

Parental Control and Fertility History^{*†}

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Abstract

Parental control over offspring has changed dramatically in Western societies. From a state, before the 19th century, where parents completely controlled their children far into adulthood, a series of laws have shifted these control rights to the current state where even younger children control many aspects of their own lives. We first document the laws that gave parents all the control and argue that these control rights, directly or indirectly, gave parents access to a large fraction of their offspring's labor income if they so desired. This paper argues that the shift in property rights that followed has important implications for fertility choice. In a simple overlapping generations model with endogenous fertility and altruism, we show that the first-order effect of such a shift is a decrease in fertility—contributing to the decline in fertility during the demographic transition. Depending on the cost structure of children, this decrease may be followed by an increase in fertility, exacerbated by the introduction of pay-as-you-go social security in the 1930s—a confounding factor to generate the baby boom in the 1950s and 1960s.

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1 Introduction

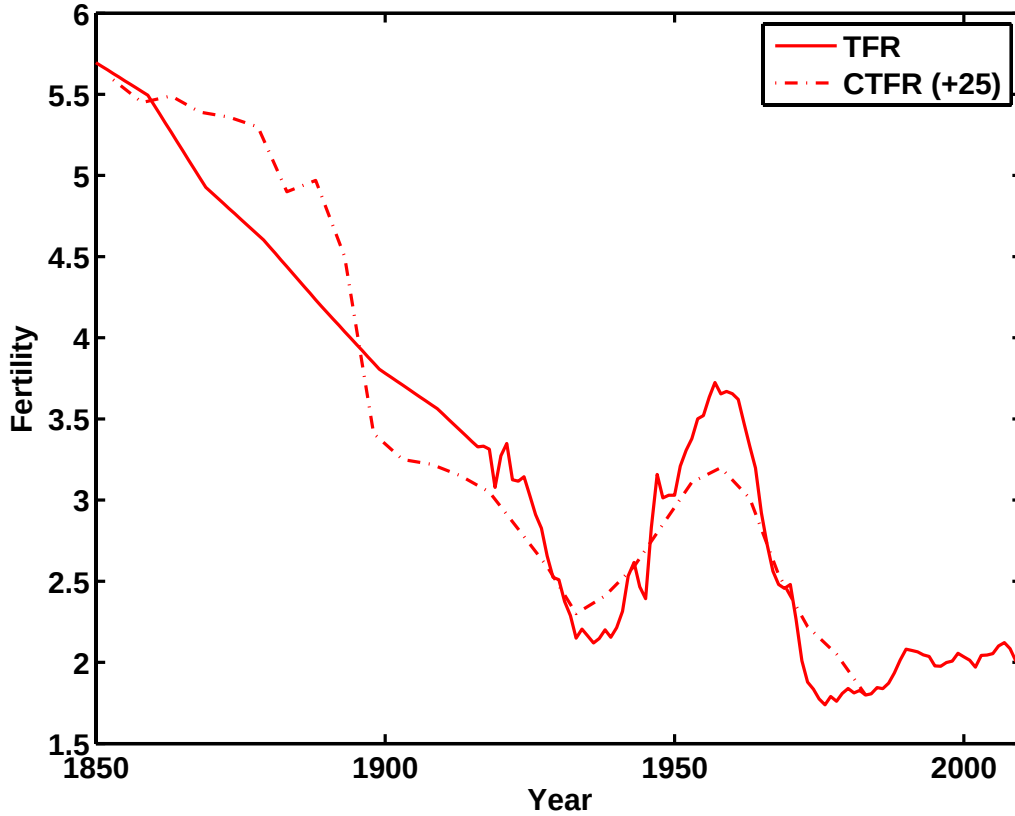
Historically parents were in a position of almost absolute control over the decisions of their children. Parents—or, in most cases, the father—had many legal recourses to assure that their wishes were executed. Examining the common law system of the United States and England along with the roman based legal system in France before the nineteenth-century, we show how western countries ensured that parents had control over children. In the mid-nineteenth century and early twentieth century, many reforms were passed in western countries that expanded children’s rights at the expense of their parents’ rights, completely changing the child-parent power structure. Today, children possess many rights that were once at the discretion of their parents. In almost all developed countries, children reach majority at 18 and marriageable age is now 18 without consent, 15-16 with court consent (parental consent is not strictly required any longer).¹ Moreover, children have more rights to represent their views (including views against their parents) in child protective proceedings. In sum, children now hold a large amount of freedom and right *vis-à-vis* their parents – very different from the situation before the 19th century.

This paper argues that this shift in property rights from parents to children has important implications for fertility choice, contributing to the trend decline during the demographic transition and, together with the introduction of pay-as-you-go social security, the baby boom that followed (see Figure 1 which plots the total fertility rate (TFR) as well as completed fertility (CTFR) since 1850). From the perspective of our theory, we are most interested in parental control over an offspring’s life-time labor income. In Section 2, we therefore first discuss laws that directly affect access to an offspring’s labor income, such as mandatory parental support and filial responsibility laws. Laws about child labor are also relevant as they allow (or prevent) access to part of an offsprings life-time labor income. Second, we discuss laws that give parents control over other aspects of their children’s lives and thereby allow them to indirectly control their offsprings’ income, e.g. by withholding consent to marriage unless filial monetary support is given. Third, de-facto control may vary with other aspects of society, such as living arrangements that may make monitoring children easier or more difficult. In essence, changes in parental support laws, other parental control rights, and de-facto control all paint the same picture. Historically, parents (in most cases the

¹In Japan and Korea, majority is reached at 20. In Canada, majority is reached at either 18 or 19 depending on the province. As well, marriageable age in Japan and Korea is 20 without consent, 18 with parental consent for males, 16 for females.

father) were in a position of almost absolute control over their offspring. Starting from the mid-19th to the mid-20th century, many different types of reforms were passed that removed most legal and de-facto control of parents and thereby essentially led to self-ownership of offspring.

Figure 1: Total Fertility Rate and Cohort Total Fertility Rate since 1850



Sources: TFR: Haines (1994), CTFR: Jones and Tertilt (2008).

In Section 3, we set up an overlapping generations model with endogenous fertility, parental altruism and variable property rights over adult children's labor income to argue that, while children used to be viewed as partly an investment good, they are now first and foremost a consumption good.² The reason is that when property rights lie with parents, parents partly have children to appropriate a fraction of the latter's labor income. Parents realize that, in addition to providing a utility benefit, children are a resource and parents reap the benefits thereof if they so desire. Due to altruism, par-

²The model is a special case of the one laid out in Schoonbroodt and Tertilt (2014) except that this paper allows for time costs, which turn out to be important for the results.

ents never leave children completely destitute. However, as property rights shift from parents to children, at some point parents are constrained and, once (adult) children own their own income, parents only have children for their consumption value.

Along this transition where parents are more and more constrained by property rights, fertility decreases. To show this, we derive comparative statics with respect to property rights. Generally speaking, the shift in property rights from parents to children can be viewed as a tightening of a constraint on borrowing against one's children's future income. A tightening of this constraint therefore effectively decreases the net benefit of children. Assuming logarithmic utility and a Cobb-Douglas production function, we therefore find that the first-order effect of a shift in property rights, through a tightening of the transfer constraint, is a decrease in fertility. This is true for the first generation. Subsequent generations also keep a larger fraction of their own income and therefore experience an additional income as well as a substitution effect if children cost time. In addition to the first-order effect described above, this income effect tends to increase fertility while the substitution effect tends to decrease it. Taken together, we show that once property rights stabilize, fertility may increase or stabilize, depending on the cost structure of children. In the goods cost case, the income effect is larger than the first-order effect and there is no substitution effect. Hence, fertility increases above its original level. In the time cost case with logarithmic utility, income and substitution effect exactly cancel out and fertility of subsequent generations stabilizes at the same level as the first generation.

Having analyzed private intergenerational transfers, we turn to pay-as-you-go (PAYG), effectively a government-mandated intergenerational transfer program. Here, we show that the introduction of pay-as-you-go (PAYG) social security relaxes the constraint on parents and tends to alleviate the downward pressure on fertility. However, the incentive to have children is not the same as with private transfers because pension payments are not directly linked to fertility choices as private transfers are.

Finally, in Section 4, we use the comparative statics results to simulate the transition path as parental control is lost over time. Though hard to quantify precisely, we show that our channel may be important to understand the history of fertility since 1850. It may have significantly contributed to the trend decline in fertility, with the baby boom partly ensuing from the introduction of PAYG social security.

This paper therefore complements other, more standard theories for the demographic transition and the baby boom. For instance, theories about the demographic transition include those based on mortality and longevity (e.g. Doepke, 2005; Cervellati

and Sunde, 2005) or economic development through industrialization and urbanization (e.g. Fernandez-Villaverde, 2001; Greenwood and Seshadri, 2002; Bar and Leukhina, 2010) and/or human capital accumulation (e.g. Tamura, 1996; Galor and Weil, 2000). Moreover, theories about the baby boom analyzed in dynamic macroeconomic models include Greenwood, Seshadri, and Vandenbroucke (2005) who relate productivity growth in the home versus the market to the baby boom, Doepke, Hazan, and Maoz (2007) who argue that female labor force participation of older women during the war led to younger women opting for higher fertility, Albanesi and Olivetti (2014) who generate a baby boom from lower maternal mortality and Jones and Schoonbroodt (2010) who relate the baby boom to the Great Depression and the economic boom that followed.

