Childless Aristocrats. Inheritance and the extensive margin of fertility*

Short title: Childless Aristocrats

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Abstract

Using genealogical data of British aristocrats, we show that inheritances can affect childlessness. We study settlements, a contract restricting heirs’ powers and settling bequests for yet-to-be-born generations. Settlements reduced childlessness to the “natural” rate, ensuring aristocratic dynasties’ survival. Our estimation exploits that settlements were signed at the heir’s wedding if the family head lived until this date. Whether the heir was born after a girl provides as-good-as-random assignment into settlements. Next, we develop a theory that reproduces our findings, shows that exponential discounting cannot rationalize inheritance systems restricting heirs, and that inheritance systems can emerge endogenously when fertility concerns exist.

JEL classification: J13, K36, N33.

Keywords: Childlessness, Inheritance, Settlement, Fertility, Elites, Intergenerational discounting.

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1 Introduction

Inheritance systems have long attracted the attention of economists. For example, Adam Smith gave a scathing criticism of primogeniture and entailment of the land: He argued that these laws exacerbated inequality, ‘making beggars’ of all but the first-born.\(^1\) This intuition has carried over to modern work. Several studies argue that inheritance systems have important effects for fiscal policy (Barro, 1974), inequality (Stiglitz, 1969; Chu, 1991; Piketty, 2011), or economic growth and the transition to modern, democratic societies (Bertocchi, 2006).

However, what effect inheritance has on inequality, social mobility, or economic growth depends crucially on fertility choices. For example, a standard implication of models of intergenerational transfers is that if the very rich have more (less) children, inheritances seemingly reduce (increase) inequality (e.g. Stiglitz, 1969; Atkinson and Harrison, 1978). Despite the central role of fertility, one common feature in the analysis of inheritance is to treat fertility as exogenous (Abel, 1987; Weil, 1987) or, more recently, to consider endogenous fertility decisions only on the intensive margin—i.e., the number of children (Cordoba and Ripoll, 2016). In contrast, the relation between inheritance systems and the extensive margin of fertility—i.e., the decision to have children or not—remains unexplored. This is surprising as the economic effects of any inheritance system and, in particular, of primogeniture or entailment, crucially hinge on the production of an heir.

In this paper, we study the relation between inheritance systems and the extensive margin of fertility through the lenses of settlements—the common inheritance system among British aristocrats. Settlements enforced primogeniture, but restricted the male heir’s powers by entailing the family estates for one generation. This arrangement guaranteed that a large portion of the inheritance would pass down to the yet-to-be-born descendants of the direct family lineage, which likely created an additional incentive to produce an heir. Using genealogical data between 1650 and 1882, we find that families signing a settlement were c. 15 percentage points more likely to have children. Given that the average childlessness rate among peers was 17%, settlements increased the extensive margin of fertility, pushing childlessness rates close to the “natural” rate of 2.4% (Tietze, 1957),\(^2\) and hence, contributed to the survival of noble dynasties. In contrast, we find that settlements did not affect the intensive margin of fertility.\(^3\)

\(^1\)Smith (1776) [1937], book III, chapter II.
\(^2\)The “natural” rate corresponds to that of Hutterites, who marry young, do not divorce, do not control fertility, and have access to modern health care.
\(^3\)A settlements protected the heir’s bequest more than the bequests of other offspring. Hence,
Our empirical setting offers several advantages. First, the institutional background of settlements can be used to address endogeneity concerns. Specifically, a father and his heir had to sign/renew a settlement every generation. Because of legal constraints and tradition, the renewal was done at the heir’s wedding day (Bonfield, 1979). Thus, when the father died (exogenously) before his heir’s wedding, a settlement was not signed. This generates as-good-as-random assignment of families into settlements. Our source of exogenous variation is the gender of the first offspring. The idea is that in families in which the heir is born after a daughter the father will be relatively older than in families where the heir is the first offspring, exogenously decreasing the probability to live until his heir’s wedding. The second advantage of our empirical setting is that it allows us to conduct placebo tests to validate our results. Unlike settlements in England and Ireland, Scottish entailments were perpetual, i.e., they did not have to be renewed upon the heir’s wedding (Habakkuk, 1994, p.6). We estimate our instrumental variables’ model for a comparable sample of women who should not be affected by settlements because they married a Scottish heir, or because they did not marry an heir. Our estimates are close to zero for these populations who did not use settlements. This suggests that our empirical model captures the effect of settlements and not other confounding factors. We also estimate a difference-in-differences model using Scottish heirs and non-heirs as control groups and obtain robust results. Third, settlements remained stable in their form between 1650 and 1881. Fourth, our historical setting allows examining implications over the long-run to which modern data remains silent. This is important because inheritance systems which, like settlements, place restrictions on heirs are increasingly popular today. For example, trusts are widely used among the top one percent (Wolff and Gittleman, 2014). In our context, we show that settlements were crucial for the survival of the British aristocracy in a time when strong demographic pressures threatened the extinction of these lineages. Around the 1600s, forty percent of all married women in the aristocracy were childless. Settlements reversed this pattern.

In sum, the first result of the paper is that settlements moved the British aristocracy to a higher fertility regime. This implies that settlements contributed to the perpetuation of elite lineages not only by entailing the land or favouring primogeniture as suggested by Adam Smith, Alexis de Tocqueville, or Karl Marx, but also through changing fertility incentives.

The second contribution of the paper is to present a novel theory of intergenerational transmission of wealth that (1) rationalizes the effect of settlements on it should alter fertility incentives on the extensive margin rather than in the intensive margin.
fertility and (2) shows that such inheritance systems can emerge endogenously in response to concerns over the dynasty’s survival. At first sight, it is not obvious why settlements should affect fertility. In a classic Barro model of wealth transmission with exponential discounting, incentives over fertility and bequests are aligned across generations. Hence, a contract like settlements—which restricts heirs’ powers to decide over future bequests—should be innocuous. Our model departs from the classic assumption of exponential discounting. Instead, we adapt the idea of hyperbolic discounting across generations, as was first introduced by Phelps and Pollak (1968). This type of discounting implies that individuals have strong dynastic preferences, as they do not value their children’s well-being significantly more than that of the future generations.\footnote{To be precise, we assume that preferences have a direct pure altruism representation (Galperti and Strulovici, 2017).} Under this assumption, settlements can change fertility incentives and resolve intergenerational time inconsistencies. The economic intuition is simple: an individual who is subject to a settlement cannot appropriate the bequest settled for the next generation (e.g., by selling parts of the family estate). The only way in which he can derive utility from this settled wealth is by continuing the family line. This effect will be larger for families with a stronger degree of hyperbolicity, i.e., “dynastic preference.”

The second theoretical result is that settlements—or, more generally, inheritance systems which place restrictions on heirs—can emerge endogenously in response to concerns over the continuation of the dynasty. Intuitively, it is not obvious why an heir would agree to sign a settlement, renouncing to freely dispose of the dynasty’s wealth and to decide next generation’s bequests. We show that a settlement is welfare improving for all the members of a dynasty with hyperbolic preferences. The family head is better off as settlements ensure the continuation of the dynasty. The heir is also \textit{ex ante} better off. Under a settlement, he can credibly commit to have children, which guarantees that a larger share of the family wealth will trickle down from the family head. Hence, the family head and the heir agree to sign a settlement as a result of their optimal decisions—even if this restricts the heir’s powers to manage the dynasty’s wealth.

Relative to the existing literature, we make the following contributions. Our paper is the first to provide empirical evidence showing that inheritance systems can change fertility incentives on the extensive margin, and hence, contribute to survival of family lineages. A growing literature shows that the extensive margin of fertility—i.e., the decision to have children or not—can respond differently to economic changes than the intensive margin of fertility—i.e., the number of
children. To the extent of our knowledge, this paper is the first to incorporate the dichotomy between the extensive and the intensive margin of fertility to the study of inheritance. This is an important step, as the economic effects of any inheritance system crucially hinge on the production of an heir.

Second, the bequests literature usually treats inheritance systems as exogenously given (see Chu, 1991, and references therein). We show that inheritance systems that restrict heirs can emerge endogenously as a result of the family head’s concerns over the survival of the dynasty and the heir’s optimal decisions. Endogenizing inheritance systems reveals that the classic assumption of exponential discounting across generations (Barro, 1974) is hard to reconcile with a wide range of historical and modern arrangements that restrict heirs’ powers to manage the dynasty’s wealth; e.g., settlements (England), trusts, fee tails (United States), entailments (Scotland), majorat (France), mayorazgo (Spain), and ordynacja (Poland). Instead, these inheritance arrangements are consistent with hyperbolic discounting across generations à la Phelps and Pollak (1968).7

Finally, we add to the large literature on inheritance systems by studying settlements, which, despite receiving a lot of attention from contemporaries like Adam Smith, Alexis de Tocqueville, or Karl Marx, are seldom considered by modern economists. So far, the study of settlements focuses on its functioning and has a descriptive nature (Habakkuk, 1950; Bonfield, 1979; English and Saville, 1983). We show that, as suggested by Adam Smith, settlements contributed to the perpetuation of elite lineages. Our results, however, suggest that they did so not only by entailing the land or favouring primogeniture, but also through changing fertility incentives. This challenges the common wisdom that fertility and inequality are negatively associated (Deaton and Paxson, 1997; Kremer and Chen, 2002; de la Croix and Doepke, 2003). Our results suggest that an increase in the extensive margin of fertility can contribute to the survival of elites.

The article proceeds as follows. Section 2 describes settlements and the data. Sections 3 and 4 present our empirical analysis. In Section 5, we present our model of inheritance and fertility. Finally, Section 6 concludes.

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5See Aaronson et al. (2014), Baudin et al. (2015, 2020), Brée and de la Croix (2019), and de la Croix et al. (2019).

6Notable exceptions are Chu (1991) and Grieco and Ziebarth (2015). They show that primogeniture can emerge endogenously as a result of, respectively, concerns over the economic survival of the dynasty and insurance against income shocks.

7Elsewhere it has been shown that hyperbolic discounting of individuals is consistent with some savings decisions (Laibson et al., 1998; Diamond and Köszegi, 2003), addictive behaviour (Gruber and Köszegi, 2001), or fertility (Wrede, 2011; Wigniolle, 2013).

8Other, non-exclusive explanations are institutional capture (Acemoglu, 2008; Allen, 2009), primogeniture (Bertocchi, 2006), or marriage (Goñi, 2018; Marcassa et al., 2020).
2 Institutional Setting and Data

2.1 Settlements

How did settlements come into being? Before 1650, settlements were used to set widowhood provisions but not to entail the land. A landowner subject to a settlement could easily sell parts of the estate, as nobody defended the interest of the beneficiary, that is, his under-aged or yet-to-be-born son (Habakkuk, 1994, p.7). This changed around 1650 with the introduction of trustees. Trustees defended the beneficiary’s interests, and hence, allowed settlements to develop into land entails. Importantly, these developments were unrelated to fertility. After the Civil War (1642–1651), both Royalist and Parliamentarian landowners were afraid of expropriation. Settlements developed into entails to ensure family estates would not be lost: When a landowner signed a settlement, the beneficiary of his estate was his under-aged or yet-to-be-born heir, who had obviously not taken sides, and thus, would not be expropriated (Habakkuk, 1994, p.12).

Although the threat of expropriation eventually disappeared, settlements became widely used by the aristocracy to entail the land and to set wife’s and younger children’s provisions. According to Habakkuk (1950, p.18), ‘about one-half of the land of England was held under strict settlement in the mid-eighteenth century’. Signing a settlement was also a strong social convention:

the full force of social convention and family custom ... [made it such that] ... only an unusually independent or unusually irresponsible young man ... would be able to stand up to such psychological pressures.

