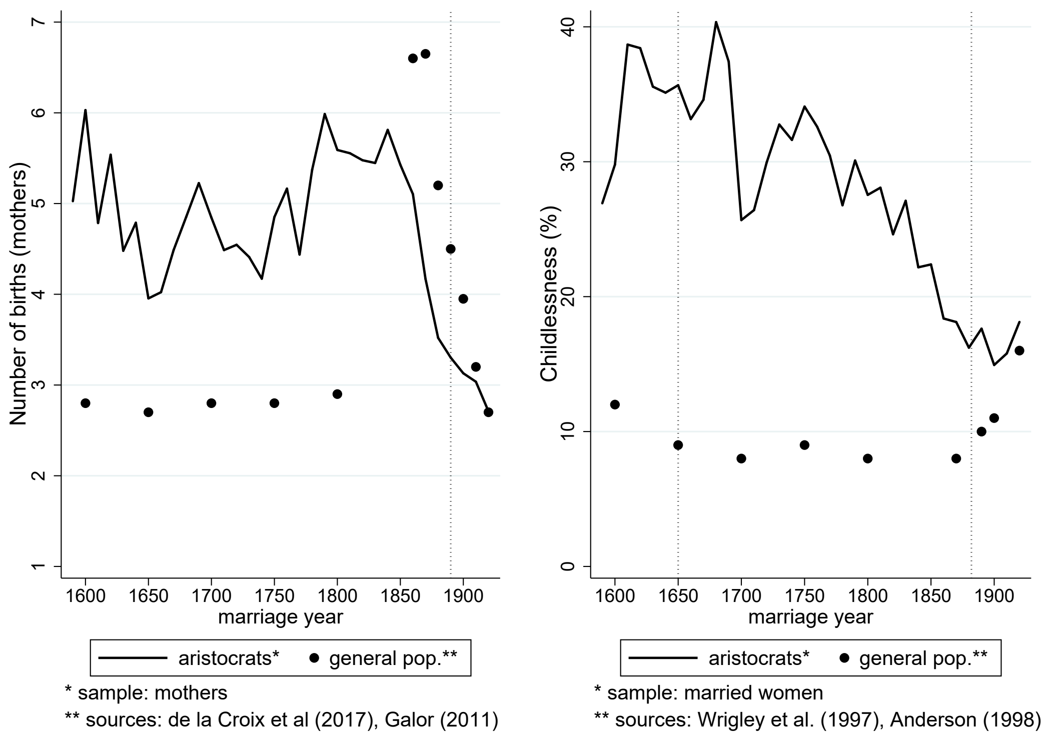


Figure 4: Quasi-hyperbolic discrete discount function

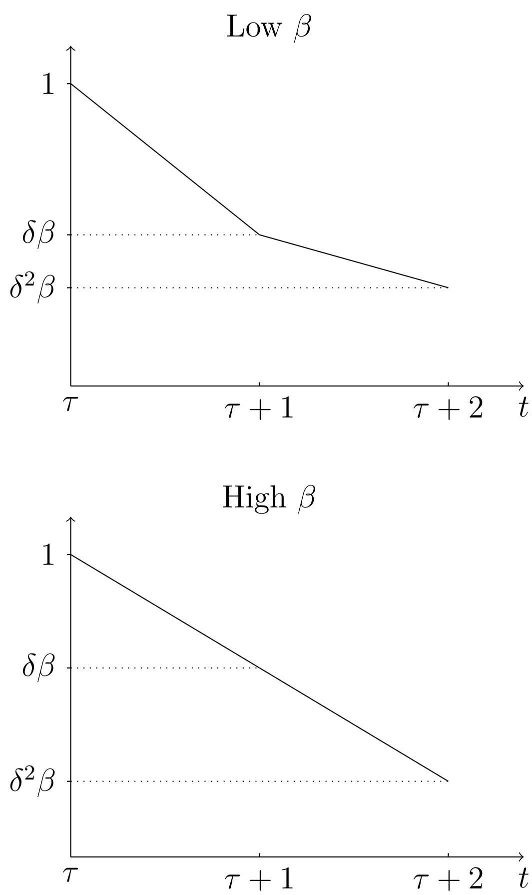
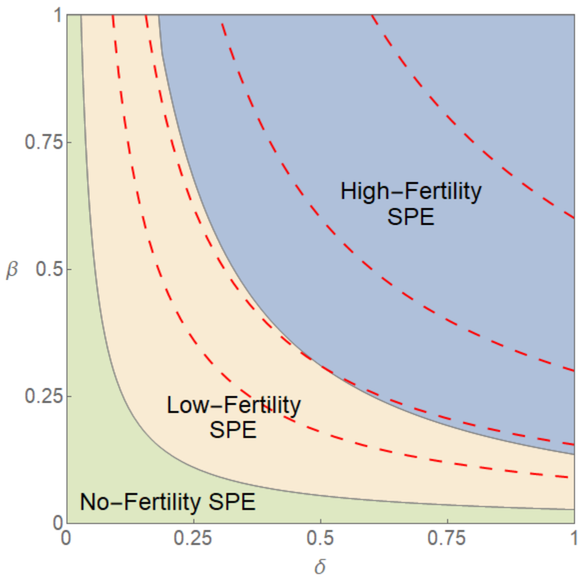
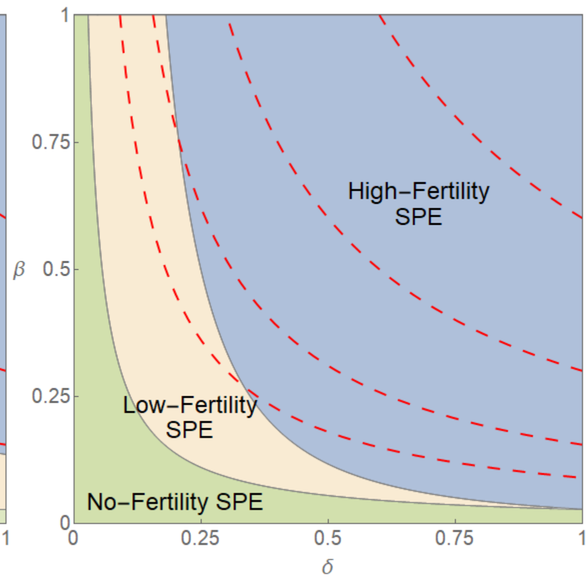