Further, changes in child labor laws and education subsidies are analyzed in Doepke (2004) and Doepke and Zilibotti (2005), while our main focus is access to income of adult children.

2 Parental Control over Children's Income over Time

The argument of this paper is that the allocation of property rights over a child's income has important economic consequences. Exploring these consequences is particularly important because such property rights have changed dramatically over time. In this section, we describe the historical change in property rights over children based on evidence from the common law system of the United States and England along with the roman based legal system in France.

2.1 Parental Control over Child's Income

In both England and the United States, (adult) children were obligated to support their parents through the (Elizabethan) Poor Law Act of 1601. To quote Callahan (1985, p.33): "The family, as a unit, was to be responsible for poverty-stricken kinfolk. [...] The Poor Law did not concentrate on the children of elderly, but extended the network of potential support to include the fathers and mothers, and the grandfathers and grandmothers, of the poor. [...] When these laws passed over into the American scene, during the seventeenth and eighteenth centuries, the focus was on the responsibilities of children towards their elderly parents." According to Kline (1992) "statutory language, almost identical to the Elizabethan counterpart, endured in American filial

responsibility laws for the next three centuries.” Parents slowly lost the benefit of relying on their adult children for support in the mid 19th and early 20th century, as England and the United States began to repeal or ignore the laws that obligated children to support their elderly parents. For a more detailed description on elderly support laws in the 19th and 20th centuries see Thomson (1984) for England and Britton (1990) for the United States.³

In the case of France, the Napoleonic Civil code also had a law, similar to those found in England and the United States that required children to support their elderly parents. Quoting Byrd (1988) (p.88), Article 205 of the code says “Children are liable for the maintenance of their parents and other ascendants in need”. While this law is technically still active in France, it is virtually no longer applicable since the social security system takes care of people “in need”. Thus children are no longer a legal source of income in old age.

Also, until 1793 in the United States, parents could legally indenture their children as servants, and some states even had laws that banned children from living apart from their families. In 1793, the Pennsylvania Supreme Court “held that there were limits to the purposes for which a parent could bind out a child: they could bind him out to learn a trade, but not as a servant. [...] Parents could have the benefit of the child’s services or relief from their obligation of support, but only as an incident of preparing him for later life.” (Marks 1975, p. 81). By the 1800s, parents were no longer allowed to indenture their children in many states, laws prohibiting children from leaving the family were “either repealed or ignored” and parents were obligated by law to provide proper care for their children (Marks 1975, p. 81).

Additionally, many states passed compulsory education laws.⁴ Kertzer and Barbagli (2001) point out that “for many poor parents among the working class, the artisans and the peasantry, the regular school attendance of their children implied enforced withdrawal from work, whether at home or in the workshop” which eliminated a form of income for parents. By 1938, child labor was banned throughout the U.S.⁵

³There is currently a heated policy debate in the United States concerning the reinstatement or enforcement of filial responsibility laws to decrease the cost of Medicaid and Medicare (see <http://www.ncpa.org/pub/ba521>, for example).

⁴Massachusetts was the first state to pass a compulsory school attendance law. “The Massachusetts law served as a model for the laws of most other states.” All states followed with compulsory education laws between 1871 and 1929, with Alaska being the last state to implement such a law. For more information on what year each state passed compulsory education laws, see Landes (1972, p. 55-58).

⁵By 1938, every state had passed laws which “effectively banned child labor and enforced compulsory schooling” (Margolin 1978, p. 443). As well, in 1938, Fair Labor Standard Acts was passed, “which broadly regulated child labor” (Guggenheim 2005, p. 4)

Another important factor in a parent's access to his child's resources is the legal definition of adulthood. In the 1970s, reforms were passed that reduced the age of majority from 21 to 18 (Castle 1986, p. 348) and provided new definitions on children's emancipation rights.⁶ Age of majority and laws governing premature emancipation from parents are important factors that determine parental rights over older children's income. For example, the essential feature of the law on emancipation of minors in the United States is to provide conditions upon which children are released from parental authority and become "adults" for important legal purposes. One purpose regarding emancipation is that it allows a child to earn and spend his own wages. This suggests that parents can appropriate the earnings of their children when said children are under age and therefore under parental authority. Laws expanding these rights therefore decrease the potential access a parent may have to the working child's income.

2.2 Other Parental Control Rights

In addition to laws that directly affect control over labor income, historically many laws existed that gave parents much control over other aspects of their offsprings' lives. Such control provides a lot of leverage for parents which they may have used to extract additional resources from their children. We thus believe that other control rights are also important in our context and in the following discuss the existence and removal of such laws.

The most extreme example of parental control over children in the United States were the stubborn child laws implemented in several states during the mid-17th century. These laws obligated children to be obedient to their parents, and if they failed to do so, parents had the right to take their children to court and their offenses could be punishable by death.⁷ In contrast to the power parents had over their children, there was little children could do to protect themselves from their parents. Interestingly, in 1641 a law was passed in the United States which made it illegal to curse or

⁶In the 1970s, many states expanded their definition of child emancipation – see Castle (1986, p.388). For a description of the 1975 California Code definition of emancipation, see Plotkin (1981, p.125).

⁷An act of the General Court of Massachusetts decreed in 1646: "If a man have a stubborn or rebellious son, of sufficient years and understanding, viz. sixteen years of age, which will not obey the voice of his Father or the voice of his Mother, and that when they have chastened him will not harken unto them: then shall his Father and Mother being his natural parents, lay hold on him, and bring him to the Magistrates assembled in Court and testify unto them, that their son is stubborn and rebellious and will not obey their voice and chastisement ... such a son shall be put to death." States that followed were Connecticut 1650, Rhode Island 1668, New Hampshire 1679 (Mason 1994, p. 11).

hit one's parents.⁸ Both of these laws applied to children age 16 and over, without an upper bound on age. Even though there is no record of the stubborn child law ever being used to execute someone, it demonstrates the amount of power parents had in the common law systems in the United States and England. Corporal punishment and physical cruelty were common methods for parents to enforce discipline (Mason 1994, p. xvii). Finally, parental consent was also necessary for marriage—another way for parents of indirectly controlling their access to the child's income.⁹

After the mid-nineteenth century, the United States passed numerous laws that reduced the control that parents had over their children. Strict laws were passed on abuse, cruelty and parental neglect.¹⁰ Agencies were created to protect children from such cruelty (for example, the famous Society for the Prevention of Cruelty to Children was founded in London in 1884) and a Child Court was established (Hawes, 1991). Finally, In the 1970s, reforms were passed that expanded children's medical rights¹¹ and increased abuse protection.¹² In short, children in the United States gained rights that dramatically reduced the amount of control a parent could have over his children.

Similar degrees of parental control were also present in Roman-based legal systems.¹³ In France, the idea of *patria potestad* underlined all legal decisions regarding children's rights. *Patria Potestad* refers to “the control which a father exercised over his children, a control similar to that over material things and one which permitted a father to sell or pawn a child if necessary and even to eat it in an extreme case” (Sponsler 1982, p. 147-148). The legal system also allowed parents to use *lettres de cachet*, letters

⁸The child has to be over 16 and the abuse could be punishable by death (Hawes 1991, p. 4).

⁹Kertzer and Barbagli (2001), p. 114.

¹⁰For example, in 1846 Michigan enacted a law making it a crime for parents to abandon a child under six years of age (Marks 1975, p. 83).

¹¹Plotkin (1981) documents changes in laws related to medical consent of minors: In 1972, Mississippi passed a statute that “allows any minor who can understand the consequences of the [medical] treatment to give personal consent, without regard to the youth's age.” Previously, all forms of medical and health treatment for minors (under the age of majority) required parental consent (p. 123). In 1975, California allowed minors to give consent for “certain types of services, such as birth control and treatment for venereal disease and pregnancy” (p. 123); In 1973, Colorado “enacted legislation that grants immunity from suit to doctors who act on a good-faith belief that parental consent is not required” (p. 124); 1971 New York Public Health Law allows “any minor, whether or not officially emancipated, who is or has been married or who has borne a child may consent to treatment” (p. 126).

¹²1973 - Child Abuse Prevention and Treatment Act passed, which “required states to meet federal standards on custody provisions”, including granting child welfare agencies the power to “remove a child from a family for three days if the agency believes the child is in danger”. (Hawes 1991, p. 101). 1974 - Congress enacted law calling for separate legal representation for children (and parents) in neglect and abuse cases (Guggenheim 2005, p. 8).