(Stone and Stone, 1984, p.78)

The typical settlement was signed between a father and his heir at the latter’s wedding. With a settlement, the heir limited his interest in the estate to that of a life-tenant, ensuring that the family estate would descend unbroken to the first-born son of his marriage (Habakkuk, 1950). That is, settlements restricted heir’s powers over the family estates and settled a large portion of the inheritance for yet-to-be-born generations. Although settlements were only valid for a generation, de facto they operated as a permanent entailment of the land, as settlements were renewed every generation. For settlements to operate in this fashion, however, it was crucial for the father to live until his heir’s wedding (Bonfield, 1979).²

²This demographic aspect of settlements is illustrated by the Brudenell and Craven families.
Settlements were signed at the heir’s wedding day for two reasons: First, because the negotiation of settlements also involved the bride’s family, who had an interest on the allowances set for her and for the couple’s children.\textsuperscript{10} Second, because as explained above settlements were originally only used to fix these provisions. Although settlements evolved into a contract entailing the land, its signing date did not change. In some cases, settlements were signed at the heir’s majority. Section 4 shows that our results are robust to this possibility.

Importantly, settlements were prevalent in England, Wales, and Ireland, but not in Scotland. There, land could be entailed \textit{ad perpetuum}. This institutional difference was the result of a stronger bias of English Common Law judges for the free alienability of land (Habakkuk, 1994, p.18). That is, it is unrelated to demographic aspects. In the empirical analysis, we will exploit this institutional difference between England and Scotland.

Settlements came to an end with the Settled Land Act in 1882. After it, the life tenant could sell parts of the family estate, as long as he obtained the best price and the money passed down to the next generation (Habakkuk, 1994, p.1).

\section*{2.2 Data}

To measure the effect of settlements on fertility, we use genealogical data on the British peerage collected by Hollingsworth (1964). The dataset covers the entire period in which settlements were prevalent (1650-1882) and provides demographic information on 1,141 heirs to English or Irish peerages and their wives.

The original Hollingsworth dataset is based on peerage records, which contain biographical entries for members of the aristocracy. Hollingsworth tracked all peers who died in 1603–1938 and their offspring. In its current form, the data has c. 26,000 individuals.\textsuperscript{11} Each entry provides the date of birth, marriage, and death, and an accuracy variable. It also states social status, title, whether he was heir-apparent at age 15, parents’ social status, and whether a title is an English, Scottish, or Irish peerage. Social status comprises five categories: (1) duke, earl, or marquis, (2) baron or viscount, (3) baronet, (4) knight, and (5) commoner. If the individual was married, we also know the spouses’ date of birth, date of death, birth

Robert Brudenell, Earl of Cardigan, settled his estates at his heir’s wedding in 1668. In contrast, the sixth Lord Craven died when his heir was barely eighteen. As no settlement was signed, the heir could sell large parts of the family estate (Habakkuk, 1994, p. 19, 45, 46).

\textsuperscript{10}We recognize the importance of allowances in settlement negotiations. However, our analysis focuses on settlements as a legal instrument to entail and ensure the integrity of family estates.

\textsuperscript{11}In 2001, the Cambridge Group for the History of Population and Social Structure re-digitized the 30,000 original index sheets. We refer to this updated dataset as Hollingsworth (2001).
and social status. For wives, social status indicates if she was the daughter of one of the five categories listed above plus foreigner. Each entry also lists the name, birth date, and accuracy of the children born to each matrimony.

The entries from the Hollingsworth dataset are not linked across generations. We match peers’ daughters and non-heir sons to their parents using the fact that their reference number is a consecutive number of their father’s reference number. The matching of heirs is less trivial: we match an entry C (children) to entry P (parent) if the information in entry C corresponds to what entry P reports about P’s children. Specifically, we match entries according to the variables surname, name, date of birth, and accuracy. We double-check potential matches where surnames display a Levenshtein distance\(^{12}\) above 1 and match the remaining 290 heirs manually. To do so, we use thepeerage.com, an online genealogical survey of the peerage. Overall, we match 98.25% of the 26,499 entries in the dataset to their parents. For further details, see Appendix A.

Table 1 presents descriptive statistics for two samples of matrimonies in 1650-1882. Panel A considers the main sample used in our empirical analysis: matrimony where the husband was heir to an English or Irish peerage (N=1,141). As explained above, these are the heirs who were potentially subject to settlements. On average, 17% of married heirs remained childless. Admittedly, some had children out of wedlock. Therefore, this childlessness rate may be an overestimate. That said, illegitimate children did not inherit and therefore are not relevant for our analysis. Those who were not childless had, on average, 5.57 children. Wives were younger than husbands at marriage (22 vs. 27 years old) and died at a similar age (61 vs. 58 years). Around 50% of these matrimony had girls as the last child, indicating that on average parents did not stop having children after producing a son.\(^ {13}\) As for socio-economic status, 59% were duke, earl, or marquis’ heirs; 59% were heirs to an English peerage and 41% to an Irish peerage. Finally, 58% of heirs married before their father’s death. Since settlements were typically signed at the heir’s wedding, this suggests that around 58% of our sample signed a settlement.\(^ {14}\)

Panel B considers a comparable sample of matrimony in 1650-1882 that should not be affected by settlements because the husband was heir to a Scottish peerage or was not an heir.\(^ {15}\) In Section 3 we use this sample to conduct

\(^{12}\) The minimum number of character edits required to change one surname into the other.

\(^{13}\) For this variable, the sample is reduced to 813 because it considers heirs who had at least a child who (i) also appears in the Hollingsworth (2001) database and (ii) who could be matched.

\(^{14}\) This is in line with Habakkuk (1950)’s claim that half of the estates were under settlements.

\(^{15}\) Specifically, we consider matrimony where the husband is not an heir and the wife is the daughter of an English or Irish peer. We impose this additional condition (i) to make this placebo group more comparable to our baseline sample of heirs to English and Irish peerages; and (ii)
Table 1: Summary Statistics for the Hollingsworth’s Dataset (1650–1882)

**Panel A:** Matrimonies where husband is heir to English or Irish peerage (1650–1882)

|                      | mean | std. dev. | min | max | N   |
|----------------------|------|-----------|-----|-----|-----|
| **A. Fertility variables** |      |           |     |     |     |
| % childless          | 0.17 | 0.37      | 0   | 1   | 1,141|
| All live births      | 4.64 | 3.82      | 0   | 17  | 1,141|
| All live births (if > 0) | 5.57 | 3.51      | 1   | 17  | 951 |
| Stillbirths          | 0.26 | 0.78      | 0   | 9   | 213 |
| **B. Other demographic variables** |      |           |     |     |     |
| Age at first marriage (wife) | 21.88 | 4.84      | 11  | 52  | 1,141|
| Age at first marriage (husband) | 27.02 | 6.79      | 8   | 62  | 1,141|
| Age at death (wife)   | 58.43 | 20.29     | 16  | 100 | 1,141|
| Age at death (husband) | 60.55 | 16.85     | 16  | 97  | 1,141|
| Last child is a girl  | 0.48 | 0.50      | 0   | 1   | 813 |
| **C. Socioeconomic status variables** |      |           |     |     |     |
| Baron/Viscount heir  | 0.41 | 0.49      | 0   | 1   | 1,141|
| Duke/Earl/Marquis heir | 0.59 | 0.49      | 0   | 1   | 1,141|
| English peerage      | 0.59 | 0.49      | 0   | 1   | 1,141|
| Irish peerage        | 0.41 | 0.49      | 0   | 1   | 1,141|
| Wife is commoner’s daughter† | 0.61 | 0.49      | 0   | 1   | 1,141|
| Proxy for settlement | 0.58 | 0.49      | 0   | 1   | 1,141|

**Panel B:** Matrimonies where husband is not heir† or is heir to Scottish peerage (1650–1882)

|                      | mean | std. dev. | min | max | N   |
|----------------------|------|-----------|-----|-----|-----|
| **A. Fertility variables** |      |           |     |     |     |
| % childless          | 0.31 | 0.46      | 0   | 1   | 1,518|
| All live births      | 3.38 | 3.57      | 0   | 22  | 1,518|
| All live births (if > 0) | 4.92 | 3.31      | 1   | 22  | 1,041|
| Stillbirths          | 0.08 | 0.33      | 0   | 3   | 197 |
| **B. Other demographic variables** |      |           |     |     |     |
| Age at first marriage (wife) | 24.00 | 6.16      | 12  | 71  | 1,518|
| Age at first marriage (husband) | 30.26 | 7.90      | 15  | 73  | 1,518|
| Age at death (wife)   | 60.30 | 19.29     | 15  | 100 | 1,518|
| Age at death (husband) | 62.39 | 15.90     | 17  | 106 | 1,518|
| Last child is a girl  | 0.64 | 0.48      | 0   | 1   | 776 |
| **C. Socioeconomic status variables** |      |           |     |     |     |
| Baron/Viscount family | 0.42 | 0.49      | 0   | 1   | 1,518|
| Duke/Earl/Marquis family | 0.58 | 0.49      | 0   | 1   | 1,518|
| English peerage      | 0.41 | 0.49      | 0   | 1   | 1,518|
| Scottish peerage     | 0.24 | 0.43      | 0   | 1   | 1,518|
| Irish peerage        | 0.35 | 0.48      | 0   | 1   | 1,518|
| Proxy for settlement | 0.59 | 0.49      | 0   | 1   | 1,518|

**Notes:** †For comparability, we consider matrimonies in 1650–1882 where the husband is not an heir and the wife is an English or Irish peers’ daughter; ‡The percentage of commoner wives includes commoners, foreigners and gentry (knights and baronets).
placebo tests and as the control group in a difference-in-difference analysis. Compared to the sample in Panel A, non-heirs and Scottish heirs were childless more often (31%) and had fewer children on the intensive margin (4.92). They married older, around three years later than heirs to English and Irish peerages, and died at a similar age. Socio-economic variables are also comparable: As before, 58% of the observations belong to families of dukes, earls, or marquis.

3 The effect of settlements on fertility

This section estimates the effect of settlements on fertility. We begin by describing historical trends in childlessness and present OLS estimates showing that that heirs who signed a settlement were less likely to be childless. To establish causality, we pursue three strategies: First, we exploit exogenous variation in the gender of the first offspring, which affects a family head’s probability to live until his heir’s wedding—when settlements were signed. Second, we perform placebo tests on two populations who did not use settlements: Scottish heirs and non-heirs. Third, we estimate a difference-in-differences model using the latter as control group.

3.1 Historical trends

Compared to the general population, the peerage had more children but a considerably higher childlessness rate. Figure 1 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 are for the general population. Mothers in the peerage had 4 to 5 children until they experienced a demographic transition c. 1810, eighty years earlier than the general population. This is consistent with previous research on wealthy individuals (Clark and Cummins, 2009).

In contrast, marital childlessness rates in the peerage were astonishingly high. In the 1600s, around a third of all married women were childless. Childlessness rates were much lower for the general population (10%) and for other European aristocracies: 5% for Hesse-Kassel (Pedlow, 1982) and 9% for France (Lévy and Henry, 1960) in 1650–99 (Table B1 in the Appendix). The high childlessness rates in the peerage posed a threat for the survival of aristocratic dynasties. By 1650, however, childlessness started to decline and by 1850 it reached 10%, the same as the general population (de la Croix et al., 2019). Next, we show that settlements crucially contributed to this decline in childlessness.
3.2 OLS estimates

Specification and Identification. To show that settlements reduced childlessness in the peerage, ideally we would compare fertility outcomes in families that signed a settlement to the outcomes of similar families who did not sign it. Unfortunately, we do not observe who signed a settlement and who did not. To resolve this issue, we exploit that, because of institutional constraints and tradition, settlements were signed at the heir’s wedding. For a settlement to be signed, it was crucial for the father to live until that date (Bonfield, 1979). If the father died before his heir’s wedding, the heir would not be subject to a settlement; he could dispose of the family estate at will, sell parts of it, and decide over the next generation’s bequest. We use the fact that a father lived (did not live) until his heir’s wedding as a proxy for the presence (absence) of a settlement. Formally, we estimate:

$$\chi_{i,j,b,q} = \beta \cdot S_i + \mu_j + \mu_b + \mu_q + \mathbf{x}'_i \gamma + \epsilon_{i,j,b,q} \, .$$

(1)

Our unit of observation is a matrimony, $i$, where the husband is heir to an English or Irish peerage. $\chi$ equals one if the matrimony was childless and zero otherwise.