Figure 5: Discount factors and fertility

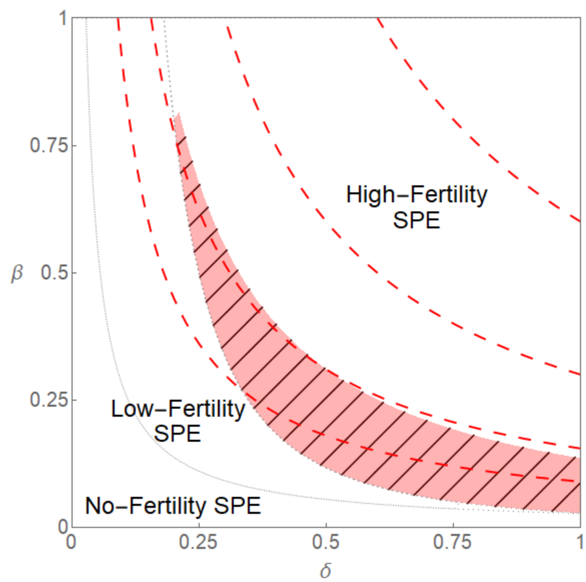
(a) Model without commitment



(b) Model with commitment



(c) Model comparison



Region where commitment increases fertility (panel (c))

Isolines for $\beta \cdot \delta$ constant

Notes: Family wealth K is fixed to 100.

	Strict settlement		Other forms	
	N	%	N	%
1660-80	26	63.4	15	36.6
1681-1700	29	78.4	8	21.6
1701-20	25	80.6	6	19.4
1721-40	25	75.8	8	24.2
Totals	105	73.9	37	26.1

Source: Bonfield (1983, p.86)

Table 1: The employment of settlements (1660-1740)

	mean	se	min	max	N	sample
A. Fertility variables						
% childless	0.249	0.004	0	1	9,632	all
% childless	0.176	0.009	0	1	1,727	heirs
All live births	3.903	0.038	0	31	9,632	all
All live births (if > 0)	5.196	0.041	1	31	7,234	parents
Stillbirths	0.128	0.013	0	9	1,503	all
B. Other demographic variables						
Age at first marriage (wom)	23.446	0.084	2	71	5,170	women
Age at first marriage (men)	28.686	0.109	8	74	4,838	men
Age at death (wom)	59.966	0.269	13	104	5,144	women
Age at death (men)	61.414	0.240	16	98	4,812	men
Age difference	0.587	0.093	-40	56	9,940	all
Number of marriages	1.159	0.004	1	4	10,129	all
Last child is a girl	0.535	0.009	0	1	2,778	matched parents
C. Socioeconomic status variables						
Baron offspring (non-heir)	0.392	0.005	0	1	10,129	all
Duke offspring (non-heir)	0.439	0.005	0	1	10,129	all
Baron heir	0.079	0.003	0	1	10,129	all
Duke heir	0.090	0.003	0	1	10,129	all
Heir	0.282	0.005	0	1	10,129	all
English peerage	0.481	0.005	0	1	10,129	all
Scottish peerage	0.210	0.004	0	1	10,129	all
Irish peerage	0.308	0.005	0	1	10,129	all
Marrying a commoner	0.671	0.003	0	1	10,129	all
Marrying after inheritance	0.251	0.005	0	1	8,582	all

Notes: The sample are all peers who married between 1650 and 1882 and their offspring. Marrying after inheritance indicates that the heir married after his father's death. It is our proxy for not having signed a marriage settlement.

Table 2: Summary statistics for the Hollingsworth's dataset (1650–1882)

Childlessness

	1650-99	1700-49	1750-99	1800-49	1850-99
Lévy and Henry (1960)[a] *ducs et pairs de France*	9% (N=34)	21% (N=24)	35% (N=20)	-	-
Pedlow (1982)[b] nobility of Hesse-Kassel	5% (N=39)	14% (N=51)	9% (N=56)	8% (N=121)	8% (N=84)
Hollingsworth (1964)[a] (dukes only)	12% (N=122)	18% (N=115)	17% (N=138)	12% (N=146)	8% (N=166)
Hollingsworth (1964)[a] (all peers)	14% (N=218)	18% (N=192)	16% (N=217)	12% (N=281)	9% (N=308)

Notes: The sample are: *a*) women marrying before 20 years old for whom the marriage did not break because either she or the spouse died before 45 years old; *b*) for whom the marriage did not break because either she or the spouse died before 45 years old.