¹³For an interesting description of the powers a father had over his children in roman times, see Arjava (1998, p. 147-165).

signed by the king often used to enforce authority and sentence someone without trial. *Lettres de cachet* “could be used by parents when their child refused to follow parental direction with respect to a marriage partner or career” (Kertzer 2001, p. 133). In general, parental consent was necessary for all marriage decisions regardless of age.¹⁴

Reforms similar to those in the United States were also witnessed in European countries. They occurred slightly later, from the late-nineteenth century to about three-quarters of the twentieth century. In France, “neglected children came under the protection of the courts (1889), children were protected from the physical abuse of their parents by criminal statute (1898) and 21 was established as the age of majority when children were allowed to undertake legal acts and marry without parental consent (1907)” (Kertzer 2001, p. 141). In legal terms, by 1972, “the relationship of parent to child [was] no longer viewed as a power of domination” and instead was “seen as an authority conferred upon parents to protect the child, thus entailing responsibilities as well as rights”(Alexandre 1972, p. 652-653). Thus parents could no longer control their children as much as they could in the past.

2.3 De facto Control

Besides changes in parental support laws and other legal ways to control one’s offspring, de facto parental control over children may have also changed for technological reasons. In particular, the process of industrialization was accompanied by changing living arrangements from extended to nuclear families, which may have lowered the de facto control parents have over their children.

In the United States, in the mid-nineteenth century, almost 70 percent of persons age 65 or older resided with their adult children; by the end of the twentieth century, fewer than 15 percent did so (see Ruggles (2007)). Parental control is much easier to exercise in a setting where multiple generations live together in the same household compared to a setting where young couples live away from their parents. Therefore, as societies develop and move towards more urban and industrial settings, the land holdings of the parents are no longer the only opportunity of children to generate wealth. Instead, children may choose to opt for a nuclear family living arrangement. In such an

¹⁴Civil Code of 1804 - “children, regardless of age, were bound to seek the consent of their parents (or grandparents if both parents were deceased) (Article 151). However, as a practical matter, consent of parents was only required for the marriage of males under the age of 25, and females under the age of 21; if the parents disagreed, the consent of the father was deemed sufficient (Article 148).” (Kertzer 2001, p. 138).

environment, it is much harder for parents to control or claim their children's income regardless of their legal rights.¹⁵

Thus, besides legal ways of controlling adult children's labor income, living arrangements may be an important factor in de-facto property rights over children's income.

2.4 From total parental control to self-determination

It is remarkable how much control parents had over their children at one point in time in comparison to the rights that children have today. Starting from the mid-nineteenth until the mid-twentieth century, reforms were passed in western countries that completely altered the rights that a parent has over his children; children went from a state of total control by their parents, to a state in which they have a lot of freedom to make their own decisions, marry without requiring parental consent and achieve majority at much lower ages. Given the laws and cultural norms documented above, one can view the history of children's rights *vis-à-vis* their parents as a period of total control, a period of transition, and, finally, the current state of children's rights.

3 Theoretical Results

3.1 Model Setup

People in our model live for three periods: childhood, (middle-aged) adulthood and retirement. In childhood, no decisions are made. Middle-aged adults work and bear children. Retired people live off their savings and potentially transfers from their children.¹⁶ Households derive utility from their own consumption when middle-aged, c_t^m , and when old, c_{t+1}^o , the number of children, n_t , as well as their offsprings' average utility. That is, in our model children are a consumption good in that n_t directly enters the utility function, but parents are also altruistic and care about their children's utility. The utility of a middle-aged household in period t (born in $t - 1$) is given by:

$$U_t = u(c_t^m) + \beta u(c_{t+1}^o) + \gamma u(n_t) + \zeta U_{t+1} \quad (1)$$

¹⁵While many scholars have attributed this change to increased resources of the old, Ruggles (2007) suggests that increased opportunities of the young have lead to this change in living arrangements.

¹⁶We introduce government transfers in Section 3.3.

where n_t is the number of children born in period t . We assume that $u(\cdot)$ is continuous, strictly increasing, strictly concave and $u'(0) = \infty$. Discounting between periods is given by β while children's utility is weighted by ζ . The budget constraints are given by

$$\begin{aligned} c_t^m + \theta_t^g n_t + s_{t+1} &\leq w_t(1 - \theta_t^l n_t)(1 + b_t) \\ c_{t+1}^o + n_t b_{t+1} w_{t+1}(1 - \theta_{t+1}^l n_{t+1}) &\leq r_{t+1} s_{t+1} \\ b_{t+1} &\geq \underline{b}_{t+1} \\ c_t^m, c_{t+1}^o, n_t &\geq 0 \end{aligned} \tag{2}$$

where θ^g is the goods cost per child while θ_t^l is the fraction of time it takes to raise a child, $(1 - \theta_t^l n_t)$ is labor supply, income is $w_t(1 - \theta_t^l n_t)$, s_{t+1} are savings, $b_{t+1} w_{t+1}(1 - \theta_{t+1}^l n_{t+1})$ —a fraction b_{t+1} of each child's income—is the transfer from parent to child if positive, from child to the parent if negative.

As in Schoonbroodt and Tertilt (2014), the minimum constraint, $\underline{b}_{t+1}$, can be interpreted as parental property rights over children's labor income. When $\underline{b}_{t+1}$ is positive, then a larger transfer floor implies that parents have to bequeath more resources to their children. When $\underline{b}_{t+1}$ is negative, a higher transfer floor means parents can expropriate fewer resources from their children. The transfer floor is only well-defined between -1 and some b^{max} . When $\underline{b}_{t+1} = -1$ then there are no (legal or effective) constraints on transfers and parents have full property rights over their children's income. If, on the other hand, $\underline{b}_{t+1} = 0$ then children own their own income. If $\underline{b}_{t+1} > 0$ then children have a claim to their parent's income. The maximum possible transfer, $\underline{b}_{t+1}^{max}$, is an endogenous object. At $\underline{b}_{t+1}^{max}$ a parent would have to bequeath his entire income to his children.

Initially, there is a mass 1 of initial old people each endowed with K_0 capital and n_{-1} children. The initial old chooses $(c_0^o, \{b_0^i\}_{i=0}^{n_{-1}})$ to maximize

$$U_{-1} = \beta u(c_0^o) + \gamma u(n_{-1}) + \zeta U_0$$

subject to:

$$c_0^o + n_{-1} b_0 w_0(1 - \theta_0^l n_0) \leq r_0 K_0, \quad b_0 \geq \underline{b}_0$$

The middle-aged adult in period t chooses $(c_t^m, c_{t+1}^o, n_t, s_{t+1}, b_{t+1})$ to maximize U_t in equation (1) subject to the constraints in (2), given the transfer from his own parents, b_t , and prices (w_t, w_{t+1}, r_{t+1}) , taking the behavior of all descendants as given. Since we as-

sume that the utility function satisfies Inada conditions, the non-negativity constraints on fertility and consumption never bind, while the minimum constraint on transfers, b_{t+1} , may or may not bind. A few additional assumptions are required to ensure that the problem is well-defined.¹⁷

In choosing fertility and savings, the parents equate marginal benefit to marginal cost with very standard first-order conditions. It is the choice of transfer per child, b_{t+1} , that is crucial for our mechanism. If the minimum transfer constraint is not binding, the parent chooses b_{t+1} to equate the marginal utility of consumption when old to the one when young. However, when the constraint is binding, the marginal utility of consumption when old is “too high”, while the marginal utility of children’s consumption is “too low” from the parent’s point of view. That is, consumption of the old is too low compared to their children’s consumption when middle aged. In addition, a tightening of the transfer constraint effectively increases the cost of children, which tends to decrease fertility as we show in the next section.¹⁸

The representative firm has a neo-classical production function $Y_t = F(K_t, L_t)$, and takes prices (r_t, w_t) as given when choosing (K_t, L_t) to maximize profits. Since our model period represents the distance between two generations, we assume full depreciation throughout which simplifies analytical results.

Finally, markets clear. Labor markets clear in period t if the firm’s labor demand per old person, L_t , is equal to the labor supplied by middle-aged people per old person, $n_{t-1}(1 - \theta_t^l n_t)$, since they are the only ones who are productive. The capital stock per old person, K_t , must be equal to savings from currently old people, s_t . Let k_t be the capital stock per unit of labor. Then we can write $s_t = k_t n_{t-1}(1 - \theta_t^l n_t)$. Hence, factor markets clear if $L_t = n_{t-1}(1 - \theta_t^l n_t)$ and $K_t = s_t = k_t n_{t-1}(1 - \theta_t^l n_t)$. Goods market clearing in period t can be expressed in per old person terms as follows:

$$c_t^o + n_{t-1}(c_t^m + \theta_t^g n_t + s_{t+1}) = F(s_t, n_{t-1}(1 - \theta_t^l n_t)) = n_{t-1}(1 - \theta_t^l n_t)F(k_t, 1).$$

¹⁷Details on these can be found in Schoonbroodt and Tertilt (2014). For example, with logarithmic utility which we extensively use below, we need $\gamma > \frac{\zeta(1+\beta)}{1-\zeta}$, to rule out that the limit where $n \rightarrow 0$ and per child consumption goes to infinity yielding infinite utility for the parent. Also, to guarantee finite utility it is necessary to assume $\zeta < 1$.

¹⁸See Appendix A for a more detailed characterization of the equilibrium allocation.