As explained in Section 2, settlements were signed at the heir’s wedding because, originally, they (only) fixed provisions for the bride’s family. Although settlements evolved into a contract entailing the land, the date of the signing did not change.
Our proxy for settlements, $S$, indicates if the heir’s father lived until i’s wedding; $\beta$ captures the association between settlements and childlessness. Following Galor and Klemp (2014), we include fixed effects for the (husband’s) family, $\mu_j$, and cluster standard errors by family.\footnote{To construct the family fixed effects, we assign families with barrelled surnames (e.g., Villiers-Mason) to the most prevalent surname in our sample (e.g., Villiers). We do so because barrelled surnames were created when spouses from two important families married and when titles were inherited by a distant relative, who would adopt the surname of the family’s senior-branch. For example, George Mason (1751-1800) adopted the Villiers-Mason surname when he inherited the Grandison earldom from his maternal grandfather John Villiers, 1st Earl Grandison.} That is, we identify the effect of settlements 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. To capture life-cycle effects, we include birth year dummies, $\mu_b$, and dummies for the quarter-century in which the marriage took place, $\mu_q$. Finally, vector $x$ includes spouses’ social status and age at death, wife’s age at marriage, history of stillbirths in the husband’s family, and the number of siblings of the husband. The latter accounts for the allowances for siblings, typically specified in the settlement.

\textit{OLS results.} Table 2 presents the results of estimating Equation (1) for all matrimony where the husband was heir to an English or Irish peerage in 1650-1882.\footnote{Because we use several fixed effects, our preferred specification is a linear probability model. Our baseline results are robust to using probit or logit models (results available upon request).} There is a strong, significant association between settlements and childlessness. Signing a settlement is associated with a decrease in the probability to be childless by 4 to 11 percentage points. Results are robust to including covariates that may also affect childlessness, like spouses’ social status, wife’s age at marriage, or the ratio of stillbirths to live births in the husband’s family (cols. 2 and 3). The precision of the model increases when we include dummies to capture life-cycle effects and family fixed effects to capture unobserved heterogeneity in genetic preconditions, culture, or social-economic position (col. 4).

This suggests that settlements altered incentives in the extensive margin of fertility. The rationale is that the decision to have children or not depends on the wealth one can bequeath them. If the family estate is broken, parts of it have been mortgaged, etc., the likelihood to have children may be lower, as the dynasty’s wealth is reduced. Signing a settlement prevents this, and hence, reduces childlessness. Note that, because of primogeniture, settlements protected the heir’s bequest. Hence, they should affect the production of an heir more than the production of a second, third, etc. offspring. That is, we expect settlements to alter fertility incentives in the extensive margin, but not in the intensive margin.
Table 2: Baseline OLS Results

|                           | (1)     | (2)     | (3)     | (4)     | (5)     |
|---------------------------|---------|---------|---------|---------|---------|
|                           | OLS     | OLS     | OLS     | poisson |
| Settlement†               | -0.053**| -0.056**| -0.040* | -0.110**| -0.039  |
|                           | (0.024) | (0.023) | (0.022) | (0.048) | (0.056) |
| Husband’s siblings        | 0.001   | 0.001   | 0.001   | 0.002   | -0.020***|
|                           | (0.003) | (0.003) | (0.003) | (0.005) | (0.007) |
| Duke/Earl/Marquis heir    | .       | 0.016   | 0.018   | -0.001  | -0.013  |
|                           | (0.022) | (0.021) | (0.057) |         | (0.077) |
| Baron/Viscount heir       | ref.    | ref.    | ref.    | ref.    | ref.    |
| Wife’s age at marriage    | .       | .       | 0.014***| 0.010** | -0.028***|
|                           | (0.003) | (0.004) |         | (0.007) |         |
| Wife’s age at death       | .       | .       | 0.001   | 0.001   | 0.000   |
|                           | (0.001) | (0.001) |         | (0.001) |         |
| Husband’s age at death    | .       | .       | -0.003***| -0.004***| 0.013***|
|                           | (0.001) | (0.001) |         | (0.002) |         |
| Still to live births (fam.)| .       | .       | 0.149   | -0.729  | -2.099  |
|                           | (0.308) | (0.722) |         | (1.291) |         |
| Wife’s social status      | NO      | YES     | YES     | YES     | YES     |
| Family FE                 | NO      | NO      | NO      | NO      | YES     |
| Birth year FE             | NO      | NO      | NO      | YES     | YES     |
| M. quarter-century FE     | NO      | NO      | NO      | YES     | YES     |
| Observations              | 1,157   | 1,156   | 1,141   | 1,141   | 951     |
| % correctly predicted     | 80.4    | 80.4    | 81.8    | 91.5    |         |

†i.e., father died after heir’s wedding.

Notes: The sample are all matrimony in 1650–1882 where the husband was heir to an English or Irish peerage. In col. (5), it is restricted to women who gave birth at least once. Constants not reported. Std. errors clustered by family in parentheses; ***p<0.01, **p<0.05, *p<0.1.

Table 2, column (5) confirms this. It presents results of a poisson regression\textsuperscript{19} of Equation (1)’s form, with the number of births as dependent variable. To capture the intensive margin of fertility, we restrict the sample to matrimony having at least one child. We find that, conditional on having at least one child, signing a settlement did not significantly affect the number of births. The magnitude is small: a coefficient of $-0.039$ indicates that an heir who signed a settlement is expected to give birth to 3.9% fewer children than an heir who did not. Given

\textsuperscript{19}Poisson regression is the standard model for count data like the number of live births.
that, conditional on not being childless, the average number of births is 5.57, this effect is equivalent to having 0.22 fewer children.\footnote{In addition to this evidence, note that historical trends suggest that peers and commoners (who did not use settlements) present a comparable record for the number of births (Figure 1).}

Altogether, the evidence indicates a strong correlation between settlements and childlessness, but not with the number of births. Next, we provide evidence suggesting that the effect of settlements on childlessness is causal.

### 3.3 IV estimates

*Specification and Identification.* Here we estimate the causal effect of settlements on childlessness using an instrumental variables model. Whether a settlement was signed or not depends on many factors, some of which might be endogenous to childlessness. Heirs with certain characteristics that are correlated to childlessness may choose not to sign a settlement by postponing marriage until their father’s death.\footnote{Figure B1 in Online Appendix B shows the density function of the number of years between an heir’s marriage and his father’s death for our baseline sample. The density function is skewed to the right: we observe a spike in the number of heirs marrying a year or two after their father’s death and a deficit below this threshold. This suggests that some heirs chose not to sign a settlement by postponing marriage until their father’s death.} We exploit exogenous variation in our proxy for settlements—whether a father lived until the heir’s wedding or not—coming from the gender of the father’s first child. Our instrument is exogenous, as families cannot manipulate a child’s gender. In some families, the first-born will be a girl and the father will be older when his male heir is born than what he would have been had his first-born been a boy. This decreases (exogenously) the probability to live until the heir’s wedding, and hence, to sign a settlement. That said, the exclusion restriction could still be violated if an heir born after a female would be more likely to be childlessness irrespective of signing a settlement. A potential concern is that, in developing contexts, breastfeeding increases with birth order to limit family size (Jayachandran and Kuziemko, 2011). This was not the case among aristocrats, as they typically hired wet nurses (Fildes, 1986, p.193). That is, breastfeeding—and its potential health benefits—are unrelated to our instrument.

Formally, we treat our proxy for settlements, $S$, as an endogenous variable:

$$S_i = \beta_g \cdot G_i + \beta_z \cdot Z_i + \mu_q + \chi_i' \gamma + \epsilon_{i,q},$$

where $i$ is a matrimony where the husband is heir to an English or Irish peerage. $S_i$ indicates if the heir’s father lived until $i$’s wedding. That is, it is equal to one
when \( i \) is likely subject to a settlement. As before, \( \mu_q \) are marriage quarter-century dummies and \( \mathbf{x} \) is our vector of covariates: spouses’ social status and age at death, wife’s age at marriage, history of stillbirths, and number of siblings of the heir.

Our instrument, \( G \), is equal to one if the heir was born after a female and equal to zero if he was his father’s first-born child. We also include the age at death of the father, \( Z \), in the first stage and exclude it from the second stage. The reason is that a first-born heir \( (G = 0) \) is more likely to sign a settlement than an heir born after a girl \( (G = 1) \) conditional on their respective fathers dying at a similar age. An unexpected or sudden death of the father reduces the first-stage probability to sign a settlement. We exclude the father’s age at death from the second stage because, conditional on the included covariates, it does not affect his heir’s fertility. Formally, this is equivalent to treating the father’s age at death as a second instrument. The implicit assumption is that it only affects childlessness by affecting the probability to sign a settlement. We directly test this assumption with a Sargan-Hansen test. The test cannot reject that the instruments are valid. Conditional on the gender of the first offspring being a valid instrument, this implies that father’s age at death only affects childlessness by affecting the probability to sign a settlement. In addition, we estimate all our effects with a large vector of controls \( \mathbf{x} \) and fixed effects. This includes controls that account for poor health conditions that are transmitted across generations and, in turn, affect childlessness, e.g., the history of stillbirths in the family or the spouses’ own age at death. We also include family fixed effects which, as the history of stillbirths, capture any genetic predisposition towards childlessness (Online Appendix B). These controls should account for any confounding effect of a father’s early death on childlessness. That is, conditional on these controls, the variable \( Z \) likely captures unexpected or sudden fathers’ deaths, unrelated to health issues affecting childlessness.

The causal effect of settlements on childlessness is captured by coefficient \( \beta \) in:

\[
\chi_{i,j,b,q} = \beta \cdot \hat{S}_i + \mu_j + \mu_b + \mu_q + \mathbf{x}_i'\gamma + \epsilon_{i,j,b,q}.
\]

where \( \hat{S}_i \) is the value of \( S_i \) estimated from Equation (2), and \( \mu_j \) and \( \mu_b \) are, respectively, family and birth year fixed effects.

Note that equations (2) and (3) describe a recursive simultaneous-equations model that includes family and birth-year fixed effects in the second stage but not in the first stage. Estimating this model is a consistent instrumental variables’ method under the standard assumptions discussed above (exclusion restric-
tion and relevance) plus the assumption that the second-stage covariates excluded from the first stage are orthogonal to the endogenous variable (Brito and Pearl, 2002; Baltagi, 2011; Murnane and Willett, 2010). Next, we present conceptual and empirical evidence from a LASSO to support this assumption. Conceptually, settlements were a contract used by all the English aristocracy and not by certain families only. In other words, there is no theoretical reason why family fixed effects should determine the first-stage decision to sign a settlement. Similarly, settlements were stable through 1650–1882, our study period (see Section 2.1). Hence, our time fixed effects (birth year and marriage-quarter century) should be orthogonal to the decision to sign a settlement. To be objective about which covariates to exclude from the first stage, we used LASSO on eq. (2). Consistent with our conceptual arguments, LASSO suggests excluding family and time fixed effects from the first stage. To allow for the possibility of time trends in settlements, we decided to keep marriage quarter-century fixed effects in the first stage. The advantage of our model over a “classic” IV model, i.e., a model including all second-stage covariates in the first stage, is in terms of efficiency. Including family and birth-year fixed effects in the first stage amounts to losing about half of the model’s degrees of freedom. Hence, we would risk running into a high-dimensional problem and losing statistical power. That said, in Online Appendix B we show that our results are robust to estimating a classic IV model: the magnitude and statistical significance of the $\beta$-estimate of Equation (3) is identical to that of our preferred specification (Table B3, cols. 1-2). We also perform the placebo tests described in the next section and obtain equivalent results (cols. 2-4). Finally, we show that results are robust to pre-selecting the set of excluded covariates and excluding them from both the first and second stage. In detail, we use LASSO on equation (1) with the full set of controls. LASSO suggests including the number of siblings, wife’s age at marriage, fixed-effects for only 11 families, and excluding the remaining covariates. We then estimate a classic IV model excluding the suggested covariates from both the first and second stage. Col. 5 in Table B3 shows that these estimates are similar to those obtained with our preferred specification.