Table 3: Comparison with other nobilities

Dep. variable: Childlessness

	(1)	(2)	(3)	(4)
Settlement	-0.050***	-0.052***	-0.036**	-0.079**
[i.e., marriage before inheritance]	(0.019)	(0.019)	(0.018)	(0.035)
Husband's siblings (#)	-0.001	-0.001	-0.001	-0.004
	(0.002)	(0.002)	(0.002)	(0.005)
Father-in-law is a duke		0.022	0.022	-0.041
		(0.019)	(0.018)	(0.049)
Father-in-law is a baron		ref.	ref.	ref.
Wife's age at marriage			0.014***	0.014***
			(0.002)	(0.004)
Wife's age at death			0.000	-0.000
			(0.000)	(0.001)
Husband's age at death			-0.003***	-0.004***
			(0.001)	(0.001)
Still to live births (fam)			0.175	0.050
			(0.311)	(2.940)
Wife's social status	NO	YES	YES	YES
Family FE	NO	NO	NO	YES
Birth year FE	NO	NO	NO	YES
Marr. quarter-century FE	NO	NO	NO	YES
Observations	1,526	1,525	1,505	1,505
% correctly predicted	81.2	81.2	82.8	90.9

Notes: The sample is all peer heirs' wives who married between 1650 and 1882. Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement. Wife's social status includes indicators for her father's position (commoner, knight, baronet, baron, or duke); Still to live births is the number of stillbirths relative to the number of children born in the husband's family; % correctly predicted shows the percent of childless individuals for whom the predicted childlessness rate is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Baseline OLS results

Dep. variable: All live births (if > 0)

	heirs' wives				non-heirs' wives	peers of scotland
	(1)	(2)	(3)	(4)	(5)	(6)
Settlement	0.041	0.042	0.013	0.036	-0.071	-0.014
[i.e., marriage before inheritance]	(0.035)	(0.035)	(0.033)	(0.042)	(0.083)	(0.143)
Number of siblings	0.011**	0.011**	0.010**	-0.010	0.001	0.028***
	(0.005)	(0.004)	(0.004)	(0.006)	(0.009)	(0.010)
Father-in-law is a duke		0.046	0.027	0.042		0.350
		(0.036)	(0.034)	(0.076)		(0.225)
Wife's age at marriage			-0.032***	-0.024***		-0.021
			(0.005)	(0.005)		(0.014)
Wife's age at death			0.000	0.003***	0.006***	0.010***
			(0.001)	(0.001)	(0.002)	(0.003)
Husband's age at death			0.012***	0.013***	0.009***	0.023***
			(0.001)	(0.002)	(0.002)	(0.004)
Still to live births (fam)			-0.38**	3.4	-4.9	10.3
			(0.19)	(2.7)	(10.0)	(28.8)
Wife's social status	NO	YES	YES	YES	YES	YES
Father-in-law status	-	-	-	-	YES	-
Family FE	NO	NO	NO	YES	YES	YES
Birth year FE	NO	NO	NO	YES	YES	YES
M. quarter-century FE	NO	NO	NO	YES	YES	YES
Observations	1,264	1,263	1,261	1,261	854	311

Notes: The sample is all peer heirs' wives who married between 1650 and 1882 in columns (1)–(4), all peer daughters' marrying non-heirs between 1650 and 1882 in column (5), and all Scottish heirs' wives who married between 1650 and 1882 in column (6). In all columns, the sample is restricted to women who gave birth at least once; Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement; Wife's social status includes indicators for her father's position (commoner, knight, baronet, baron, or duke); Father-in-law status considers the same categories; Still to live births is the number of stillbirths relative to the number of children born in the husband's family. Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Poisson regressions for the number of children

Dep. Variable: Settlement [i.e., marriage before inheritance]

	coef.	s.e.
Birth order of the heir		
1st	reference	
2nd	-0.037	(0.024)
3rd	-0.102***	(0.026)
4th	-0.119***	(0.033)
5th	-0.118***	(0.045)
6th	-0.150***	(0.055)
7th	-0.165**	(0.074)
8th	-0.117	(0.106)
9th	-0.154	(0.114)
10th	-0.042	(0.093)
11th	0.108	(0.235)
12th	-0.139	(0.115)
13th	0.222	(0.196)
15th	0.426***	(0.049)
Father age at death	0.021***	(0.001)
Number of siblings	0.005*	(0.003)
Father is a duke	0.040*	(0.024)
Wife's age at marriage	-0.009***	(0.002)
Wife's age at death	-0.001***	(0.001)
Husband's age at death	-0.001	(0.001)
Still to live births (fam)	-0.549***	(0.145)
Wife's social status	YES	
Marr. quarter-century FE	YES	
Observations	1,530	
% correctly predicted	74.8	
F test	110.0	

Notes: The sample is all peers who married between 1650 and 1882; Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement; Wife's social status includes indicators for her father's position (commoner, knight, baronet, baron, or duke); Still to live births is the number of stillbirths relative to the number of children born in the husband's family; % correctly predicted shows the percent of individuals who married after inheritance for whom the predicted value is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 6: First-stage