3.2 Changes in property rights and fertility choice

Here we analyze how a permanent shift in property rights (from parents to children) affects fertility choice. A tightening of the transfer constraint, if binding, means that children are more costly, so that the first order effect is a decline in fertility. However, several indirect effects are present and complicate the analysis. For the analysis below, it is useful to derive a general expression for equilibrium fertility. For simplicity, we assume logarithmic utility and a Cobb-Douglas production function with the capital share denoted by α .¹⁹ In this case, fertility is given by

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{\overbrace{w_t(1 + b_t)}^{(2a)}}{\underbrace{\theta_t^g + \theta_t^l w_t(1 + b_t)}_{(2b)} + \underbrace{b_{t+1}}_{(1)} \frac{w_{t+1}}{r_{t+1}} (1 - \theta_{t+1} n_{t+1})} \right) \quad (3)$$

Note that $\frac{\gamma}{1 + \beta + \gamma}$ is the utility weight on fertility, $w_t(1 + b_t)$ is wealth or potential income and the denominator is the effective cost of a child, goods costs plus time costs plus the present value of transfers. Hence, this expression simply states the usual result with homothetic preferences: total expenditure on fertility is a constant fraction of wealth.

Except for those who are old when the law is changed, a tightening of the transfer constraint, potentially affects people in three ways. First, they receive less from their own children in the future (1). This is the first-order cost effect. Second, they also owe less to their own parents today (2a). The latter is an income effect which may lead to higher desired fertility. Third, due to the time cost, children also become relatively cheaper today (2b). In addition to these direct effects, general equilibrium effects are present as the tightening of the transfer constraint affects the capital-labor ratio, thus changing relative prices, which in turn changes the incentive to invest in children vs. capital.

Below, we analyze the following thought experiment. Assume the economy is in a steady state where all parameters are constant and the constraint is constant and binding at $\underline{b}$. In period s , there is an (unanticipated) permanent shift in property rights from parents to children so that $\underline{b}' > \underline{b}$ in all future periods, $t > s$. We assume that this change in the law takes place *after* transfers of generation s to their own parents have taken place, but before any other decisions are made. In other words, $\underline{b}_s = \underline{b}$

¹⁹Appendix A provides details on this derivation. When relevant, we perform sensitivity of our results to these assumptions. In particular, we extend result to CES utility and production specifications in Appendices C and D.

while $\underline{b}_t = \underline{b}' > \underline{b}$ for all $t > s$. Therefore, the change in the law affects generation s differently from generations born later but it does not affect generation s 's parents or any generation before. With this thought experiment in mind, we use marginal arguments below to simplify the analysis.

Below, we first analyze the effect of an increase in the transfer constraint on generation s , where only the first-order effect (1) is at work. The effects on later generations are more complicated. To gain some insights, we consider two extreme cases: (A) the case where children only cost goods, i.e. $\theta^g > 0$ and $\theta^l = 0$, and (B) the case where children only cost time, i.e. $\theta^g = 0$ and $\theta^l > 0$. In case (A) only effects (1) and (2b) are at work, while in case (B), only effect (1) is at work because effects (2a) and (2b) cancel out. In the next section, we give a numerical example where both goods and time costs are present, $\theta^g > 0$ and $\theta^l = 0$, and, hence, effects (1), (2a) and (2b) are at work. There we simulate the transition path of fertility in response to progressive increases in the transfer constraint, $\underline{b}$.

In equation (3), the number of children chosen today, n_t , depends on the number of grand-children chosen next period, n_{t+1} . To eliminate this term, combine the first-order condition for fertility, the budget constraint when old and capital market clearing to get

$$\frac{w_{t+1}}{r_{t+1}}(1 - \theta_{t+1}^l n_{t+1}) = \frac{\beta(\theta_t^g + \theta_t^l w_t(1 + b_t))}{\frac{\gamma\alpha}{1-\alpha} - (\beta + \gamma)b_{t+1}}. \quad (4)$$

Using this in equation (3), fertility is given by

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{w_t(1 + \underline{b}_t)}{\theta_t^g + \theta_t^l w_t(1 + \underline{b}_t)} \right) \left(\frac{\gamma \frac{\alpha}{1-\alpha} - (\beta + \gamma)\underline{b}_{t+1}}{\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}_{t+1} \right)} \right). \quad (5)$$

If parents are transfer constrained, we see that this expression gives us fertility as a function of parameters only.

3.2.1 The effects on the first generation

First, consider generation s . Note that $\underline{b}_s = \underline{b}$ is unchanged by assumption and that w_s is only a function of the capital-labor ratio—the components of which were chosen in the previous period and are therefore unaffected by the legal change. However, this is the first generation that experiences a tightened constraint on $\underline{b}_{s+1} = \underline{b}' > \underline{b}$. Taking the

total derivative with respect to $\underline{b}'$, we have

$$\frac{dn_s}{d\underline{b}'} = - \underbrace{\frac{\gamma}{1 + \beta + \gamma} \left(\frac{w_s(1 + \underline{b})}{\theta^g + \theta^l w_s(1 + \underline{b})} \right)}_{(1)} \frac{\beta \gamma \frac{\alpha}{1-\alpha}}{\left[\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right) \right]^2}. \quad (6)$$

Clearly, we have $\frac{dn_s}{d\underline{b}'} < 0$. Thus, we can see that the first-order effect on generation s is a decrease in fertility due to the decreased benefit from / increased cost of children. This effect is the effect labelled (1) in equation (3) and is independent on any further assumptions.

3.2.2 The effects on subsequent generations

(A) Goods cost case ($\theta^g > 0$ and $\theta^l = 0$)

In this case, fertility for generation $t > s$ is given by

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{w_t(1 + \underline{b}')}{\theta^g} \right) \left(\frac{\gamma \frac{\alpha}{1-\alpha} - (\beta + \gamma) \underline{b}'}{\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right)} \right). \quad (7)$$

Taking the total derivative, we have

$$\begin{aligned} \frac{dn_t}{d\underline{b}'} = & \underbrace{- \frac{\gamma}{1 + \beta + \gamma} \left(\frac{w_t(1 + \underline{b}')}{\theta^g} \right) \frac{\beta \gamma \frac{\alpha}{1-\alpha}}{\left[\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right) \right]^2}}_{(1)} \\ & + \underbrace{\frac{\gamma}{1 + \beta + \gamma} \left(\frac{\gamma \frac{\alpha}{1-\alpha} - (\beta + \gamma) \underline{b}'}{\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right) \theta^g} \right) \left(w_t + (1 + \underline{b}') \frac{dw_t}{d\underline{b}'} \right)}_{(2a)} \end{aligned} \quad (8)$$

Comparing equation (8) to (6) we see that for generations beyond s there are two additional terms—both dampening the fertility decline. The first term comes from the fact that these later generations owe their own parents less, which is a positive income effect, leading to higher fertility. The second term is a general equilibrium effect on the wage rate, which is increasing in the capital-labor ratio. In the goods cost case, we can solve for k_t , $t > s$, from equation (4) to get

$$k_t = \left(\frac{\alpha}{1 - \alpha} \right) \frac{\beta \theta^g}{\frac{\gamma \alpha}{1-\alpha} - (\beta + \gamma) \underline{b}'} \quad (9)$$

Clearly, the capital labor ratio is increasing in $\underline{b}$.²⁰ Therefore, the wage rate also increases in response to the change in $\underline{b}$, $\frac{dw_t}{d\underline{b}} > 0$, which generates a further positive income effect.

The overall effect of the change in property rights on fertility for generations $t > s$ may therefore be positive or negative. To see this, let's follow Schoonbroodt and Tertilt (2014) and define three special values of $\underline{b}$. First, let b^* be the transfer chosen if the parent is unconstrained. For $\underline{b} < b^*$, Schoonbroodt and Tertilt (2014) show that at an interior equilibrium $\theta^g r > w$ and $n > r$. Once, $\underline{b}$ increases beyond b^* , we have shown above that the capital-labor ratio, k , increases, and hence the wage rate, w , increases while the rental rate of capital, r , decreases. Now, define $b_M > b^*$ as the minimum transfer constraint such that $\theta^g r = w$. At $\underline{b} = b_M$, steady state fertility is increasing in $\underline{b}$. Beyond b_M , define b_P as the minimum transfer constraint such that $n = r$. At $\underline{b} = b_P$, a sufficient condition for steady state fertility to be decreasing in $\underline{b}$ is $\frac{\alpha}{1-\alpha} > \frac{\beta}{1+\beta}$.²¹ Hence, for very tight minimum transfer constraints, steady state fertility may be decreasing in $\underline{b}$. These cases are illustrated in Figure 2 which plots steady state to steady state fertility as a function of $\underline{b}$ in the goods cost case.

(B) Time cost case ($\theta_t^g = 0$ and $\theta_t^l > 0$)

In this case, fertility for generation $t > s$ is given by

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{1}{\theta^l} \right) \left(\frac{\gamma \frac{\alpha}{1-\alpha} - (\beta + \gamma) \underline{b}'}{\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right)} \right). \quad (10)$$

That is, the income effect coming from one's parents losing rights and the substitution effect coming from a lower opportunity cost of children exactly cancel out.²² Hence, in

²⁰With a CES production function, we need capital and labor to be substitutable enough for these comparative statics to hold, see Appendix C for details.