**IV results.** Table 3 (col. 1) presents the results from estimating equations (2) and (3). First-stage estimates in Panel B confirm that the gender of the first

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22 Baltagi (2011, p.268) calls such method a ‘feasible 2SLS’. We estimate the recursive simultaneous-equations model (2) and (3) by maximum likelihood using the STATA command cmp (Roodman, 2007).

23 Excluding these fixed effects does not alter our main results (Appendix Table B3, col. 5).

24 The placebo tests yield similar results under. We do not report them because the LASSO pre-selected controls vary across heirs, non-heirs, and Scottish heirs.
offspring is a relevant instrument for our proxy for settlements: when the first offspring is a female, her father is 5.4 percentage points less likely to live until his heir’s wedding, and hence, to sign a settlement. Moreover, the F-stat is large enough to rule out weak instruments. The remaining covariates have expected signs: the probability to sign a settlement increases in the father’s age at death and decreases with the heir’s wife’s age at marriage (Table B2 in the Online Appendix). Importantly, the Sargan-Hansen cannot reject the null hypothesis that the instruments are valid (stat=0.67, p-val=0.41). As explained above, this suggests that, conditional on gender of the first offspring being a valid instrument, the father’s age at death is orthogonal to his heir’s childlessness. In other words, this justifies the exclusion of father’s age at death from the second stage.

Second-stage estimates (Panel A) show that settlements had a negative, causal effect on childlessness: An heir who married before his father’s death and, hence, who signed a settlement, was 14.6 percentage points less likely to be childless. This corresponds to an increment by 85.9% in the extensive margin of fertility. Given that the average childlessness rate for English and Irish heirs was 17%, settlements pushed childlessness close to the natural rate of 2.4% (Tietze, 1957). Note that the bias affecting OLS is an attenuation bias. One possibility is that if the father lived until the heir’s wedding, he likely influenced the choice of a bride. If such marriages have less children because they are socially convenient and not love matches, this could explain the attenuation bias corrected by the IV model.25

Covariates have expected signs (see Appendix Table B2). For example, marrying an older wife significantly increases the probability to be childless. The effect is lower than that of settlements: to match the estimated effect of settlements on childlessness one would have to marry a wife aged 16 years younger.

Finally, we allow settlements signed by heirs to have heterogeneous effects by the wives’ social rank (see Appendix Table B4).26 We first split the sample into matrimonies of heirs and commoner/foreigners’ daughters (col. 2), heirs and commoners’ daughters (col. 3), and heirs and peer/gentry’s daughters (col. 4).

25Table B6 in the Online Appendix shows that results are robust to using heir’s birth order as instrument. That is, to exploit variation from the gender of all the births before an heir. In our main specifications, we use the gender of the first birth and not the heir’s birth order because the latter is potentially correlated with family size, a confounder for fertility choices. Hazan and Zoabi (2015) show that when the returns from boys are large relative to girls—a likely scenario in the peerage—family size can depend on the gender composition of the first couple of births. To fully rule-out such concerns all our specifications control for the number of siblings.

26Marrying a commoner did not affect the probability to sign a settlement. Settlements were widely used among peers irrespectively of the bride’s status (Habakkuk, 1994; Stone and Stone, 1984). In addition, peer heirs were not disinherited for marrying commoners. Hence, settlements, which regulated inheritances, also had to be signed when peer heirs married commoners.
Table 3: Causal Effect of Settlements on Childlessness

| Panel A. Dep. Var.: Childlessness | Instrumental Variables | Difference-in-Differences |
|-----------------------------------|------------------------|---------------------------|
|                                   |                          |                           |
|                                   | heir (treatment group) vs. non-heir + Scot. (control) |
| Settlement                         | heirs                  | non-heirs                 | Scotland       | 0.019 |
| [i.e., father died after heir wedding] | (0.046)               | (0.065)                   | (0.078)        | (0.041) |
| Ho:                                | β(1) = β(2)           | β(1) = β(3)               |
| prob > chi2                        | 0.036**               | 0.055*                    |
| Heir (treatment group)             |                       |                           |
| Heir × Settlement                  |                       |                           |
| Controls                           | YES                    | YES                       | YES†           |
| Family FE                         | YES                    | YES                       | YES†           |
| Birth year FE                     | YES                    | YES                       | YES            |
| M. quarter-century FE             | YES                    | YES                       | YES            |
| Observations                      | 1,141                  | 1,154                     | 364            | 2,659 |
| % correctly predicted              | 93.7                   | 88.3                      | 98.1           | 87.2  |

| Panel B: First stage | Dep. Variable: Settlement [i.e., father died after heir’s wedding] |
|----------------------|---------------------------------------------------------------------|
| Gender of first birth: | reference | reference | reference |
| son                  |          |           |           |
| daughter             | -0.054** | -0.062*   | -0.146*** |
|                      | (0.024)  | (0.035)   | (0.041)   |
| Controls             | YES       | YES       | YES       |
| M. quarter-century FE| YES       | YES       | YES       |
| Observations         | 1,141     | 1,154     | 364       |
| % correctly predicted | 84.5      | 72.6      | 71.1      |
| F-stat               | 85.7      | 46.0      | 38.7      |
| Sargan-Hansen J      | 0.67      |           |           |
|                       | (p-val = 0.41)                      |

Notes: The sample are all matrimony in 1650–1882 where the husband is heir to an English or Irish peerage (col. 1), the husband is not an heir and the wife is an English or Irish peers’ daughter (col. 2), and the husband is heir to a Scottish peerage (col. 3). For our DiD estimates (col. 4), the treatment group is the sample of column (1) and the control group is the sample of columns (2)+(3). Controls are number of siblings of the husband, wife’s age at marriage, spouses’ age at death, history of stillbirths in husband’s family, spouses’ social status. †All controls and family FE are interacted with the treatment indicator (col. 4). Constants not reported. Standard errors clustered by family in parentheses; ***p<0.01, **p<0.05, *p<0.1.
The IV estimates suggest that settlements reduced childlessness independently of the wife’s social rank. Since splitting the data into these sub-samples reduces the number of observations and degrees of freedom, we also consider a pooled specification (col. 5). We use our full sample of heirs and include interactions between our proxy for settlements and indicators for the wife’s social rank. To instrument each interaction term (e.g., “Settlement × wife is commoner’s dau.”), we use our instruments interacted with wife’s status indicators (e.g., “first-offspring Gender × wife is commoner’s dau.”). The estimated effects are 3 percentage points larger for heirs marrying duke/earls/marquis’ daughters than for heirs marrying commoners: signing a settlement reduced childlessness by 16.7 percentage points for the former and by 13.5 for the latter. That said, the total effect of settlements remains negative and significant for heirs marrying commoners.

3.4 Placebo tests

So far, we have shown that families in which the father lived until the heir’s wedding, that is, families which likely signed a settlement, were less likely to be childless. We interpreted this as evidence that settlements reduced childlessness. However, since we do not observe which families signed a settlement, our interpretation crucially hinges on the assumption that our proxy does not affect fertility through other channels. That is, that the survival of the father until the heir’s wedding does not affect fertility through channels other than the settlement. We plausibly addressed this by controlling for genetic and socio-economic factors that are likely correlated with the survival of the father and the next generation’s fertility. To further validate our conclusions, we use data from two populations that did not use settlements: non-heirs and Scottish heirs.

Specifically, we conduct two placebo tests. We estimate the instrumental variables system in eq. (2) and (3) with a comparable sample of matrimony who should not be affected by settlements because the husband (a) was not an heir, or (b) was heir to a Scottish peerage. Unlike settlements in England and Ireland, Scottish entails were perpetual, i.e., they did not had to be renewed every generation at the heir’s wedding (Habakkuk, 1994, p.6). If our proxy—i.e., whether father lived until his heir’s wedding—only affects fertility through settlements, we should find a zero effect for these populations that did not use settlements. If our estimation captures confounding factors correlated with fertility, the estimates will also be negative for these placebo samples. Similarly, this placebo test can be used to assess the validity of the IV exclusion restriction. If the gender of the first born
child (or the father’s age at death) only affects childlessness through our proxy for settlements, we should find zero-effects for these placebo populations.

Table 3 presents the results of the placebo tests. The effect of our settlement proxy on childlessness is much smaller and not significantly different from zero for matrimones where the husband was not an heir and the wife was the daughter of an English or Irish peer\(^\text{27}\) (col. 2). In other words, for those who did not inherit the family estates, our proxy rightly indicates that settlements did not affect their decision to have children. A Wald test confirms that the estimated coefficient is significantly different from that of heirs (14.6 vs 0.9 pp). Hence, our proxy (and our instruments) do not seem to have a direct effect on childlessness other than that operating through settlements. We find similar results when we compare heirs to an English or Irish peerage (col. 1) to heirs to a Scottish peerage (col. 3). The childlessness rate of Scottish heirs is not affected by the fact that the father lived until his heir’s wedding or not: the coefficient is small and not significantly different from zero. The Wald test also confirms that the coefficient is significantly different between English/Irish vs. Scottish heirs (14.6 vs 0.9 pp).

Note that the Wald tests can be interpreted as difference-in-differences estimators: The tests capture the differential effect of our settlement proxy on English and Irish heirs (treatment group) versus non-heirs or Scottish heirs (control group). In this DiD framework, the control group washes away any factor other than settlements that is correlated with our proxy (or our instruments) and may affect fertility. We find that childlessness was reduced only for those who signed a settlement: English and Irish heirs whose father lived until their wedding. In contrast, for non-heirs or heirs to a Scottish peerage, marrying before their father’s death did not affect childlessness. This strongly suggests that our estimates capture the effect of settlements on fertility. Next, we confirm this by estimating a DiD model.

### 3.5 Difference-in-differences

*Specification and Identification.* Here we estimate the effect of settlements on childlessness using a difference-in-differences strategy. We compare heirs to English or Irish peerages (treatment group) and non-heirs or heirs to Scottish peerages (control group) between families where our proxy indicates that the heir signed and did not sign a settlement (the treatment). We also use control groups excluding Scottish heirs and with heirs’ siblings only. As explained above, our proxy for settlements should not affect these control groups, as non-heirs and Scottish heirs

\(^{27}\)See Footnote 15 for more details on this placebo sample.
were not subject to settlements (Habakkuk, 1994, p.6).

Our identifying assumption is that if settlements had no effect on childlessness, the differential childlessness between heirs in the treatment group and their relatives in the control group would be the same in families where the heir signed and did not sign a settlement. This assumption could be violated due to reverse causality and omitted variables. Reverse causality refers to the possibility that settlements were introduced in England and not in Scotland (or, similarly, for heirs and not for their younger siblings) because childlessness was more prevalent among English heirs. This scenario is unlikely: First, the existing literature argues that settlements were introduced c. 1650 to protect family estates from expropriation after the Civil War, not to increase fertility (Habakkuk, 1994, p.12). Moreover, settlements were not introduced in Scotland due to a different interpretation of land alienability by Scottish common law judges (p.18). Similarly, settlements were signed by heirs and not by their younger siblings because its purpose was to entail the inherited family estates. Hence, we can treat the introduction of settlements for English and Irish heirs as exogenous to childlessness. Second, we can compare the treatment and control group before the widespread use of settlements (1640–60). Childlessness was high for both groups, but higher for non-heirs and heirs to Scottish peerages, negating the reverse causality hypothesis.\textsuperscript{28}

Next, we turn to the issue of omitted variables. One possibility is that heirs with characteristics that are correlated with childlessness chose not to sign a settlement by delaying marriage until their father's death. In this case, our DiD estimates may capture a spurious correlation, not the causal effect of settlements. To alleviate this concern, we control for a large set of covariates potentially correlated with childlessness, e.g., age at marriage, social status, and the history of stillbirths in the family. We also include family fixed effects to capture any predisposition towards childlessness among genetically related individuals. In addition, Sections 3.3 and 3.4 performed several exercises suggesting that, in our setting, the omitted variable bias is small. First, we used exogenous variation in the probability to sign a settlement from the gender of the first offspring. A Wald test suggests that the OLS and IV estimates are not statistically different, and a Durbin-Wu-Hausman test cannot reject the consistency of OLS. This points to a small impact of omitted variables. In the worst scenario, our previous estimates suggest that the omitted variable bias is an attenuation bias. That is, our DiD estimates can be interpreted as a lower bound of the true effect of settlements. Second, we performed placebo tests comparing the IV estimates for heirs, non-heirs, and Scottish peerages.