Dep. Variable: Childlessness

	OLS	IV
Settlement	-0.079**	-0.147***
[i.e., marriage before inheritance]	(0.035)	(0.036)
Number of siblings	-0.004	-0.002
	(0.005)	(0.003)
Father-in-law is a duke	-0.041	-0.039
	(0.049)	(0.035)
Wife's age at marriage	0.014***	0.012***
	(0.004)	(0.003)
Wife's age at death	-0.000	-0.000
	(0.001)	(0.001)
Husband's age at death	-0.004***	-0.004***
	(0.001)	(0.001)
Still to live births (family)	0.050	-0.116
	(2.94)	(2.09)
Wife's social status	YES	YES
Family FE	YES	YES
Birth year FE	YES	YES
Marr. quarter-century FE	YES	YES
Observations	1,506	1,506
% correctly predicted	90.9	91.1
Sargan-Hansen test	-	13.12
		(p-val .44)

Notes: The sample is all peer heirs' wives who married between 1650 and 1882; Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement; Wife's social status includes indicators for her father's position (commoner, knight, baronet, baron, or duke); Still to live births is the number of stillbirths relative to the number of children born in the husband's family; % correctly predicted shows the percent of childless individuals for whom the predicted childlessness rate is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Second-stage

Dep. Variable: Childlessness

	(1)	(2)	(3)	(4)
	benchmark	non-heirs	England and Ireland	Scotland
Settlement	-0.145***	0.031	-0.159***	0.025
[i.e., marriage before inheritance]	(0.036)	(0.054)	(0.054)	(0.094)
Ho:	-	$\beta(1) = \beta(2)$	-	$\beta(3) = \beta(4)$
prob > chi2	-	7.04***	-	2.89*
Controls	YES	YES	YES	YES
Family FE	YES	YES	YES	YES
Birth year FE	YES	YES	YES	YES
M. quarter-century FE	YES	YES	YES	YES
Father-in-law status	-	YES	-	-
Observations	1,506	1,442	1,139	366
% correctly predicted	91.1	54.2	79.0	40.0
F-stat from first stage	110.0	92.2	85.0	52.1

Notes: The sample is all peer heirs' wives who married between 1650 and 1882 in column (1), all peers' daughters marrying non-heirs between 1650 and 1882 in column (2), all English and Irish peers heirs' wives who married between 1650 and 1882 in column (3), and all Scottish heirs' wives who married between 1650 and 1882 in column (4); Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement; Controls are the number of siblings of the husband, age at marriage of the wife, age at death of both spouses, the history of stillbirths relative to the number of children born in the husband's family, and wife's social status (wife's father is a commoner, a knight, a baronet, a baron, or a duke); Father-in-law status considers the same categories; % correctly predicted shows the percent of childless individuals for whom the predicted childlessness rate is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Test for the exclusion restriction – Second-stage (1650-1882)

Dep. Variable:	Childlessness				All live births (if > 0)
	(1)	(2)	(3)	(4)	(5)
	heir's wives		non-heirs	Scotland	heir's wives
	OLS	IV	IV	IV	Poisson
Settlement	-0.077***	-0.149***	0.029	0.034	0.025
[i.e., heir's majority bef. inheritance]	(0.030)	(0.038)	(0.054)	(0.053)	(0.040)
Ho:	-	-	$\beta(2) = \beta(3)$	$\beta(2) = \beta(4)$	-
prob > chi2	-	-	6.85***	8.07***	-
Controls	YES	YES	YES	YES	YES
Family FE	YES	YES	YES	YES	YES
Birth year FE	YES	YES	YES	YES	YES
Marr. quarter-century FE	YES	YES	YES	YES	YES
Father-in-law status	-	YES	-	-	-
Observations	1,701	1,701	1,807	434	1,417
% correctly predicted	90.23	90.05	58.07	33.14	-
F-stat from first stage	-	105.8	101.7	52.8	-

Notes: The sample is all peer heirs' wives who married between 1650 and 1882. For columns (3) and (4), the sample is restricted to women not exposed to settlements because they married a non-heir (col. 3) or a Scottish heir (col. 4). For column (5), the sample is restricted to women who gave birth at least once. Heir's majority before inheritance indicates that the heir turned 21 before the family head died. It is our alternative proxy for signing a settlement; Controls are the number of siblings of the husband, age at marriage of the wife, age at death of both spouses, the history of stillbirths relative to the number of children born in the husband's family, and wife's social status (wife's father is a commoner, a knight, a baronet, a baron, or a duke); Father-in-law status considers the same categories; % correctly predicted shows the percent of childless individuals for whom the predicted childlessness rate is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Robustness: inheritance before majority as a proxy for not signing a settlement

Dep. Variable: Settlement [i.e., heir's majrity before inheritance]

	coef.	s.e.
Birth order of the heir		
1st	reference	
2nd	-0.031	(0.020)
3rd	-0.085***	(0.025)
4th	-0.117***	(0.026)
5th	-0.114***	(0.035)
6th	-0.164***	(0.048)
7th	-0.148**	(0.059)
8th	-0.122*	(0.069)
9th	-0.116**	(0.056)
10th	-0.118	(0.078)
11th	-0.128	(0.134)
12th	-0.390**	(0.178)
13th	-0.029	(0.164)
15th	0.288***	(0.042)
Father age at death	0.020***	(0.001)
Number of siblings	0.012***	(0.002)
Father is a duke	0.006	(0.020)
Wife's age at marriage	0.001	(0.002)
Wife's age at death	-0.000	(0.000)
Husband's age at death	0.000	(0.001)
Still to live births (fam)	-0.225	(0.270)
Wife's social status	YES	
Marr. quarter-century FE	YES	
Observations	1,726	
% correctly predicted	87.6	
F test	105.8	

Notes: Sample is all peers who married between 1650 and 1882; Heir's majority before inheritance indicates that the heir turned 21 before the family head died. It is our alternative proxy for signing a settlement; Wife's social status includes indicators for her father's position (commoner, knight, baronet, baron, or duke); Still to live births is the number of stillbirths relative to the number of children born in the husband's family; % correctly predicted shows the percent of individuals who married after inheritance for whom the predicted value is higher than 0.5; Standard errors clustered by family in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 10: Robustness: First-stage

B Appendix

This appendix proves Propositions 1 to 11.