²¹See Appendix B for details.

²²With a CES utility function of the form $u(x) = \frac{x^{1-\sigma}-1}{1-\sigma}$, income and substitution effect do not generally cancel out. In fact, the direct effect of the increase in $w_t(1 + \underline{b}_t)$ due to an increase in $\underline{b}$ is the usual one: if $\sigma > 1$ the income effect dominates and, hence, we get similar results as in the goods cost case, while if $\sigma < 1$ the substitution effect dominates and the first-order effect is reinforced for subsequent generations. However, these effects may be mitigated by general equilibrium effects on the interest rate between t and $t + 1$. See Jones, Schoonbroodt, and Tertilt (2010, Section 3.2) for the basic result in a static model and Appendix D for details in this model.

this case we get

$$\frac{dn_t}{d\underline{b}'} = \underbrace{-\frac{\gamma}{1+\beta+\gamma} \left(\frac{w_s(1+\underline{b})}{\theta^g + \theta^l w_s(1+\underline{b})} \right)}_{(1)} \frac{\beta\gamma \frac{\alpha}{1-\alpha}}{\left[\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}' \right) \right]^2} = \frac{dn_s}{d\underline{b}'}. \quad (11)$$

This means that, compared to the initial steady state, fertility of generations $t > s$ falls by the same amount as fertility of generation s . That is, fertility remains at $n_t = n_s$ for all $t > s$. As an illustration, Figure 3 plots steady state to steady state fertility as a function of $\underline{b}$ in the time cost case.

3.3 The effects of pay-as-you-go social security

In this section, we analyze the effects on fertility of introducing pay-as-you-go (PAYG) social security. At first, one might think that, as in Barro (1974), PAYG undoes any binding intergenerational transfer constraints. This is true when fertility is exogenously given. In our framework with endogenous fertility, the system indeed relaxes a binding transfer constraint, and therefore tends to counteract the latter's effects on fertility, but only partially because the incentives for fertility differ: infinitesimal parents do not take into account the effect of their own fertility on the size of the pension pot. We use these results in our numerical example of the fertility history in Section 4 to argue that the introduction of PAYG may have contributed to the baby boom in the 1950s and 1960s.

With PAYG social security, the budget constraints, equations (21) and (22), become:

$$c_t^m + \theta_t^g n_t + s_{t+1} \leq w_t(1 - \theta_t^l n_t)(1 + b_t - \tau_t) \quad (12)$$

$$c_{t+1}^o + n_t b_{t+1} w_{t+1}(1 - \theta_{t+1}^l n_{t+1}) = r_{t+1} s_{t+1} + T_{t+1} \quad (13)$$

While the PAYG system exactly counteracts increases in b_t in the budget constraint when young, we see that it does not reverse the reduced fertility incentives through intergenerational transfers in the budget constraint when old. If fertility was exogenously given, the PAYG system would counteract the effects of $\underline{b}$ on the intergenerational allocation of consumption. The reason for this is as follows. Government budget balance for the PAYG system is given by $T_{t+1} = n_t(1 - \theta_{t+1}^l n_{t+1})\tau_{t+1}w_{t+1}$. Hence, when fertility is exogenous, the pension pot T is also exogenous. With endogenous fertility, however, if an individual household has more children, the increased pension pot is distributed

Figure 2: Steady State to Steady State Fertility as a Function of $\underline{b}$ — Goods Cost

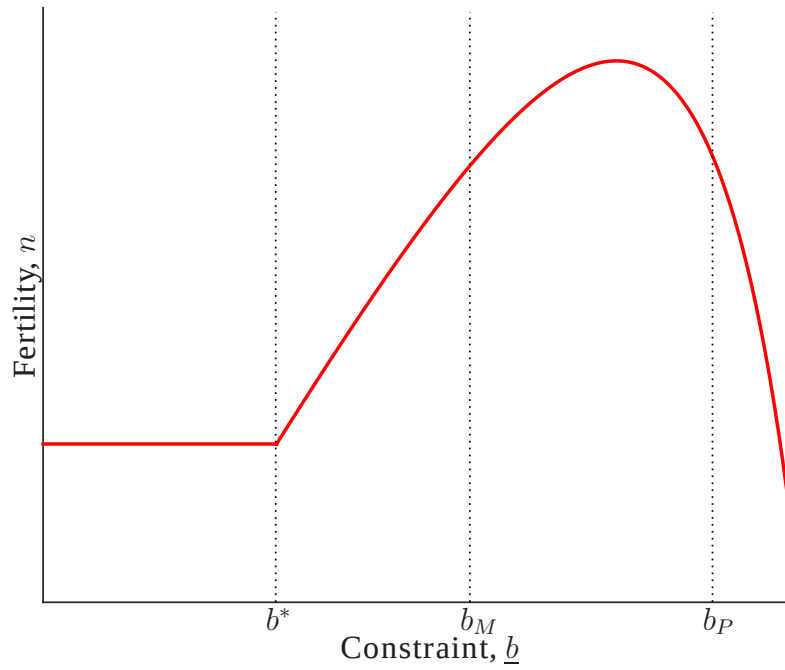
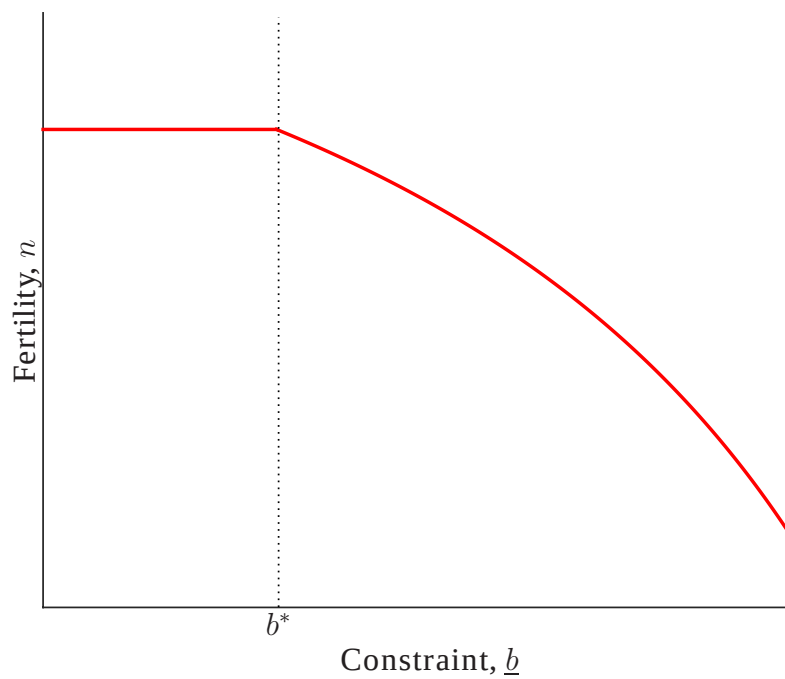


Figure 3: Steady State to Steady State Fertility as a Function of $\underline{b}$ — Time Cost



to the entire generation of parents but it does not affect individual pensions received as much as a change in $\underline{b}$ does. Thus, an increase in $\underline{b}$ is not fully counteracted by an increase in τ .

In fact, assuming logarithmic utility and a Cobb-Douglas production function and following the same steps as in the previous section, we can again derive an expression for fertility.

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{w_t(1 + \underline{b}_t - \tau_t)}{\theta_t^g + \theta_t^l w_t(1 + \underline{b}_t - \tau_t)} \right) \left(\frac{\gamma \frac{\alpha}{1-\alpha} - (\beta + \gamma) \underline{b}_{t+1}}{\gamma \left(\frac{\alpha}{1-\alpha} - \underline{b}_{t+1} + \frac{\beta + \gamma}{1 + \beta + \gamma} \tau_{t+1} \right)} \right). \quad (14)$$

As can be seen in the equation an increases in taxes paid, τ_t , completely undoes any tightening in the constraint imposed on one's parents, $\underline{b}_t$. However, the effect of an increase in future pensions received, through τ_{t+1} , only partly counteracts the effects of a tightening of the constraint in the future, $\underline{b}_{t+1}$. A larger pension pot means that there is an income effect but the household is not incentivized to increase fertility accordingly, while higher transfer constraints decreases income but also generates a substitution effect.²³

4 Fertility History: A Numerical Simulation

With the above comparative statics in hand, we now describe how our mechanism may have contributed to the fertility decline during the demographic transition and the baby boom that followed. We describe a history where we assume that there are some goods, $\theta^g > 0$, and some time costs, $\theta^l > 0$, that are stable over time so that we can concentrate on the main mechanism in this paper: an increase in $\underline{b}_t$ over time.