\textsuperscript{28}Their childlessness rates in 1640–60 were, respectively, 35 and 15%.
heirs. As explained above, these comparisons can be interpreted as DiD estimators with a \textit{plausibly exogenous} proxy for settlements. The results are consistent with our estimates here, further alleviating omitted variable bias concerns.

Our difference-in-differences specification takes the following form:

\[ \chi_i = \alpha \cdot S_i + \delta \cdot \text{Heir}_i + \beta \cdot (S_i \times \text{Heir}_i) + \mu_b + \mu_q + \mu_{j,\text{Heir}_i} + x_i' \gamma + \epsilon_{i,b,q}, \]

where \( \chi_i \) indicates if matrimony \( i \) was childless or not; \( S_i \), is a dummy variable equal to one if matrimony \( i \) is from a family where the heir signed a settlement, i.e., if the father lived until his heir’s wedding. \( \text{Heir}_i \) indicates if matrimony \( i \) is part of the treatment group (the husband is an English or Irish heir) or not (the husband is not an heir\(^{29}\) or is a Scottish heir). Our parameter of interest is \( \beta \), the estimated average effect of settlements on the childlessness of English and Irish heirs. \( x \) includes our full-set of covariates: spouses’ social status, wife’s age at marriage, spouses’ age at death, history of stillbirths in the family, and number of siblings. All covariates are also interacted with \( \text{Heir}_i \). That is, we allow our full-set of covariates to have heterogeneous effects on childlessness for the treatment and control groups. For example, the number of siblings did not affect the heir’s decision to have children (see Table 2). However, it may affect the decision for non-heirs through an income effect—non-heirs had to split their allowance with their siblings (see Section 2.1). Similarly, we consider family-heir fixed effects, \( \mu_{j,\text{Heir}_i} \), which allows any socio-economic characteristics proxied by the family surname to affect childlessness differently for heirs, non-heirs, or Scottish heirs. Finally, \( \mu_b \) and \( \mu_q \) are birth-year and marriage quarter-century fixed effects. These allow us to control for life-cycle effects which are common across the treatment and control group. As before, we cluster standard errors at the family level.

\textit{DiD results}. Table 3, col. (4) reports estimates of \( \alpha, \delta, \) and \( \beta \) from Equation 4. The estimated effect of settlements on childlessness, \( \beta \), is negative and statistically significant: in families where our proxy indicates that the heir signed a settlement, heirs were 11 percentage points (pp) less likely to be childless than their relatives in the control group. In terms of magnitude, this effect lies between OLS (11 pp) and IV (14.6 pp) estimates. As argued above, this DiD estimates can be interpreted as lower-bound effects. Importantly, the effect of settlements on childlessness is estimated tightly around zero for the control group (\( \hat{\alpha} = 0.019 \)). That is, those who did not use settlements had the same childlessness in families where the heir

\(^{29}\)As before, these are matrimonies where the husband was not an heir and the wife was the daughter of an English or Irish peer (see Footnote 15).
signed and did not sign a settlement. Finally, our estimates for $\delta$ are negative: On average, the control group had larger childlessness rates than heirs in the treatment group. This is consistent with the identifying assumptions discussed above.

So far our control group pools non-heirs and heirs to Scottish peerages. This is because in some families an heir’s brother was heir to a Scottish peerage. In addition, defining a broad control group helps to estimate precisely our large set of covariates (age at marriage, social status...). In Table B5 of Online Appendix B, we show that results are robust to excluding Scottish heirs from the control group (col. 2). We also restrict the control group to the siblings of treated heirs (col. 3). That is, we compare heirs to their siblings between families where the heir signed and did not sign a settlement. Using these alternative control groups, we find that settlements reduced childlessness by 12 to 14.7 percentage points.

Altogether, the DiD analysis yields consistent results with our OLS, IV, and placebo tests. This strongly suggests that settlements reduced childlessness for peer heirs, and that the effect is causal.

4 Robustness and extensions

Here we present several extensions of our analysis. This section describes them; the detailed results are available in Online Appendix B.

4.1 Settlements signed at heir’s majority.

So far, our empirical strategy assumes that a settlement was signed if the family head lived until the wedding of his heir. Although most settlements were signed at the heir’s wedding, some settlements were signed when the heir turned 21, the age of majority. The reason was 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, 1994, p.26).

Here we show that assuming that settlements were signed at the heir’s majority does not alter our main conclusions. Formally, we estimate the IV model in eq. (2) and (3) with an alternative proxy for settlements, $S_i$, indicating if $i$’s father lived until $i$’s majority. Table B7 in the Online Appendix presents the results. Signing

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30 For example, William Murray was heir to an English peerage (Earl Mansfield). His brother, David Murray, was heir to a Scottish peerage (Viscount Stormont).

31 Note that non-heirs and heirs’ siblings are not the same control group. First, because some heirs’ siblings were heirs to Scottish peerages. Second, because by construction the non-heirs control group includes the siblings of married heirs (i.e., heirs in the treatment group) and the siblings of unmarried heirs. The heirs’ siblings control group includes only the former.
a settlement decreased the probability to be childless by 15.8 percentage points (col. 2). The magnitude of the coefficient is not significantly different to that of Table 3. The gender of the first offspring is still a relevant instrument. First-stage results (Panel B) show that heirs born after a daughter were less likely to turn 21 before their father’s death. Cols. 3 and 4 present placebo tests under this alternative specification. The childlessness rates of those who did not use settlements (non-heirs or Scottish heirs) were not affected by the fact that the family head lived until his heir’s majority or not. Finally, our alternative proxy for settlements is not associated with the intensive margin of fertility (col. 5).

Importantly, these results can disentangle the two purposes of a settlement: entailing the land and setting a provision for the wife. As reflected in Habakkuk’s quote, settlements signed at the heir’s majority would only reflect the former, while settlements signed at the heir’s wedding may also reflect the interest of the bride’s family for a larger provision. The fact that we find similar results as before suggests that the effect of settlements on childlessness is the result of entailing the land, and not of the bride’s family interest in setting provisions.

4.2 The Industrial Revolution: old vs. new peerages.

Did the Industrial Revolution, an event that triggered major economic and demographic changes, alter the effect of settlements on fertility? On the one hand, the value of land relative to industrial wealth decreased after the 1770s. Commoners who earned their fortune in manufacturing entered the peerage, whose size increased after the Industrial Revolution (see Figure B2 in Online Appendix B). The effect of settlements on fertility may be different for such new peerages. On the other hand, according to Doepke and Zilibotti (2008), the ‘fine tastes for leisure’ of landowners were not affected by the Industrial Revolution; they continued to live off their land rents. If this was the case, neither the incentive to sign a settlement nor its effect on fertility should be altered.

We perform two exercises to answer this question. First, we allow settlements to have heterogeneous effects by the date of formation of the peerage. Specifically, we compile the date of the formation of all 487 peerage titles in our baseline

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32 As before, we find an attenuation bias in OLS estimates. We conjectured that heirs who delayed marriage until their father’s death were freer to chose a bride, and hence, had higher fertility. This conjecture is still valid, as on average heirs married around age 27, above the age of majority.

33 This is a relative statement. Until the twentieth century, landownership was a major source of wealth: in 1800–70, 80–95% of millionaires were landowners (Rubinstein, 1977, p.102).
sample. We use this data to compare the effect of settlements for heirs to old peerages (i.e., titles created before the Industrial Revolution) vs. heirs to new peerages (i.e., titles created thereafter). Table B8 in Online Appendix B presents IV estimates using our full sample of heirs (cols. 1-3). In col. (3), we interact our proxy for settlements with an indicator for new peerages. The first stage instruments this interaction term with our instruments times the new-peerage indicator. We also include the date of the formation of the peerage as an additional control. We find that the effect of settlements on childlessness is 0.3 percentage points lower for new peerages, a difference that is not statistically significant. That is, settlements reduced childlessness for old and new peerages similarly.

Second, we restrict our sample to old peerages and check if their behaviour changed after the Industrial Revolution. Table B8 (col. 4) presents IV-estimates for all old-peerage heirs. Those who signed a settlement were 14.7 percentage points less likely to be childless. We then split the sample into old-peerage heirs who married before the Industrial Revolution (col. 5) and old-peerage heirs who married afterwards (col. 6). The estimates are very similar across groups.

Overall, this suggests that aristocrats’ preferences over signing a settlement and fertility persisted after the Industrial Revolution. This provides empirical support for the theory by Doepke and Zilibotti (2008), which claims that preferences of landowners were constant over time, eventually triggering their downfall.

4.3 Size and value of inherited estates.

Signing a settlement guaranteed that a peer’s estates would pass down to his heir’s yet-to-be-born descendants. We have shown that this created an incentive to reduce childlessness for peer heirs. Note that this incentive would be stronger in families where a settlement guaranteed that larger, more valuable estates would pass down to the heir’s yet-to-be-born descendants. Next, we test this hypothesis and allow settlements to have heterogeneous effects by the size and value of inherited family estates.

To do so, we incorporate new data from Bateman (1883), who lists the family estates of Great Landowners in Britain and Ireland in 1876. It includes all estates above 3,000 acres, worth more than £3,000 per year and 1,300 estates above 2,000 acres.

34 We use data from Hollingsworth and hand-collected information from various sources. See Online Appendix A for details.
35 We chose 1770 to mark the start of the Industrial Revolution because in the 1770s the spinning jenny was patented (1770), water frames were installed in cotton mills (1771), the Boulton & Watt partnership was founded (1775), and the spinning mule was invented (1779).
36 We use data originally compiled by Goñi (2018). See Online Appendix A for details.
acres. Around 75% of the heirs in our baseline sample belong to great landowning families listed by Bateman. For these 856 heirs, we added the size of their family estates (excluding estates in Scotland) and annual value in 1876.\footnote{Admittedly, this data reflects the size and value of estates in 1876 and not at the time the settlements were signed. In fact, the size and value of a family’s estates by 1876 might be endogenous to previous generations’ decisions over settlements and fertility. That said, we use this data for two reasons: First, the size and value of Britain’s great estates was stable from 1750 onward (Beckett, 1977, p.567). That is, Bateman’s data is representative for most of our sample (1650-1882). Second, data on peers’ estates is scarce: between the Domesday book in 1086 and the 1870s, no complete survey of the distribution of land in Great Britain exists.}

To test whether settlements had heterogeneous effects by the size and value of the inherited family estates, we estimate our IV model in eq. (2) and (3) for three samples (see Table B9 in Online Appendix B): First, we consider heirs from families not listed in Bateman (1883). That is, heirs with the smallest, less-valuable inherited family estates. Signing a settlement reduced their probability to be childless by 19 percentage points (col. 2), a similar effect to our baseline IV estimate (col. 1). That said, limiting the sample to 285 heirs reduces the precision of our estimate, which is not significantly different from zero (p-value = 0.136).