B.1 Proof of Proposition 1

We solve for the optimal levels of consumption and bequests by backward induction. Generation 3 chooses the level of consumption that maximizes (8) subject to $x_3 = k_3$, where k_3 follows from the choices of generation 2.

Generation 2 chooses consumption, x_2, and bequests, k_3, to maximize (6) subject to (7), given the level of bequests chosen by generation 1, k_2. The optimal choices depend on whether generation 2 has children or not. If $n_2 = 0$, the optimal solutions are $x_2 = x_2^* := k_2$ and $k_3 = 0$. If $n_2 = 1$, the optimal solutions are

$$x_2 = x_2^{**} := \frac{k_2}{1+\beta\delta}, \quad \text{and} \quad k_3 = x_3^{**} := \frac{\beta\delta k_2}{1+\beta\delta}.$$

Generation 1 chooses consumption, x_1, and the bequests, k_2, to maximize (4) subject to (5). If $n_1 = 0$, the optimal solutions are $x_1 = K$ and $k_2 = 0$. If $n_2 = 0$ and $n_1 = 1$, the optimal solutions are

$$x_1 = x_1^* := \frac{K}{1+\beta\delta}, \quad \text{and} \quad k_2 = k_2^* := \frac{\beta\delta K}{1+\beta\delta}.$$

If $n_2 = 1$ and $n_1 = 1$, the optimal solutions are

$$x_1 = x_1^{**} := \frac{K}{1+\beta\delta+\beta\delta^2}, \text{ and } k_2 = k_2^{**} := K - \frac{K}{1+\beta\delta+\beta\delta^2}.$$

Replacing k_2^* in x_2^*, and k_2^{**} in x_2^{**} and x_3^{**}, Proposition 1 summarizes the optimal conditions detailed above.

B.2 Proof of Proposition 2

Generation 3 is always childless, $n_3 = 0$.

For generation 2, f is the difference between the indirect utility when $n_2 = 1$ and the indirect utility when $n_2 = 0$.

$$f(k_2, \beta, \delta) = \ln\left(\frac{k_2}{1+\beta\delta}\right) + \beta\delta \ln\left(\frac{\beta\delta k_2}{1+\beta\delta}\right) - \ln(k_2).$$

The partial derivative with respect to k_2 is $f_{k_2} = \dfrac{\beta\delta}{k_2} > 0$.

For generation 1, g is the difference between the indirect utility when $n_1 = 1,\ n_2 = 0$ and the indirect utility when $n_1 = 0$. Given the optimal solution on consumptions given in Proposition 1, x_1^* and x_2^*,

$$g(K, \beta, \delta) = \ln\left(\frac{K}{1+\beta\delta}\right) + \beta\delta \ln\left(\frac{\beta\delta K}{1+\beta\delta}\right) - \ln(K).$$

The partial derivative is $g_K = \dfrac{\beta\delta}{K} > 0$.

For generation 1, h is the difference between the indirect utility when $n_1 = 1,\ n_2 = 1$ and the indirect utility when $n_1 = 0$. Given the optimal solution on consumptions given in Proposition 1, x_1^{**}, x_2^{**} and x_3^{**},

$$\begin{aligned} h(K, \beta, \delta) = \ln\left(\frac{K}{1+\beta\delta+\beta\delta^2}\right) &+ \delta\beta \ln\left(\frac{1+\delta}{1+\beta\delta}\ \frac{\beta\delta K}{1+\beta\delta+\beta\delta^2}\right) \\ &+ \beta\delta^2 \ln\left(\frac{\beta(1+\delta)}{1+\beta\delta}\ \frac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}\right) - \ln(K). \end{aligned}$$

The partial derivative is $h_K = \dfrac{\beta\delta(1+\delta)}{K} > 0$.

B.3 Proof of Proposition 3

From Proposition 2, the functions g and h, compare the indirect utilities of generation 1 when $n_1 = 1$ and when $n_1 = 0$ at the optimal levels of x_1, x_2, and x_3 given in Proposition 1. The function f, compares the indirect utilities of generation 2 when $n_2 = 1$ and when $n_2 = 0$ at the optimal level of k_2 given in Proposition 1. The sign of these functions gives the SPE.