²³With a fertility dependent PAYG system (FDPAYG), the budget constraints, equations (21) and (22), become:

$$c_t^m + \theta_t n_t + s_{t+1} \leq w_t(1 + b_t - \tau_t^F) \quad (15)$$

$$c_{t+1}^o + b_{t+1} w_{t+1} n_t \leq r_{t+1} s_{t+1} + \tau_{t+1}^F w_{t+1} n_t \quad (16)$$

Let us define $\tilde{b}_t = b_t - \tau_t^F$ and $\tilde{\underline{b}}_t = \underline{b}_t - \tau_t^F$, for all t . Then we can use this change of variables to recover the same problem for the household as the one without taxes—with one difference: the constraint, $\tilde{b}_t \geq \tilde{\underline{b}}_t$ is less tight than the original one. That is, the FDPAYG pension system exactly undoes any tightening in the constraint but has no effect if the minimum transfer constraint is no longer binding. Hence, we have $\frac{dn_t}{d\tau_t^F} = -\frac{dn_t}{d\tilde{b}_t}$ if the constraint is binding and $\frac{dn_t}{d\tau_t^F} = 0$ if the constraint is not binding. See Schoonbroodt and Tertilt (2014) for details.

In this simulation where both goods and time costs are present, it is useful to simplify effect (1) and confound effects (2a) and (2b) by rewriting equation (3) as follows

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \underbrace{\left(\frac{1}{\frac{\theta_t^g}{w_t(1+\underline{b}_t)} + \theta_t^l} \right)}_{(2)} \overbrace{\left(1 - \frac{\beta}{\gamma \left(\frac{1}{\underline{b}_{t+1}} \left(\frac{\alpha}{1-\alpha} \right) - 1 \right)} \right)}^{(1)}. \quad (17)$$

That is, from the generation fertile in period t 's point of view, effect (1) corresponds to a change in the future constraint of loosing control over one's children, $\underline{b}_{t+1}$, while effect (2) refers to the income effect of one's parents having lost control before, $\underline{b}_t$. The latter effect is confounded the goods cost related income effect net of the time cost related substitution effect on fertility in period t , n_t .

We start in 1800 with $\underline{b}_{1800} = -1$, where parents have full property rights over their offspring's labor income. Then, from 1850 to 1950 we slowly increase children's rights to $\underline{b}_{1950} = 0$, where every generation owns their own income. We then introduce a PAYG pension system. The changes in $\underline{b}$ and τ are shown in Figure 4 together with chosen transfers and the resulting path of fertility is shown in Figure 5. The transition path of fertility in response to the progressive change in parental control, $\underline{b}_t$, is represented by the solid line in Figure 5.

In the early days, circa 1850 and before, parents had almost full control over their children and, in particular, their income. Hence, the minimum transfer constraint was not binding and fertility was high and stable. In the second half of the 19th century, as parents were loosing control over children's income, the constraint became binding and fertility started to decline. In our numerical example, the first generation for whom the constraint binds is parents fertile around 1870 foreseeing a binding constraint around 1890. Looking at Figure 5, the initial drop in fertility is rather small because the constraint is not that far from their desired transfer, as can be seen in Figure 4. For the next two generations, the effect becomes stronger and stronger because of the non-linear relationship between fertility in period t , n_t , and transfers in period $t + 1$, $\underline{b}_{t+1}$ (effect (1) in equation (17)). This acceleration remains despite the presence of goods costs which tends to increase fertility a generation later as parents are bound to leave their offspring better off (effect (2)). ***Recall some milestones from Section 2 once we have them*** By 1950, we postulate that children owned their own income. As can be seen in Figure 5, the lowest fertility in history therefore occurs around 1930.

As parental control remained stable thereafter, fertility increased slightly. In our numerical example, this happens because of the presence of a goods cost. There is no further decrease in fertility because, compared to their parents the generation fertile in the 1950s has no further incentive to decrease fertility (effect (1) is unchanged); but have a larger income effect than their parents did (only effect (2) is at work).

When PAYG social security was introduced in addition, fertility increased some more but then decreased slightly to reach a steady state with higher fertility than in the 1930s but lower than in the 19th century, an effect represented by dashed line in Figure 5.

Hence, while our mechanism attributes part of the trend decline in fertility to the loss of control of parents over children, the baby boom can be understood as a combination of an echo effect of stabilized parental control on the one hand and a public policy effect, imperfectly reversing lost parental control, on the other.

Figure 4: Changes in Property Rights, PAYG and Chosen Transfer

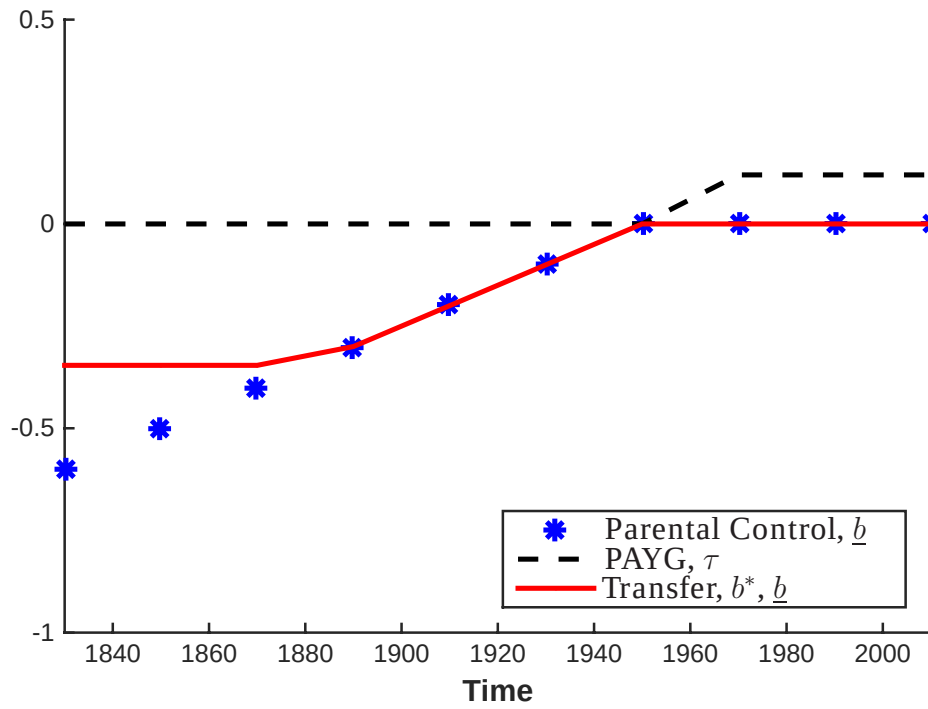
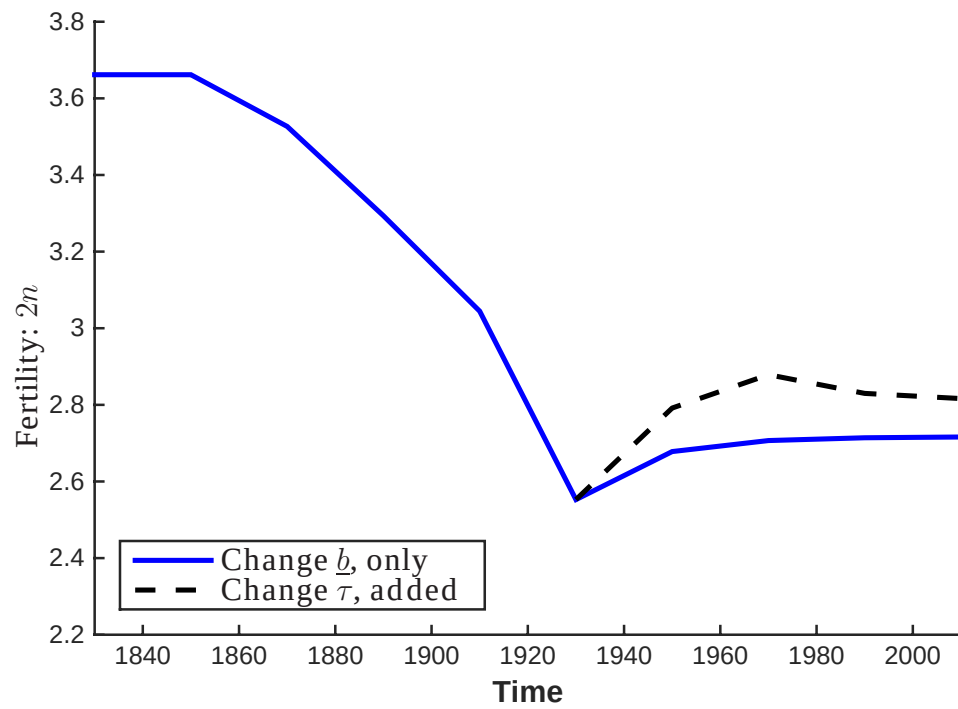


Figure 5: Transition Path of Fertility



5 Concluding Remarks

[TBW]

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APPENDIX

A Characterizing equilibria

The first-order conditions for the household are

$$\gamma u'(n_t) = u'(c_t^m)(\theta_t^g + \theta_t^l w_t(1 + b_t)) + \beta u'(c_{t+1}^o) b_{t+1} w_{t+1} (1 - \theta_{t+1}^l n_{t+1}) \quad (18)$$

$$u'(c_t^m) = \beta u'(c_{t+1}^o) r_{t+1} \quad (19)$$

$$\beta u'(c_{t+1}^o) n_t = \zeta u'(c_{t+1}^m) + \frac{\lambda_{b,t+1}}{w_{t+1}(1 - \theta_{t+1}^l n_{t+1})} \quad (20)$$

$$c_t^m + \theta_t^g n_t + s_{t+1} = w_t(1 - \theta_t^l n_t)(1 + b_t) \quad (21)$$

$$c_{t+1}^o + n_t b_{t+1} w_{t+1} (1 - \theta_{t+1}^l n_{t+1}) = r_{t+1} s_{t+1} \quad (22)$$

$$\lambda_{b,t+1}(b_{t+1} - \underline{b}_{t+1}) = 0. \quad (23)$$

Note that, without heterogeneity other than period of birth, savings will always be positive as long as the production function satisfies Inada conditions.