Second, we consider Great Landowners listed by Bateman (1883). That is, heirs from families that, by 1876, had estates above 2,000 acres. We begin by Great Landowners in the bottom 75% of the land distribution, both in terms of estate size (col. 3) and value (col. 4). Similarly to our baseline estimates, we find that signing a settlement reduced childlessness by 11.4-14.7 percentage points.

Third, we consider the top 25% Great Landowners. This includes heirs with inherited family estates above 30,000 acres (col 5), worth more than £37,000 per year (col 6). Signing a settlement reduced their probability to be childless by 27.6-33.9 percentage points. This estimate is two to three times larger than that of heirs in the bottom 75% of the distribution and of heirs of families not listed in Bateman. Altogether, this confirms the hypothesis that settlements signed over larger, more valuable inheritances provided stronger incentives to reduce childlessness.

5 A model of inheritance and fertility

Here we provide a theoretical model that rationalizes settlements and its effects on fertility. The model has important implications for time discounting and the emergence of inheritance systems which restrict heirs, e.g., settlements or trusts.
5.1 Setup

We assume a three-period sequential-move game played by three generations, \( i=\{1, 2, 3\} \), of the same dynasty. One can think of these as father, son, and grandson. Each generation decides his consumption, \( x_i \), and fertility, \( n_i=\{0,1\} \). We model fertility as a binary choice and assume there is no uncertainty regarding the production of an heir. If a generation decides not to have children, we assume that the dynasty dies out after this generation. This can be interpreted as the dynasty’s wealth passing to a distant relative whose utility is fully discounted.

Each generation derives utility from his consumption and that of the following generation(s) in case the dynasty continues. Formally, the utilities of generations 1, 2 and 3, respectively \( v_1, v_2, \) and \( v_3 \), are

\[
v_1(x_1, x_2, x_3, n_1, n_2) = u(x_1) + n_1 \cdot [\beta \delta \, u(x_2) + n_2 \cdot \beta \delta^2 \, u(x_3)],
\]
\[
v_2(x_2, x_3, n_2) = u(x_2) + n_2 \cdot \beta \delta \, u(x_3),
\]
\[
v_3 = u(x_3).
\]

We depart from the classic bequests’ models by assuming a hyperbolic discount function towards future generations. This means that individuals are present biased but, at the same time, do not value their children’s well-being significantly more than that of future generations, namely their grandsons. To be precise, we assume direct pure altruism. As shown in Galperti and Strulovici (2017), hyperbolic discounting is a consequence of the assumption of direct pure altruism.

Formally, the discount function has two components: \( \delta \in [0, 1] \) is the standard discount for future generations; \( \beta \in [0, 1] \) discounts all the future consumptions compared to his own. This additional discount factor captures dynastic preferences. To see this, consider Figure 2. For low values of \( \beta \), generation 1 has a strong dynastic preference, as he discounts generations 2 and 3 similarly. For high values of \( \beta \), the discount function tends to the exponential discount function, implying that he values the consumption of generation 3 much less than that of
generation 2. In Section 5.3 we will show that hyperbolic discounting is crucial to rationalize settlements, or more generally, inheritance systems that restrict heirs.

Figure 2: *Quasi-Hyperbolic Discrete Discount Function*

![Quasi-Hyperbolic Discrete Discount Function](image)

Each dynasty is endowed with wealth $K$, e.g., landholdings. This endowment is used to subsidize consumption of all generations. Therefore, the decisions of each generation depend on how the dynasty’s wealth $K$ is passed down from one generation to the next—that is, they depend on the inheritance system.

Dynasties are heterogeneous with respect to the inheritance system. We consider two dynasties: In one, each generation decides the bequest of the next generation. Henceforth, we refer to this as the no-settlement inheritance regime (subscripted by $\neg s$). Alternatively, in another dynasty generation 1 decides the bequests of generations 2 and 3. We call this the settlement regime (subscripted by $s$). This regime allows generation 1 (the father) to settle part of the dynasty’s wealth for generation 3 (the grandson). More generally, it represents any inheritance system that restricts heirs’ powers to manage the dynasty’s wealth.

We model these two inheritance regimes with the budget constraints. For the dynasty in the no-settlement regime, generation $i$ decides the bequests of the next generation, $k_{i+1}$. The budget constraints of generations 1 and 2 are, respectively,

$$K = x_1 + k_2$$
$$k_2 = x_2 + k_3.$$  

(8)  
(9)

For the dynasty in the settlement regime, i.e., generation 1 decides all bequests $k_2$ and $k_3$, the budget constraints of generations 1 and 2 are, respectively,

$$K = x_1 + k_2 + k_3$$
$$k_2 = x_2.$$  

(10)  
(11)

Finally, the dynasty disappears after generation 3. Hence, this last generation will consume all the bequests he receives from previous generations: $k_3 = x_3$. 

28
5.2 Equilibrium

This subsection defines and characterizes the model’s equilibrium. 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)** The SPE is a strategy profile \( \{k_2, k_3, x_1, x_2, x_3, n_1, n_2\} \) for the dynasty in the no-settlement regime and a strategy profile \( \{k'_2, k'_3, x'_1, x'_2, x'_3, n'_1, n'_2\} \) for the dynasty in the settlement regime, where:

- \( \{k_2, x_1, n_1\} \) maximize \( v_1 \) subject to (8), \( \{k_3, x_2, n_2\} \) maximize \( v_2 \) subject to (9), and \( x_3 \) maximize \( v_3 \) subject to \( x_3 = k_3 \),
- \( \{k'_2, k'_3, x'_1, n'_1\} \) maximize \( v_1 \) subject to (10), \( \{x'_2, n'_2\} \) maximize \( v_2 \) subject to (11), and \( x'_3 \) maximize \( v_3 \) subject to \( x'_3 = k'_3 \).

We solve the model in three steps: First, we use backward induction to find optimal consumption and bequests. Second, we define fertility gains by comparing the indirect utilities of having children and being childless. This shows how settlements affect fertility incentives. Third, we use fertility gains to characterize the SPE. Hereafter, we assume log-utility for simplicity, i.e., \( u(x_i) = \ln x_i \).

*Consumption and bequests.* We begin by briefly describing optimal consumption and bequests. All characterizations are in Appendix C.1, Lemmas C.1 and C.2. Consumption and bequests are identical for dynasties in the settlement and no-settlement regime when fertility is low. When \( n_1 = 0 \) generation 1 consumes all the dynasty’s wealth, \( x_1 = K \), regardless of the inheritance regime. Similarly, when \( n_1 = 1 \) and \( n_2 = 0 \) the optimal consumption and bequests are given by \( x^*_1 \), \( x^*_2 \), and \( k^*_2 \) in both regimes. Only for high fertility levels, i.e., when \( n_1 = n_2 = 1 \), consumption and bequests do differ: \( x^*_1, x^*_2, x^*_3, k^*_2, k^*_3 \) in the no-settlement regime, and \( x^{**}_1, x^{**}_2, x^{**}_3, k^{**}_2, k^{**}_3 \) in the settlement regime. Importantly, \( x^{**}_2 < x^{**}_3 \), \( x^{**}_3 > x^{**}_1 \), and \( k^{**}_3 > k^{**}_2 \). That is, in the settlement regime, generation 1 redistributes consumption from generation 2 to generation 3. He does so by settling a larger bequest for generation 3 than the one generation 2 would have passed down in the no-settlement regime.

*Fertility.* Next, we use these optimal consumptions and bequests to define fertility gains. Specifically, we compare the indirect utilities of having children and being childless under the different inheritance (and fertility) regimes.

**Definition 2 (Fertility gains)** Fertility gain is the difference of the indirect utility of having children and being childless. For generation 2, \( f_{2,n} \) and \( f_{2,s} \) are the fertility gains in, respectively, the no-settlement and the settlement regimes.
tively, the no-settlement and settlement inheritance regimes: 

\[ f_{2-n}(k_2) := v_2 \left( x_2 = \frac{k_2}{1 + \beta \delta}, x_3 = \frac{\beta \delta k_2}{1 + \beta \delta}, n_2 = 1 \right) - v_2(x_2=k_2, x_3=0, n_2=0), \]

\[ f_{2,s}(k_3) := v_2(x_2=k_2, x_3=k_3, n_2=1) - v_2(x_2=k_2, x_3=0, n_2=0). \]

For generation 1, \( f_{1-n}^{n_2=0} \) defines fertility gains when \( n_2=0 \) in both regimes:

\[ f_{1-n}^{n_2=0}(K) := v_1(x_1^*, x_2^*, n_1=1) - v_1(x_1=K, n_1=0) \]

and \( f_{1-s}^{n_2=1} \) and \( f_{1-s}^{n_2=1} \) are the fertility gains of generation 1 when \( n_2=1 \) in, respectively, the no-settlement and settlement inheritance regimes:

\[ f_{1-s}^{n_2=1}(K) := v_1(x_{1,-s}^*, x_{2,-s}^*, x_{3,-s}^*, n_1=1) - v_1(x_1=K, n_1=0), \]

\[ f_{1,s}^{n_2=1}(K) := v_1(x_{1,s}^*, x_{2,s}^*, x_{3,s}^*, n_1=1) - v_1(x_1=K, n_1=0). \]

The fertility gains of generation 2 illustrate the mechanism through which settlements can change fertility incentives. Consider the dynasty in the no-settlement regime. Generation 2’s fertility gains, \( f_{2-n}(k_2) \), are increasing in his bequest, i.e., \( \partial f_{2-n}/\partial k_2 > 0 \). In other words, by passing down a larger bequest, generation 1 can manipulate generation 2’s incentives to have children. This differs in the dynasty subject to the settlement regime. Generation 2’s fertility gains \( f_{2,s}(k_3) \) no longer depend on the bequest he receives but on the bequest settled for generation 3, that is, \( k_3 \). If generation 1 settles a larger share of the dynasty wealth, generation 2 will be more likely to have children, i.e., \( \partial f_{2,s}/\partial k_3 > 0 \).

\[ \text{Equilibrium.} \] Finally, Proposition 1 characterizes the SPE. It identifies three possible equilibrium strategies for dynasties in the settlement and no-settlement regime: a high-fertility strategy in which generations 1 and 2 have children, a low-fertility strategy in which only generation 1 has children, and a no-fertility strategy in which generation 1 is childless.

**Proposition 1 (SPE).** The SPE of the model is characterized by the equilibrium strategies of dynasties in the no-settlement and the settlement inheritance regimes. For the dynasty in the no-settlement regime the equilibrium strategy is:

(i) A high-fertility strategy \( \{k_{2-n}, k_{3-n}, x_{1-n}, x_{2-n}, x_{3-n}, n_1=n_2=1\} \) if:

(a) \( f_{2-n}(k_{2-n}) \geq 0; f_{1-n}^{n_2=1}(K) > 0; \) and

(b) \( v_1(x_{1,-n}^*, x_{2,-n}^*, x_{3,-n}^*, n_1=n_2=1) > v_1(x_1^*, x_2^*, 0, n_1=1, n_2=0) \)

when \( f_{2-n}(k_{2-n}) < 0 \) and \( f_{2-n}(k_{2-n}^*) > 0 \).

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

(a) \( f_{2-n}(k_2^*) < 0; f_{1-n}^{n_2=0}(K) > 0; \) and

(b) \( v_1(x_{1-n}^*, x_{2-n}^*, x_{3-n}^*, n_1=n_2=1) \leq v_1(x_1^*, x_2^*, 0, n_1=1, n_2=0) \)

when \( f_{2-n}(k_2^*) < 0 \) and \( f_{2-n}(k_{2-n}^*) > 0 \).
(iii) A no-fertility strategy \(\{k_2 = k_3 = 0, x_1 = K, x_2 = x_3 = 0, n_1 = n_2 = 0\}\) if
\[ f_{1,n_2}^{n_2 = 0}(K) \leq 0 \text{ and } f_{1,n_2}^{n_2 = 1}(K) \leq 0. \]

And for the dynasty in the settlement regime the equilibrium strategy is:

(i) A high-fertility strategy \(\{k_2^{**}, k_3^{**}, x_1, x_2, x_3 = 0, n_1 = n_2 = 1\}\) if:
   
   (a) \(f_{2,s}(k_3^{**}) \geq 0; f_{1,s}^{n_2 = 1}(K) > 0\); and
   (b) \(v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1 = n_2 = 1) > v_1(x_1^*, x_2^*, 0, n_1 = 1, n_2 = 0)\),

(ii) A low-fertility strategy \(\{k_2^*, k_3 = 0, x_1^*, x_2, x_3 = 0, n_1 = n_2 = 0\}\) if:
   
   (a) \(f_{1,n_2}^{n_2 = 0}(K) > 0\), and
   (b) \(v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1 = n_2 = 1) \leq v_1(x_1^*, x_2^*, 0, n_1 = 1, n_2 = 0)\) when \(f_{2,s}(k_3^{**}) > 0\).