B.4 Proof of Proposition 4

Let $\Gamma := \beta \cdot \delta$. The conditions for a high fertility SPE can be written as:

$$f(k_2^{**}, \beta, \delta) \geq 0 \iff \mathcal{C}_1(\beta) := \ln \frac{\beta\Gamma(1+\Gamma)K}{(1+\Gamma)(\beta+\beta\Gamma+\Gamma^2)} + \Gamma \ln \frac{\beta\Gamma^2(1+\Gamma)K}{(1+\Gamma)(\beta+\beta\Gamma+\Gamma^2)} - \ln \frac{\beta\Gamma(1+\Gamma)K}{\beta+\beta\Gamma+\Gamma^2} \geq 0, \quad (11)$$

$$h(K, \beta, \delta) > 0 \iff \mathcal{C}_2(\beta) := \ln \frac{\beta K}{\beta+\beta\Gamma+\Gamma^2} + \Gamma \ln \frac{\beta+\Gamma}{1+\Gamma} \frac{\Gamma K}{\beta+\beta\Gamma+\Gamma^2} + \frac{\Gamma^2}{\beta} \ln \frac{\beta+\Gamma}{1+\Gamma} \frac{\Gamma^2 K}{\beta+\beta\Gamma+\Gamma^2} - \ln K \quad (12)$$

and

$$v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) > v_1(x_1^{*}, x_2^{*}, x_3{=}0, n_1{=}1, n_2{=}0) \iff$$
$$\mathcal{C}_3(\beta) := \ln \frac{\beta K}{\beta+\beta\Gamma+\Gamma^2} + \Gamma \ln \frac{\beta+\Gamma}{1+\Gamma} \frac{\Gamma K}{\beta+\beta\Gamma+\Gamma^2} + \frac{\Gamma^2}{\beta} \ln \frac{\beta+\Gamma}{1+\Gamma} \frac{\Gamma^2 K}{\beta+\beta\Gamma+\Gamma^2} - \ln \frac{K}{1+\Gamma} - \Gamma \ln \frac{\Gamma K}{1+\Gamma} > 0. \quad (13)$$

For a constant Γ, conditions (11)-(13) only depend on β. We then need to show that $\frac{\partial \mathcal{C}_1(\beta)}{\partial \beta} < 0$, $\frac{\partial \mathcal{C}_2(\beta)}{\partial \beta} < 0$, and $\frac{\partial \mathcal{C}_3(\beta)}{\partial \beta} < 0$. Computing the derivatives, we have:

$$\frac{\partial \mathcal{C}_1(\beta)}{\partial \beta} = -\frac{\Gamma^2}{(\beta+\Gamma)(\beta+\beta\Gamma+\Gamma^2)} < 0,$$

and

$$\frac{\partial \mathcal{C}_2(\beta)}{\partial \beta} = \frac{\partial \mathcal{C}_3(\delta)}{\partial \delta} = -\left(\frac{\Gamma}{\beta}\right)^2 \ln \frac{\beta+\Gamma}{1+\Gamma} \frac{\Gamma^2 K}{\beta+\beta\Gamma+\Gamma^2} = -\left(\frac{\Gamma}{\beta}\right)^2 \ln x_3^{**} > 0,$$

since n_2 would be nil otherwise.

B.5 Proof of Proposition 5

We solve for the optimal levels of consumption and bequests by backward induction. Generation 3 chooses the level of consumption that maximizes (8) subject to $x_3 = k_3$, where k_3 is given by the choices of generation 1.

Generation 2 chooses the level of consumption that maximizes (6) subject to $x_2 = k_2$, where k_3 is given by the choices of generation 1.

Generation 1 chooses consumption, x_1, and bequests, k_2 and k_3 to maximize (4) subject to (9). If $n_1 = 0$, the optimal solutions are $x_1 = K$ and $k_2 = k_3 = 0$. If $n_2 = 0$ and $n_1 = 1$, the optimal solutions are

$$x_1 = x_1^* := \frac{K}{1+\beta\delta}, \quad k_2 = k_2^* := \frac{\beta\delta K}{1+\beta\delta}, \quad \text{and} \quad k_3 = k_3^* := 0.$$

If $n_2 = 1$ and $n_1 = 1$, the optimal solutions are

$$x_1 = x_{1c}^{**} := \frac{K}{1+\beta\delta+\beta\delta^2}, \quad k_2 = k_{2c}^{**} := \frac{\beta\delta K}{1+\beta\delta+\beta\delta^2},$$

$$\text{and} \quad k_3 = k_{3c}^{**} := \frac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}.$$

Replacing k_2^* and k_3^* in x_2^*, k_{2c}^{**} in x_{2c}^{**}, and k_{3c}^{**} in x_{3c}^{**}, Proposition 5 summarizes the optimal conditions detailed above.

B.6 Proof of Proposition 6

Generation 3 is always childless, $n_3 = 0$.

For generation 2, $\mathcal{F}$ is the difference between the indirect utility when $n_2 = 1$ and the indirect utility when $n_2 = 0$.

$$\mathcal{F}(k_3, \beta, \delta) = \ln(k_2) + \beta\delta \ln(k_3) - \ln(k_2) = \beta\delta \ln(k_3).$$

The partial derivative is $\mathcal{F}_{k_3} = \beta\delta \dfrac{1}{k_3} > 0$.

For generation 1, g is the difference between the indirect utility when $n_1 = 1,\ n_2 = 0$

and the indirect utility when $n_1 = 0$. Note that this function is equivalent to the one defined in the model without commitment. Hence, Proof B.2 shows that $h_K > 0$.

For generation 1, $\mathcal{H}$ is the difference between the indirect utility when $n_1 = 1,\ n_2 = 1$ and the indirect utility when $n_1 = 0$.

$$\mathcal{H}(K,\beta,\delta) = \ln\left(\frac{K}{1+\beta\delta+\beta\delta^2}\right) + \beta\delta\ln\left(\frac{\beta\delta K}{1+\beta\delta+\beta\delta^2}\right) + \beta\delta^2\ln\left(\frac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}\right) - \ln(K).$$

The partial derivative is $\mathcal{H}_K = \dfrac{\beta\delta(1+\delta)}{K} > 0$.