The first-order conditions for the firm's problem are given by:

$$w_t = F_L(k_t, 1) \quad (24)$$

$$r_t = F_K(k_t, 1) \quad (25)$$

Combining the first-order conditions of the household, equations (18) to (23), and those for the firm, equations (24) and (25), characterize the equilibrium allocation. Equations (18) and (19) are intertemporal conditions equating marginal costs and benefits of “investment” in children and physical capital. Equation (20) is an *intratemporal* but *intergenerational* condition, equating the parent's marginal cost and benefit of an additional unit of transfer per child, b_{t+1} , unless the minimum constraint is binding. Recall that $\lambda_{b,t+1}$ is the multiplier on the transfer constraint. So when the constraint is binding, the marginal utility of consumption when old is “too high”, while the marginal utility of children's consumption is “too low” from the parent's point of view. That is, consumption of the old is too low compared to their children's consumption when middle aged. The fourth and fifth equations are the budget constraints when young and when old. The last equation is complementary slackness for the minimum transfer constraint.

Next, we derive of equation (3). First, derive the present value budget constraint

by substituting out s_{t+1} in equations (21) and (22). Assuming logarithmic utility, equations (18) and (19) are

$$\gamma c_t^m = n_t(\theta_t^g + \theta_t^l w_t(1 + b_t) + b_{t+1} \frac{w_{t+1}}{r_{t+1}}(1 - \theta_{t+1}^l n_{t+1})) \quad (26)$$

$$c_{t+1}^o = \beta r_{t+1} c_t^m. \quad (27)$$

Using equations (26) and (27) in the present value budget constraint, we get

$$c_t^m = \frac{w_t(1 + b_t)}{1 + \beta + \gamma}.$$

Using this in equation (18) again, the expression for fertility in equation (3).

To derive equation (4), combine equation (26) and (27) to relate c_{t+1}^o and n_t . Use the budget constraint when old, equation (22), to eliminate c_{t+1}^o and capital market clearing to eliminate s_{t+1} . Assuming a Cobb-Douglas production function, we can substitute for $k_{t+1} = \frac{w_{t+1}}{r_{t+1}} \frac{\alpha}{1-\alpha}$. Now, n_t cancels out and we get equation (4).

Finally, note that with a Cobb-Douglas production function, we have

$$\underline{b}^{max} = \left(\frac{\gamma}{\beta + \gamma} \right) \left(\frac{\alpha}{1 - \alpha} \right).$$

Hence, for an interior solution, we need

$$\underline{b}_t < \left(\frac{\gamma}{\beta + \gamma} \right) \left(\frac{\alpha}{1 - \alpha} \right) \quad \forall t.$$

B Details around $\underline{b} = b_M$ and $\underline{b} = b_P$ —goods cost case

In the goods cost case, equation (3) in steady state becomes

$$n_t = \frac{\gamma}{1 + \beta + \gamma} \left(\frac{w(1 + \underline{b}')}{\theta_t^g + \underline{b}' \frac{w}{r}} \right) \quad (28)$$

Totally differentiating gives

$$\begin{aligned}\frac{dn}{d\underline{b}} &= \frac{\gamma}{1+\beta+\gamma} \left[\frac{\left(w + (1+\underline{b}) \frac{dw}{d\underline{b}} \right) \left(\theta^g + \underline{b} \frac{w}{r} \right) - (w(1+\underline{b})) \left(\frac{w}{r} + \underline{b} \frac{d(w/r)}{d\underline{b}} \right)}{\left(\theta^g + \underline{b} \frac{w}{r} \right)^2} \right] \\ &= \frac{\gamma}{1+\beta+\gamma} \left[\frac{\left(w + (1+\underline{b}) \alpha \frac{w}{k} \frac{dk}{d\underline{b}} \right) \left(\theta^g + \underline{b} \frac{w}{r} \right) - (w(1+\underline{b})) \left(\frac{w}{r} + \underline{b} \left(\frac{1-\alpha}{\alpha} \right) \frac{dk}{d\underline{b}} \right)}{\left(\theta^g + \underline{b} \frac{w}{r} \right)^2} \right]\end{aligned}$$

Now $\frac{dn}{d\underline{b}} > 0$ iff numerator > 0 (cancel w in every term in numerator)

$$\left(1 + (1+\underline{b}) \frac{\alpha}{k} \frac{dk}{d\underline{b}} \right) \left(\theta^g + \underline{b} \frac{w}{r} \right) > (1+\underline{b}) \left(\frac{w}{r} + \underline{b} \left(\frac{1-\alpha}{\alpha} \right) \frac{dk}{d\underline{b}} \right) \quad (29)$$

(replace $\frac{\alpha}{k} = \frac{r}{w}(1-\alpha)$)

$$\left(1 + (1+\underline{b}) \frac{r}{w}(1-\alpha) \frac{dk}{d\underline{b}} \right) \left(\theta^g + \underline{b} \frac{w}{r} \right) > (1+\underline{b}) \left(\frac{w}{r} + \underline{b} \left(\frac{1-\alpha}{\alpha} \right) \frac{dk}{d\underline{b}} \right) \quad (30)$$

(gather terms in $\frac{dk}{d\underline{b}}$)

$$(1+\underline{b})(1-\alpha) \left(\theta^g \frac{r}{w} + \underline{b} - \frac{\underline{b}}{\alpha} \right) \frac{dk}{d\underline{b}} > \frac{w}{r} - \theta^g \quad (31)$$

(simplify)

$$(1+\underline{b})(1-\alpha) \left(\theta^g \frac{r}{w} - \left(\frac{1-\alpha}{\alpha} \right) \underline{b} \right) \frac{dk}{d\underline{b}} > \frac{w}{r} - \theta^g \quad (32)$$

Now, at $\underline{b} = b_M$, we have $RHS = 0$. If $LHS > 0$, we know $\frac{dn}{d\underline{b}} > 0$. Since $\frac{dk}{d\underline{b}} > 0$ and $\underline{b} < 1$, $LHS > 0$ iff

$$\theta^g \frac{r}{w} > \left(\frac{1-\alpha}{\alpha} \right) \underline{b}$$

At $\underline{b} = b_M = \frac{\gamma\alpha - \beta(1-\alpha)}{(1-\alpha)(\beta+\gamma)}$, this is

$$1 > \left(\frac{1-\alpha}{\alpha} \right) \frac{\gamma\alpha - \beta(1-\alpha)}{(1-\alpha)(\beta+\gamma)}$$

$$1 > \frac{\gamma\alpha - \beta(1-\alpha)}{\alpha(\beta+\gamma)}$$

$$\alpha(\beta + \gamma) > \gamma\alpha - \beta(1 - \alpha)$$

$$0 > -\beta$$

which is true by assumption.

On the other hand $\frac{dn}{d\underline{b}} < 0$ iff numerator < 0

(cancel w in every term in numerator)

(replace $\frac{\alpha}{k} = \frac{r}{w}(1 - \alpha)$)

(gather terms in $\frac{dk}{d\underline{b}}$)

(simplify)

$$(1 + \underline{b})(1 - \alpha) \left(\theta^g \frac{r}{w} - \left(\frac{1 - \alpha}{\alpha} \right) \underline{b} \right) \frac{dk}{d\underline{b}} < \frac{w}{r} - \theta^g \quad (33)$$

Now, at $\underline{b} = b_P > b_M$, we have $RHS > 0$. If $LHS < 0$, we know $\frac{dn}{d\underline{b}} < 0$. Since $\frac{dk}{d\underline{b}} > 0$ and $\underline{b} < 1$, $LHS < 0$ iff

$$\theta^g \frac{r}{w} < \left(\frac{1 - \alpha}{\alpha} \right) \underline{b}$$

Or, since $\frac{r}{w} = \frac{\alpha}{(1 - \alpha)k}$

$$\theta^g \frac{\alpha}{(1 - \alpha)k} < \left(\frac{1 - \alpha}{\alpha} \right) \underline{b}$$

Or, since $k = \left(\frac{\alpha}{1 - \alpha} \right) \frac{\beta\theta^g}{\frac{\gamma\alpha}{1 - \alpha} - (\beta + \gamma)\underline{b}}$

$$\frac{\gamma\alpha}{1 - \alpha} - (\beta + \gamma)\underline{b} < \beta \left(\frac{1 - \alpha}{\alpha} \right) \underline{b}$$