(iii) A no-fertility strategy \(\{k_2 = k_3 = 0, x_1 = K, x_2 = x_3 = 0, n_1 = n_2 = 0\}\) if
\[ f_{1,n_2}^{n_2 = 0}(K) \leq 0 \text{ and } f_{1,n_2}^{n_2 = 1}(K) \leq 0. \]

Proof: See Appendix C.2. ■

For each possible equilibrium strategy, condition (a) guarantees that generations 1 and 2 optimize fertility decisions 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. Specifically, for some parameter values generation 1 can choose between an equilibrium in which generation 2 is childless and another one in which generation 2 has children. If he prefers the equilibrium with high-fertility strategy, he gives a high bequest to generation 2, \(k_2^{**}\), in the no-settlement regime, and settles a high bequest to the third generation, \(k_3^{**}\), in the settlement regime.

5.3 Results

Here we present our model’s main results. First, the model replicates the effect of settlements on fertility documented in the empirical analysis. Second, we show that under exponential discounting the settlement and no-settlement regimes are equivalent. Instead, settlements increase fertility for discount functions with a strong degree of hyperbolicity. Third, we show that settlements, or, more generally, inheritance systems that restrict heirs, can emerge endogenously as a result of a father’s concerns over the dynasty’s survival and his heir’s optimal decision.

Settlements and fertility. First, we show that settlements can increase fertility. As discussed above, generation 1 can affect the probability that the dynasty survives until generation 3: In the no-settlement regime, he does so by giving generation 2 a large bequest \(k_2\). In the settlement regime, he does so by settling a larger share of the dynasty’s wealth \(k_3\) for the third generation (see Definition 2).
The second mechanism is more effective in moving the dynasty to a high-fertility equilibrium. For the sake of illustration, Figure 3 plots the equilibrium strategies (no-fertility, low-fertility, and high-fertility) for different discount factors $\beta$ and $\delta$ and a given $K$. Panel (a) is for the dynasty in the no-settlement regime and panel (b) is for the dynasty in the settlement regime. The highlighted area in panel (c) is the parameter region where settlements (strictly) increase fertility; i.e., where generation 2 is childless in the no-settlement regime, but has children in the settlement regime. Proposition 2 generalizes this result.

**Proposition 2 (The effect of settlements on fertility)** The set of parameters supporting a high-fertility equilibrium strategy for the dynasty in the settlement regime nests the corresponding set for the dynasty in the no-settlement regime.

**Proof:** See Appendix C.3. ■

Intuitively, for any bequest profile $\{k_2, k_3\}$, generation 2 has a lower incentive to deviate to a low-fertility strategy if he is subject to a settlement. In the no-settlement regime, generation 2 can remain childless and appropriate all the bequest $k_2$—which otherwise would be split between his own consumption and that of generation 3. In contrast, in the settlement regime, 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.\(^{42}\) Hence, generation 1 can increase the fertility of generation 2 more effectively in the settlement regime (i.e., by settling a large bequest $k_3$) than in the no-settlement regime (i.e., by giving generation 2 a large bequest $k_2$).

**Discount function.** Here we show that the effect of settlements on fertility is driven by the intergenerational discount function. We begin by showing that under the standard assumption of exponential discounting both the settlement and no-settlement inheritance regimes are equivalent.

**Proposition 3 (Exponential discounting)** Assume that the discount function is exponential, i.e., $\beta = 1$. The equilibrium strategies of dynasties in the settlement and no-settlement inheritance regime are identical for all $\delta$ and $K$.

**Proof:** See Appendix C.4. ■

Intuitively, under exponential discounting preferences are time consistent across generations: Generation 1 values his consumption $x_1$ relative to generation 2’s consumption $x_2$ in the same manner as generation 2 values his own consumption $x_2$ relative to generation 3’s consumption $x_3$. In other words, generations 1 and 2

\(^{42}\)Alternatively, one can think of $k_3$ going to a distant relative whose utility is fully discounted.
Notes: Dotted lines show isolines for $\beta \cdot \delta$ constant. Family wealth $K$ is 100. (father and son) agree on how to provide for generation 3 (grandson). In this scenario, a contract like a settlement—which restricts a son’s powers to decide over the grandson’s bequest—is innocuous. Exponential discounting, hence, is hard to reconcile with the existence of settlements and its effects on fertility.

Next, we show that the effect of settlements on fertility can be rationalized by introducing intergenerational hyperbolic discounting (i.e., dynastic preferences). To see this we first need to define a measure capturing the degree of hyperbolism of the discount function. Note that our discount function has two elements: the discount rate for future generations, $\delta$, and the discount rate for all the future consumptions, $\beta$. On the one hand, for low values of $\beta$ (and $\delta$) individuals are present biased, and hence, are likely to pursue a low- or a no-fertility strategy. On specifically, if generation 1 is present biased he either consumes all dynasty wealth $K$ and
the other hand, for low values of $\beta$ preferences are more hyperbolic. In other words, individuals have strong dynastic preferences, and hence, may prefer the dynasty not to die out. To disentangle the two effects of $\beta$, we consider combinations of $\beta$ and $\delta$ with the same degree of present-biasedness; i.e., we keep $\beta \cdot \delta$ constant.44

**Definition 3 (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 $\beta < \beta'$.

Once equipped with this definition, we evaluate how hyperbolic discounting affects fertility. Consider Figure 3. Isolines represent combinations of $\beta$ and $\delta$ with the same present-biasedness, i.e., $\beta \cdot \delta$ constant. Along an isoline, lower values of $\beta$ capture more hyperbolicity. More hyperbolic discount functions are associated with high-fertility strategies, independently of the inheritance regime (see isolines in panel (a) and (b)). Proposition 4 generalizes this result:

**Proposition 4 (Hyperbolic discounting and fertility)** Under both the settlement and no-settlement inheritance regimes, the conditions for a high-fertility strategy are more likely to be satisfied for more hyperbolic discount functions.

**Proof:** See Appendix C.5. ■

In other words, if generation 1 exhibits more hyperbolic discounting, i.e., dynastic preferences, he strongly prefers the dynasty not to die out after generation 2. This objective, however, is achieved more effectively in the settlement regime than in the no-settlement regime (Proposition 2). As a result, a parameter region exists where discounting is hyperbolic, and hence, generation 1 would like to keep the dynasty alive, but can only do so with a settlement. Panel (c) of Figure 3 illustrates this region: when individuals exhibit exponential discounting ($\beta = 1$), are highly present-biased (low $\beta$ and $\delta$), or do not discount the future (high $\beta$ and $\delta$), both inheritance regimes produce identical fertility outcomes. Only when the dynasty exhibits hyperbolic discounting do outcomes differ across regimes. Specifically, lower values of $\beta$ along a given isoline lead to the parameter region where the settlement regime is associated with high-fertility and the no-settlement regime with low-fertility strategies. Proposition 5 generalizes this result.

**Proposition 5 (Settlements and hyperbolic discounting)** For more hyperbolic discount functions, fertility is weakly larger in the dynasty under the settlement regime than in the dynasty under the no-settlement regime.

is childless or passes down a small share of it such that generation 2 chooses to remain childless. 44Formally, let $\beta \cdot \delta = \Gamma$. Generation 1 discounts the next two generations with $\Gamma$ and $\Gamma^2$ respectively, where $\beta \in [\Gamma, 1]$. Keeping $\Gamma$ constant, a lower $\beta$ is associated with a more similar discounting for the next two generations; that is, a more hyperbolic discount function.
Proof: See Appendix C.6.

In sum, Propositions 3 to 5 show that the empirical effect of settlements on fertility can only be rationalized with discount functions that (1) value the dynasty’s survival and (2) generate a time-inconsistency across generations—which is resolved by settlements. Exponential discounting, hence, is hard to reconcile with the effect of settlements on fertility. In contrast, our proposed hyperbolic discount function (or dynastic preference) satisfies both conditions.

Endogenous settlements. So far, we have shown both empirically and theoretically that settlements can increase fertility on the extensive margin. Here we show that, in turn, settlements can emerge endogenously as a result of an individual’s concerns over the dynasty’s survival and his heir’s optimal decisions.

To do so, we endogenize the decision to sign a settlement. We assume a settlement is signed between generation 1 and 2 if both are better off in the settlement regime than in the no-settlement regime. Clearly, this decision is only binding in the parameter region where the two inheritance regimes produce different outcomes; i.e., where settlements increase fertility. Proposition 6 compares each generation’s utility in this parameter region.

**Proposition 6 (Welfare)** Consider the parameter region where a dynasty in the no-settlement regime follows a low-fertility strategy and a dynasty in the settlement regime follows a high-fertility strategy. All generations are better off in the settlement regime; i.e.,

\[ v_3(x_3^{**}, s) > v_3(x_3 = 0), \quad v_2(x_2^{**}, x_3^{**}, n_2 = 1) > v_2(x_2^*, x_3 = 0, n_2 = 0), \]

and

\[ v_1(x_1^{**}, x_2^{**}, x_3^{**}, n_1 = 1, n_2 = 1) > v_1(x_1^*, x_2^*, x_3 = 0, n_1 = 1, n_2 = 0). \]

Proof: See Appendix C.7.

Signing a settlement is welfare improving for each individual generation of a dynasty with hyperbolic discounting. Clearly, generation 1 always prefers to sign a settlement. Under this contract, he can solve the intergenerational time inconsistency and ensure that the dynasty will not die out after generation 2.

What is less obvious is why generation 2 agrees to sign a settlement. Under a settlement, he gives away his powers to decide generation 3’s bequest and freely dispose of the dynasty’s wealth. However, a settlement makes him better off ex ante. The reason is that by signing a settlement he credibly commits to have children, which ensures that generation 1 will pass down a larger share of the dynasty’s wealth \( K \) to the following two generations; i.e.,

\[ k_2^{**} + k_3^{**} > k_2^*. \]

Finally, note that settlements will only emerge in the parameter region corresponding to more hyperbolic discounting, i.e., stronger dynastic preferences. This suggests that settlements (trusts) emerged among aristocrats (the very wealthy) because they exhibit stronger dynastic preferences than the general population.
6 Conclusion

From 1650 to 1882, British aristocrats did not freely dispose of their wealth. Upon their marriage, they signed a settlement committing to pass down the family estate, unbroken, to the next generation. This paper shows that such arrangements were crucial to change fertility incentives and to ensure the survival of peerage dynasties. Using demographic data from 1,141 peer heirs in 1650–1882, we find that signing a settlement increased the probability to have children by 85.9%, pushing childlessness rates close to the natural rate of 2.4% (Tietze, 1957). To establish causality, we use two particularities of our setting: First, because of tradition and institutional constraints, settlements were signed by a father and his heir at the heir’s wedding. Hence, a father was more likely to live until his heir’s wedding when the heir was the first-born than when he was born after a girl. This generates as good as a random assignment into signing a settlement. Second, we use data on non-heirs and heirs to Scottish peerages—two groups who did not use settlements—to conduct placebo tests and to estimate a difference-in-differences’ model. This allows us to compare heirs to their siblings between families where the heir signed and did not sign a settlement. We find that settlements reduced childlessness for heirs but had no effect on those who did not use settlements.