B.7 Proof of Proposition 7

From Proposition 6, the functions g and $\mathcal{H}$ compare the indirect utilities of generation 1 when $n_1 = 1$ and when $n_1 = 0$ at the optimal levels of x_1, x_2, and x_3 given in Proposition 5. The function $\mathcal{F}$, compares the indirect utilities of generation 2 when $n_2 = 1$ and when $n_2 = 0$ at the optimal level of k_2 given in Proposition 5. The sign of these functions gives the SPE.

B.8 Proof of Proposition 8

Let $\Gamma := \beta\cdot\delta$. The conditions for a high fertility SPE can be written as:

$$\mathcal{F}(k_{3c}^{**},\beta,\delta) \geq 0 \iff \mathcal{C}_{1c}(\beta) := \Gamma\ln\frac{\Gamma^2 K}{\beta(1+\Gamma)+\Gamma^2} \geq 0, \tag{14}$$

$$\mathcal{H}(K,\beta,\delta) > 0 \iff \mathcal{C}_{2c}(\beta) := \ln\frac{\beta K}{\beta(1+\Gamma)+\Gamma^2} + \Gamma\ln\frac{\beta\Gamma K}{\beta(1+\Gamma)+\Gamma^2} + \frac{\Gamma^2}{\beta}\ln\frac{\Gamma^2 K}{\beta(1+\Gamma)+\Gamma^2} - \ln K > 0 \tag{15}$$

and

$$v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1{=}1, n_2{=}1) > v_1(x_1^*, x_2^*, x_3{=}0, n_1{=}1, n_2{=}0) \iff$$

$$\mathcal{C}_{3c}(\beta) := \ln \frac{\beta K}{\beta(1+\Gamma)+\Gamma^2} + \Gamma \ln \frac{\beta \Gamma K}{\beta(1+\Gamma)+\Gamma^2} + \frac{\Gamma^2}{\beta} \ln \frac{\Gamma^2 K}{\beta(1+\Gamma)+\Gamma^2} - \ln \frac{K}{1+\Gamma} - \Gamma \ln \frac{\Gamma K}{1+\Gamma} > 0. \quad (16)$$

Keeping Γ constant, conditions (14)-(16) only depend on β. We then need to show that $\frac{\partial \mathcal{C}_{1c}(\beta)}{\partial \beta} < 0$, $\frac{\partial \mathcal{C}_{2c}(\beta)}{\partial \beta} < 0$, and $\frac{\partial \mathcal{C}_{3c}(\beta)}{\partial \beta} < 0$. Computing the derivatives, we then have:

$$\frac{\partial \mathcal{C}_{1c}(\beta)}{\partial \beta} = -\frac{\Gamma(1+\Gamma)}{\beta + \Gamma(\Gamma+\beta)} < 0,$$

and

$$\frac{\partial \mathcal{C}_{2c}(\beta)}{\partial \beta} = \frac{\partial \mathcal{C}_{3c}(\beta)}{\partial \beta} = -\left(\frac{\Gamma}{\beta}\right)^2 \ln \frac{\Gamma^2 K}{\beta(1+\Gamma)+\Gamma^2} = -\left(\frac{\Gamma}{\beta}\right)^2 \ln x_3^{**} < 0.$$

B.9 Proof of Proposition 9

We need to show that $\mathcal{F}(k_{3c}^{**}, \beta, \delta) - f(k_2^{**}, \beta, \delta) > 0$, $\mathcal{H}(K, \beta, \delta) - h(K, \beta, \delta) > 0$, and $v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1{=}1, n_2{=}1) - v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) > 0$. Notice that the last two inequalities are identical. Starting with $\mathcal{F}(k_{3c}^{**}, \beta, \delta) - f(k_2^{**}, \beta, \delta)$ we have

$$\mathcal{F}(k_{3c}^{**}, \beta, \delta) - f(k_2^{**}, \beta, \delta) = \ln \frac{1+\beta\delta}{1+\delta} + \ln(1-\delta) + \beta\delta \ln \frac{1+\beta\delta}{(1+\delta)\beta}$$

where the last term is strictly positive and

$$\ln \frac{1+\beta\delta}{1+\delta} + \ln(1-\delta) > 0 \iff K\beta^2\delta^2(1+\delta) > 0.$$

Computing the difference $\mathcal{H}(K, \beta, \delta) - h(K, \beta, \delta)$ we have

$$\mathcal{H}(K, \beta, \delta) - h(K, \beta, \delta) = \beta\delta \ln \frac{1+\beta\delta}{1+\delta} + \beta\delta^2 \ln \frac{1+\beta\delta}{\beta(1+\delta)}.$$

Let $\mathcal{A}(\beta, \delta)$ be defined as

$$\mathcal{A}(\beta, \delta) := \ln \frac{1+\beta\delta}{1+\delta} + \delta \ln \frac{1+\beta\delta}{\beta(1+\delta)}.$$

We have that $\mathcal{A}(\beta, 0) = \mathcal{A}(1, \delta) = 0$,

$$\mathcal{A}(\beta, 1) = \ln \frac{(1+\beta)^2}{4\beta} > 0 \quad \text{and} \quad \lim \mathcal{A}(\beta, 1)_{\beta \to 0} = +\infty.$$

Moreover,

$$\frac{\partial A(\beta, \delta)}{\partial \beta} = -\frac{(1-\beta)\delta}{\beta(1+\beta\delta)} < 0 \quad \text{and} \quad \frac{\partial A(\beta, \delta)}{\partial \delta} = -\frac{1-\beta}{1+\beta\delta} + \ln \frac{1+\beta\delta}{\beta(1+\delta)},$$

with $\lim \left.\frac{\partial A(\beta, \delta)}{\partial \delta}\right|_{\beta \to 0} = +\infty$ and $\frac{\partial A(\beta, \delta)}{\partial \delta} < 0$ for $\beta > 0$.