Simplifying

$$\frac{\gamma\alpha^2}{1 - \alpha} < (\alpha\gamma + \beta)\underline{b}$$

At $\underline{b} = b_P = \frac{\alpha(1 + 2\beta + \gamma) - \beta}{(1 - \alpha)(1 + 2\beta + \gamma)}$, this is

$$\frac{\gamma\alpha^2}{1 - \alpha} < (\alpha\gamma + \beta) \frac{\alpha(1 + 2\beta + \gamma) - \beta}{(1 - \alpha)(1 + 2\beta + \gamma)}$$

$$\gamma\alpha^2(1 + 2\beta + \gamma) < (\alpha\gamma + \beta)\alpha(1 + 2\beta + \gamma) - (\alpha\gamma + \beta)\beta$$

$$0 < \beta\alpha(1 + 2\beta + \gamma) - (\alpha\gamma + \beta)\beta$$

$$0 < \alpha(1 + 2\beta + \gamma) - (\alpha\gamma + \beta)$$

$$0 < \alpha(1 + 2\beta) - \beta$$

$$0 < \alpha(1 + \beta) - (1 - \alpha)\beta$$

$$\alpha(1 + \beta) > (1 - \alpha)\beta$$

$$\frac{\alpha}{1 - \alpha} > \frac{\beta}{1 + \beta}$$

C Comparative statics of the capital-labor ratio with a CES production function—goods cost case

In the log utility case, we derive an equation that characterizes the equilibrium capital stock when parents are transfer constrained. Using equation (18), the first-order conditions for the firm and capital market clearing in the budget constraint when old, we get

$$\beta\theta_s^g \frac{F_K(\hat{k}_{s+1}, 1)}{F_L(k_{s+1}, 1)} + (\beta + \gamma)\underline{b}_{s+1} = \gamma\hat{k}_{s+1} \frac{F_K(\hat{k}_{s+1}, 1)}{F_L(k_{s+1}, 1)}. \quad (34)$$

Suppose $F(K_t, L_t) = A[\alpha K_t^\rho + (1 - \alpha)L_t^\rho]^{\frac{1}{\rho}}$. In this case, we have

$$w_t = F_L(k_t, 1) = A(1 - \alpha)[\alpha k_t^\rho + (1 - \alpha)]^{\frac{1-\rho}{\rho}}$$

$$r_t = F_K(k_t, 1) = A\alpha[\alpha + (1 - \alpha)k_t^{-\rho}]^{\frac{1-\rho}{\rho}} = A\alpha[\alpha k_t^\rho + (1 - \alpha)]^{\frac{1-\rho}{\rho}} k_t^{\rho-1}$$

where $k_t \equiv \frac{K_t}{L_t}$. Using this in equation (34), we get

$$\beta\theta_s^g \left(\frac{\alpha}{1 - \alpha} \right) k_{t+1}^{\rho-1} + (\beta + \gamma)\underline{b}_{t+1} = \gamma \left(\frac{\alpha}{1 - \alpha} \right) \hat{k}_{t+1}^\rho.$$

Since $\rho < 1$, the LHS of this equation is always decreasing in $\hat{k}_{t+1}$. The RHS is

- increasing in $\hat{k}_{t+1}$ if $\rho > 0$ (substitutes case);
- independent of $\hat{k}_{t+1}$ if $\rho = 0$ (the Cobb-Douglas Case);
- decreasing in $\hat{k}_{t+1}$ if $\rho < 0$ (complements case).

Now, an increase in $\underline{b}_{t+1}$ shifts the LHS up. As long as the RHS is either weakly increasing ($\rho \geq 0$) or decreasing but less steep than the LHS ($\gamma\rho\hat{k}_{t+1} > -\beta\theta_t^g(1 - \rho)$), we have $\frac{d\hat{k}_{t+1}}{d\underline{b}_{t+1}} > 0$. To see this formally, take the total derivative to get

$$\frac{d\hat{k}_{t+1}}{d\underline{b}_{t+1}} = \frac{\beta + \gamma}{\hat{k}_{t+1}^{\rho-2} \left(\frac{\alpha}{1 - \alpha} \right) \left(\gamma\rho\hat{k}_{t+1} + \beta\theta_t^g(1 - \rho) \right)}$$

Thus $\frac{d\hat{k}_{t+1}}{db_{t+1}} > 0$ if and only if

$$\gamma\rho\hat{k}_{t+1} > -\beta\theta_t^g(1-\rho). \quad (35)$$

Similarly, we can show that under PAYG,

$$\frac{d\hat{k}_{t+1}}{d\tau_{t+1}} = -\frac{\gamma}{\hat{k}_{t+1}^{\rho-2} \left(\frac{\alpha}{1-\alpha}\right) \left(\gamma\rho\hat{k}_{t+1} + \beta\theta_t^g(1-\rho)\right)}.$$

Thus, $\frac{d\hat{k}_{t+1}}{d\tau_{t+1}^F} < 0$ if and only if condition (35) holds. Finally, we can show that under FDPAYG,

$$\frac{d\hat{k}_{t+1}}{d\tau_{t+1}^F} = -\frac{\beta + \gamma}{\hat{k}_{t+1}^{\rho-2} \left(\frac{\alpha}{1-\alpha}\right) \left(\gamma\rho\hat{k}_{t+1} + \beta\theta_t^g(1-\rho)\right)} = -\frac{d\hat{k}_{t+1}}{db_{t+1}}.$$

Thus, $\frac{d\hat{k}_{t+1}}{d\tau_{t+1}^F} < 0$ if and only if condition (35) holds.

D Comparative statics of fertility with a CES utility function—time cost case

As in the main text, first, derive the present value budget constraint by substituting out s_{t+1} in equations (21) and (22). Assuming a CES utility function of the form $u(x) = \frac{x^{1-\sigma}-1}{1-\sigma}$, equations (18) and (19) are

$$\gamma^{1/\sigma} c_t^m = n_t \left(\theta_t^l w_t (1 + b_t) + b_{t+1} \frac{w_{t+1}}{r_{t+1}} (1 - \theta_{t+1}^l n_{t+1}) \right)^{1/\sigma} \quad (36)$$

$$c_{t+1}^o = (\beta r_{t+1})^{1/\sigma} c_t^m. \quad (37)$$

To simplify the expressions below, let $\mathcal{C} \equiv \theta_t^l w_t (1 + b_t) + b_{t+1} \frac{w_{t+1}}{r_{t+1}} (1 - \theta_{t+1}^l n_{t+1})$ denote the net cost of children. Using equations (36) and (37) in the present value budget constraint, we get

$$c_t^m = \frac{w_t(1 + b_t)}{1 + \beta^{1/\sigma} r_{t+1}^{\frac{1-\sigma}{\sigma}} + \gamma^{1/\sigma} \mathcal{C}^{\frac{\sigma-1}{\sigma}}}.$$

Using this in equation (36) again, the expression for fertility is

$$n_t = \left(\frac{\gamma^{1/\sigma}}{1 + \beta^{1/\sigma} r_{t+1}^{\frac{1-\sigma}{\sigma}} + \gamma^{1/\sigma} \mathcal{C}^{\frac{\sigma-1}{\sigma}}} \right) \frac{w_t(1 + b_t)}{\mathcal{C}^{1/\sigma}} \quad (38)$$

What we are interested in here is how income and substitution effect from a change in $\underline{b}_t$ affect generations $t > 0$ over and above the effect of $\underline{b}_{t+1}$, which also affects generation s . To gain some insights, consider the following thought experiment. As per our historical account, suppose $\underline{b}_{t+1} = 0$, while we are considering the effects of a marginal change in $\underline{b}_t$.

In this case, the expression for fertility can be written as:

$$n_t = \frac{1}{(\theta^l)^{1/\sigma}} \left(\frac{\gamma^{1/\sigma}}{\left(1 + \beta^{1/\sigma} r_{t+1}^{\frac{1-\sigma}{\sigma}}\right) (w_t(1 + \underline{b}_t))^{\frac{1-\sigma}{\sigma}} + \gamma^{1/\sigma} (\theta^l)^{\frac{\sigma-1}{\sigma}}} \right) \quad (39)$$

Holding r_{t+1} fixed, the effect of the increase in $w_t(1 + \underline{b}_t)$ due to an increase in $\underline{b}_t$ is as follows: if $\sigma > 1$ the income effect dominates and, hence, we get similar results as in the goods cost case, while if $\sigma < 1$ the substitution effect dominates and the first-order effect is reinforced for generations $t > s$.

Generally speaking, however, unlike in the goods cost case, r_{t+1} is not independent of $\underline{b}_t$. If an increase in $\underline{b}_t$ generates an increase in the capital-labor ratio in period $t + 1$, then $\frac{dr_{t+1}}{d\underline{b}_t} < 0$ and the income and substitution effects from the increase in $w_t(1 + \underline{b}_t)$ are dampened by the adjustment of the interest rate, and vice versa.