This paper also provides a novel theory of wealth transmission to pin down the mechanism through which settlements changed fertility incentives. In our model, individuals are present-biased, but discount their offspring and future generations similarly. Under this type of hyperbolic discounting, a family head would like the dynasty to survive, and hence, pass down a large bequest. When an heir is subject to a settlement, he cannot appropriate the bequest settled for the next generation. He can only derive utility from it by continuing the family line, which alters fertility incentives in the intensive margin. We show that this effect of settlements on fertility is increasing in the hyperbolicity of the discount function, and disappears under exponential discounting. Furthermore, our model rationalizes why a father and his heir would agree to sign a settlement, even if this limits the latter’s powers to freely dispose of all the dynasty’s wealth: A settlement increases the heir’s welfare by allowing him to commit ex ante to have children—which guarantees that a larger share of the dynasty’s wealth will pass down in the form of bequests. This shows that settlements can emerge endogenously in response to concerns over the dynasty’s survival and the heir’s optimal decisions.

These results have several important implications: First, research on inheritance typically treats fertility as exogenous or ignores endogenous fertility choices
on the extensive margin, i.e., to have children or not. In contrast, we show that inheritance systems can affect this margin of fertility and, in turn, concerns over childlessness can shape inheritance systems endogenously. Second, we argue that models of bequests assuming exponential discounting (Barro, 1974) are inconsistent with a broad range of inheritance systems that restrict successors’ powers to manage inherited wealth: settlements (England), trusts, fee tails (United States), entails (Scotland), *majorat* (France), *mayorazgo* (Spain), or *ordynacja* (Poland). Third, our results imply that settlements contributed to the perpetuation of elite lineages, as suggested by Adam Smith. However, we argue that they did so not only by entailing the land or favouring primogeniture, but also through changing fertility incentives. This challenges the common wisdom that fertility and inequality are negatively related (Deaton and Paxson, 1997; Kremer and Chen, 2002; de la Croix and Doepke, 2003). This relation may be the opposite on the extensive margin of fertility. Finally, the historical episode we studied echoes with today’s fertility concerns and inheritance practices among the richest. Specifically, British aristocrats faced high childlessness rates in the sixteenth century. Their response was to restrict their heir’s powers to manage the dynasty’s wealth with a settlement. Similarly, today’s elite, i.e., individuals at the top of the income distribution, are facing high childlessness rates (Baudin *et al.*, 2015) and are increasingly restricting their successors powers with trust funds (Wolff and Gittleman, 2014). Whether fertility and inheritance systems are related in the same manner as in the past is a question for future research.

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**References**

Aaronson, D., Lange, F. and Mazumder, B. (2014). ‘Fertility transitions along the extensive and intensive margins’, *American Economic Review*, vol. 104(1), pp. 3701–3724.

Abel, A.B. (1987). ‘Operative gift and bequest motives’, *The American Economic Review*, vol. 77(5), pp. 1037–1047.

Acemoglu, D. (2008). ‘Oligarchic versus democratic societies’, *Journal of the European Economic Association*, vol. 6(1), pp. 1–44.

Allen, D.W. (2009). ‘A theory of the pre-modern british aristocracy’, *Explorations in Economic History*, vol. 46(3), pp. 299–313.
Anderson, M. (1998). ‘Highly restricted fertility: Very small families in the british fertility decline’, Population Studies, vol. 52(2), pp. 177–199.

Atkinson, A.B. and Harrison, A.J. (1978). Distribution of Total Wealth in Britain, Cambridge University Press, Cambridge.

Baltagi, B.H. (2011). Econometrics, Springer, fifth edition edn., ISBN 978-3-642-20058-8.

Barro, R.J. (1974). ‘Are government bonds net wealth?’, Journal of Political Economy, vol. 82(6), pp. 1095–1117.

Bateman, J. (1883). The Great Landowners of Great Britain and Ireland, London: Harrison.

Baudin, T., de la Croix, D. and Gobbi, P.E. (2015). ‘Fertility and childlessness in the united states’, American Economic Review, vol. 105(6), pp. 1852–1882.

Baudin, T., de la Croix, D. and Gobbi, P.E. (2020). ‘Endogenous childlessness and stages of development’, Journal of the European Economic Association, vol. 18(1), pp. 83–133.

Beckett, J.V. (1977). ‘English landownership in the later seventeenth and eighteenth centuries: The debate and the problems’, Economic History Review, vol. 30(4), pp. 567–581.

Bertocchi, G. (2006). ‘The law of primogeniture and the transition from landed aristocracy to industrial democracy’, Journal of Economic Growth, vol. 11(1), pp. 43–70.

Bonfield, L. (1979). ‘Marriage settlements and the ‘rise of great estates’: The demographic aspect’, Economic History Review, vol. 32(4), pp. 483–493.

Brée, S. and de la Croix, D. (2019). ‘Key forces behind the decline of fertility: lessons from childlessness in Rouen before the industrial revolution’, Cliometrica, vol. 13(1), pp. 25–54.

Brito, C. and Pearl, J. (2002). ‘Generalized instrumental variables’, in (A. Darwiche and N. Friedman, eds.), Uncertainty in Artificial Intelligence. Proceedings of the 18th Conference, pp. 85–93, San Francisco: Morgan Kaufmann.

Chu, C.Y.C. (1991). ‘Primogeniture’, Journal of Political Economy, vol. 99(1), pp. 78–99.

Clark, G. and Cummins, N. (2009). ‘Urbanization, mortality, and fertility in malthusian england’, American Economic Review, vol. 99(2), pp. 242–47.

Cordoba, J.C. and Ripoll, M. (2016). ‘Intergenerational transfers and the fertility-income relationship’, The Economic Journal, vol. 126(593), pp. 949–977.
de la Croix, D. and Doepke, M. (2003). ‘Inequality and growth: Why differential fertility matters’, American Economic Review, vol. 93(4), pp. 1091–1113.

de la Croix, D., Schneider, E.B. and Weisdorf, J. (2019). ‘Childlessness, celibacy and net fertility in pre-industrial England: the middle-class evolutionary advantage’, Journal of Economic Growth, vol. 24(3), pp. 223–256.

Deaton, A. and Paxson, C. (1997). ‘The effects of economic and population growth on national saving and inequality’, Demography, vol. 34(1), pp. 97–114.

Diamond, P. and Kőszegi, B. (2003). ‘Quasi-hyperbolic discounting and retirement’, Journal of Public Economics, vol. 87(9-10), pp. 1839–72.

Doepke, M. and Zilibotti, F. (2008). ‘Occupational choice and the spirit of capitalism’, The Quarterly Journal of Economics, vol. 123(2), pp. 747–793.

English, B. and Saville, J. (1983). Strict Settlement: A Guide for Historians, Hull: University of Hull Press.

Fildes, V.A. (1986). Breasts, Bottles, and Babies: A History of Infant Feeding, Edinburgh: Edinburgh University Press.

Galor, O. (2011). Unified Growth Theory, Princeton: Princeton University Press.

Galor, O. and Klemp, M. (2014). ‘The biocultural origins of human capital formation’, CEPR Discussion Paper 10136.

Galperti, S. and Strulovici, B. (2017). ‘A theory of intergenerational altruism’, Econometrica, vol. 85(4), pp. 1175–1218.

Goğüş, M. (2018). ‘Assortative matching at the top of the distribution. evidence from the world’s most exclusive marriage market’, Unpublished.

Grieco, P.L.E. and Ziebarth, N.L. (2015). ‘Unigeniture in an uncertain world’, Chiometrica, vol. 9(2), pp. 139–166.

Gruber, J. and Kőszegi, B. (2001). ‘Is addiction ‘rational’? theory and evidence’, Quarterly Journal of Economics, vol. 116(4), pp. 1261–304.

Habakkuk, H.J. (1950). Marriage settlements in the eighteenth century’, Transactions of the Royal Historical Society, vol. 32, pp. 15–30.

Habakkuk, H.J. (1994). Marriage, Debt, and the Estates System: English Landownership, 1650-1950, Oxford: Clarendon Press.

Hazan, M. and Zoabi, H. (2015). ‘Sons or daughters? sex preferences and the reversal of the gender educational gap’, Journal of Demographic Economics, vol. 81(2), pp. 179 – 201.

Hollingsworth, T.H. (1964). ‘The demography of the British peerage’, Population Studies, vol. Supplement.
Hollingsworth, T.H. (2001). ‘“Hollingsworth Genealogical Data on the British Peerage”’, Database. Re-digitised from handwritten original index sheets and archived by the Cambridge Group for the History of Population and Social Structure.

Jayachandran, S. and Kuziemko, I. (2011). ‘Why do mothers breastfeed girls less than boys? evidence and implications for child health in India’, The Quarterly Journal of Economics, vol. 126(3), pp. 1485–1538.

Kremer, M. and Chen, D.L. (2002). ‘Income distribution dynamics with endogenous fertility’, Journal of Economic Growth, vol. 7(3), pp. 227–258.

Laibson, D.I., Repetto, A. and Tobacman, J. (1998). ‘Self control and saving for retirement’, Brookings Papers on Economic Activity, vol. 1(1), pp. 91–172.

Lévy, C. and Henry, L. (1960). ‘Ducs et pairs sous l’ancien régime. caractéristiques démographiques d’une caste’, Population, vol. 15(5), pp. 807–830.

Li, Q. and Pantano, J. (2014). ‘The demographic consequences of sex-selection technology’, Unpublished.

Marcassa, S., Pouyet, J. and Trégouët, T. (2020). ‘Marriage strategy among the European nobility’, Explorations in Economic History, vol. 75, p. 101303.

Murnane, R. and Willett, J. (2010). Methods matter: Improving causal inference in educational and social science research, Oxford University Press.

Pedlow, G.W. (1982). ‘Marriage, family size, and inheritance among hessian nobles, 1650-1900’, Journal of Family History, vol. 7(4), pp. 333–352.

Phelps, E.S. and Pollak, R.A. (1968). ‘On second-best national saving and game-equilibrium growth’, The Review of Economic Studies, vol. 35(2), pp. 185–199.

Piketty, T. (2011). ‘On the long-run evolution of inheritance: France 1820–2050’, The Quarterly Journal of Economics, vol. 126(3), p. 1071.

Roodman, D. (2007). ‘Cmp: Stata module to implement conditional (recursive) mixed process estimator’, Statistical Software Components S456882, Boston College Department of Economics, revised 24 May 2020.

Rubinstein, W.D. (1977). ‘Wealth, elites and the class structure of modern britain’, Past and Present, vol. 76, pp. 99–126.

Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations, Reprint. New York: Modern Library, 1937.

Stiglitz, J.E. (1969). ‘Distribution of income and wealth among individuals’, Econometrica, vol. 37(3), pp. 382–397.

Stone, J.C. and Stone, L. (1984). An Open Elite? England, 1540–1880, Oxford: Clarendon Press.
Tietze, C. (1957). ‘Reproductive span and rate of reproduction among hutterite women’, *Fertility and Sterility*, vol. 8(1), pp. 89–97.

Weil, P. (1987). ‘Love thy children: Reflections on the barro debt neutrality theorem’, *Journal of Monetary Economics*, vol. 19, pp. 377–391.

Wigniolle, B. (2013). ‘Fertility in the absence of self-control’, *Mathematical Social Sciences*, vol. 66(1), pp. 71–86.

Wolff, E.N. and Gittleman, M. (2014). ‘Inheritances and the distribution of wealth or whatever happened to the great inheritance boom?’, *The Journal of Economic Inequality*, vol. 12(4), pp. 439–468.

Wreden, M. (2011). ‘Hyperbolic discounting and fertility’, *Journal of Population Economics*, vol. 24(3), pp. 1053–1070.

Wrigley, E., Davies, R.S., Oeppen, J. and Schoeld, R. (1997). *English Population History from Family Reconstitution: 1580-1837*, Cambridge: Cambridge University Press.