Therefore, for $\{\beta, \delta\} \in (0, 1)$, $\mathcal{H}(K, \beta, \delta) - h(K, \beta, \delta) > 0$ (and $v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1{=}1, n_2{=}1) - v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1{=}1, n_2{=}1) > 0$).

B.10 Proof of Proposition 10

For any fixed value of $\Gamma := \beta \cdot \delta$, we need to show that:

$$\frac{\partial(\mathcal{C}_{1c} - \mathcal{C}_1)}{\partial \beta} < 0, \quad \frac{\partial(\mathcal{C}_{2c} - \mathcal{C}_2)}{\partial \beta} < 0, \quad \text{and} \quad \frac{\partial(\mathcal{C}_{3c} - \mathcal{C}_3)}{\partial \beta} < 0,$$

where $\mathcal{C}_1$, $\mathcal{C}_2$ and $\mathcal{C}_3$ are the conditions for a high-equilibrium SPE in the model without commitment defined in (11)-(13) and $\mathcal{C}_{1c}$, $\mathcal{C}_{2c}$ and $\mathcal{C}_{3c}$ are the conditions for a high-equilibrium SPE in the model with commitment defined in (14)-(16). Computing the three derivatives we have,

$$\frac{\partial(\mathcal{C}_{1c} - \mathcal{C}_1)}{\partial \beta} = -\frac{\Gamma}{\Gamma + \beta} < 0 \quad \text{and} \quad \frac{\partial(\mathcal{C}_{2c} - \mathcal{C}_2)}{\partial \beta} = \frac{\partial(\mathcal{C}_{3c} - \mathcal{C}_3)}{\partial \beta} = \left(\frac{\Gamma}{\beta}\right)^2 \ln \frac{\beta + \Gamma}{1 + \Gamma} < 0.$$

B.11 Proof of Proposition 11

Generation 1 is better off in the model with commitment as the condition

$$v_1(x_{1c}^{**}, x_{2c}^{**}, x_{3c}^{**}, n_1 = 1, n_2 = 1) > v_1(x_1^*, x_2^*, x_3 = 0, n_1 = 1, n_2 = 0) \tag{17}$$

defines the region characterized in Proposition 9. Note that condition (17) can be rewritten as:

$$\frac{1+\beta\delta}{\delta}\ln\left(\frac{1+\beta\delta}{1+\beta\delta+\beta\delta^2}\right) + \beta\delta\ln\left(\frac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}\right) > 0. \tag{18}$$

Generation 2 is better off in the model with commitment in the region characterized in Proposition 9 if and only if

$$v_2(x_{2c}^{**}, x_{3c}^{**}, n_2 = 1) > v_2(x_2^*, x_3 = 0, n_2 = 0)$$

which holds if and only if

$$\ln\left(\frac{1+\beta\delta}{1+\beta\delta+\beta\delta^2}\right) + \beta\delta\ln\left(\frac{\beta\delta^2 K}{1+\beta\delta+\beta\delta^2}\right) > 0. \tag{19}$$

Inequality (18) implies that inequality (19) is satisfied.

C Additional figures and tables

Dep. Variable: Childlessness

	(1)	(2)	(3)	(4)	(5)
	IV triangular	IV classic			
	heirs	heirs	non-heirs	England and Ireland	Scotland
Settlement	-0.144***	-0.145***	0.026	-0.165***	-0.008
[i.e., marriage before inheritance]	(0.036)	(0.035)	(0.060)	(0.050)	(0.077)
Controls	YES	YES	YES	YES	YES
Family FE	YES	YES	YES	YES	YES
Birth year FE	YES	YES	YES	YES	YES
M. quarter-century FE	YES	YES	YES	YES	YES
Father-in-law status	-	-	YES	-	-
Observations	1,531	1,504	1,258	1,139	365
% correctly predicted	91.0	90.9	55.8	55.8	59.8
F-stat from first-stage	23.0	27.5	23.1	15.8	3.3

Notes: Column 1 presents the results from the benchmark IV triangular model described in section 3.3. Columns 2 to 5 present the results from a classic IV model including all covariates in the first stage. The sample is all peer heirs' wives who married between 1650 and 1882 in columns (1) and (2), all peers' daughters marrying non-heirs between 1650 and 1882 in column (3), all English and Irish peers heirs' wives who married between 1650 and 1882 in column (4), and all Scottish heirs' wives who married between 1650 and 1882 in column (5); Marriage before inheritance indicates that the heir married before the family head died. It is our proxy for signing a settlement; Controls are the number of siblings of the husband, age at marriage of the wife, age at death of both spouses, the history of stillbirths relative to the number of children born in the husband's family, and wife's social status (wife's father is a commoner, a knight, a baronet, a baron, or a duke); Father-in-law status considers the same categories; % correctly predicted shows the percent of childless individuals for whom the predicted childlessness rate is higher than 0.5; Standard errors clustered by family in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 11: IV with all covariates in first-stage (1650-1882)