

Strulik, Holger

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Higher education and the income-fertility nexus

Holger Strulik¹ 

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Abstract

Fertility and income are negatively related at the aggregate level. However, evidence from recent periods suggests that increasing income leads to higher fertility at the individual level. In this paper, I provide a simple theory that resolves the apparent contradiction. I consider the education and fertility choices of individuals with different learning abilities. Acquiring higher education requires an investment of time and income. As a result, people with higher education have fewer children but, controlling for the level of education, increasing income leads to higher fertility. Rising income and skill premiums motivate more people to pursue higher education, resulting in a negative income-fertility association at the aggregate level. I investigate the explanatory power of the theory in a model calibrated for the US during 1950–2010.

Keywords Fertility · Income · Education · Skill premium · Inequality

JEL Classification I23 · J11 · J22 · J24 · O15

1 Introduction

It is a well-known stylized fact of economic development that the average number of children per family declines as average income per capita grows (e.g., Galor 2011; Guinnane 2011; Herzer et al. 2012). The association at the aggregate level seems to indicate that parents respond to increasing income with lower fertility, and since (Becker 1960) economists have searched for theories that explain the negative income-fertility nexus at the individual level (i.e., at the family level).

In this paper, I propose an alternative channel that explains a negative income-fertility nexus at the *aggregate* level although the relationship is mildly positive at

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✉ Holger Strulik
holger.strulik@wiwi.uni-goettingen.de

¹ Department of Economics, University of Göttingen, Platz der Göttinger Sieben 3, Göttingen 37073, Germany

the *individual* level. By aggregate level, I mean that the proposed model explains a negative relationship between fertility and income in the cross-section of a population as well as a negative relationship between a population's average fertility and income over time. These results are derived as composition effects of a model society, in which young adults are heterogeneous in terms of their abilities and thus in the effort required for higher education. This implies, depending on the level of income and the skill premium, a stratification of society into low-skilled and high-skilled individuals. Due to the time investment for higher education, high-skilled individuals face higher opportunity costs of fertility and have fewer children. Across educational groups, fertility is therefore negatively associated with income. Within the group of high-skilled individuals, however, higher income leads to higher fertility because it reduces the relative cost of education and therewith releases resources that can be allocated for children and consumption. I show that the negative composition effect dominates the individually positive income effect such that increasing average income and increasing skill premiums lead to declining average fertility in society.

Following most of the related literature, the theory focuses on a unisex model and neglects (complementary) channels that operate through the division of household chores and female labor force participation. This simplification seems justified because, as argued in Jones et al. (2010), the main challenge is to explain the strong negative association of fertility with *male* income in cross-sectional studies. The theory focuses on economies where primary education and large parts of secondary education are compulsory and considers the decision of young adults about their *own* higher education. It complements theories in which *parents* determine the education of their children jointly with their fertility decision. While these theories consider mostly the takeoff of economic growth and the onset of the fertility transition (e.g., Galor and Weil 2000; Galor and Moav 2002; Madsen and Strulik 2023), the theory proposed here examines the trade-off between education and fertility at a more advanced stage of development.

The paper is related to three strands of literature: theoretical studies attempting to explain a negative impact of income on fertility, empirical studies demonstrating that the relationship between income and fertility is positive at the individual level, and a recent literature arguing that the relationship between income and fertility has faltered or even reversed in some economically advanced countries in the twenty-first century. In the next three paragraphs, I explain how my study relates to these literatures.

The extensive theoretical literature on a causally negative influence of income on fertility at the level of individuals or families has been reviewed by Jones et al. (2010). Their careful analysis shows that a common channel of most theories is based on the time-intensity of childbearing and rearing. However, to generate a negative income-fertility nexus, the time cost channel requires a high degree of substitution between consumption and children. For example, a conventional utility function with additive and logarithmic subutility functions would not suffice to generate the result. The canonical model of unified growth theory therefore argues that the income-fertility correlation is spurious and that both variables are determined by technological change (Galor 2011). Here, I propose an alternative explanation that complements the unified growth channel. I omit the negative impact of income on fertility at the individual level and show that, in a population of heterogeneous individuals, there exists a negative

impact of income on fertility at the aggregate level, i.e., on average fertility over time and across individuals at a given time.

The paper also draws on the empirical literature that argues for a positive causal effect of (male) income on fertility using the exogeneity of labor market shocks. For example, the study by Lindo (2010) shows that a temporary job displacement of the husband has a permanently negative influence on fertility. The study argues for a positive causal influence of income on fertility observed in a sample of US American households for which the income-fertility nexus is negative in the cross-section. Black et al. (2013) show that the fertility of married American couples is positively associated with the husband's income within groups of women with similar levels of education and that positive income shocks in the energy sector are associated with higher fertility. The theory proposed here explains how the findings of a positive impact of income on fertility at the individual level can be consistent with a negative impact of (male) income on fertility in the cross-section and with the observation that average fertility declines with increasing income per capita.

Finally, the paper is related to a recent literature observing that the negative income-fertility relationship has flattened since the 1980s in the US and some other developed countries and uses this observation (and other trends) as motivation to develop new economic theories of fertility (Doepke et al. 2022). These new theories focus on the interaction between women's career choices and fertility. For example, Hazan and Zoabi (2015) show how the marketization of child care can explain why fertility is increasing with the level of education for women with advanced degrees of education. Bar et al. (2018) show that the marketization mechanism can explain the flattening of the income-fertility profile. While the present work is not intended to contribute to this literature, its predictions are consistent with the observation of a decreasing income-fertility gradient over time. The compositional effect on fertility is generated by the increasing enrolment in higher education, which is in turn motivated by increasing wages for high-skilled work. The composition effect thus disappears when the proportion of highly educated people stops growing. Recent evidence suggests that the process of increasing higher education slowed down and may have reached a plateau. For example, the proportion of 18- to 24-year-olds enrolling in college rose from 25.7% in 1970 to 41.2% in 2010 and has remained around that level ever since (NCES 2023). When the share of college graduates is constant, the only remaining income effect in the model operates at the individual level and leads to the prediction of (slightly) increasing fertility with rising income within the group of highly educated individuals.

The remainder of the paper is structured as follows. In Sect. 2, I set up the model and derive the main analytical results. In Sect. 3, I calibrate the model with the US data and explore the quantitative power of the proposed theory in explaining the fertility decline over the period 1950–2010 and compute the implied income elasticities of fertility at the micro- and macro-level. Section 4 concludes the paper. Appendix C discusses an extended model, in which parents have a motive to invest in child quality. It is shown that the extended model generates a child quantity-quality trade-off and preserves all results from the basic model. Appendix D discusses an extended model, in which fertility decisions are made by a couple. It is shown that the elasticity of

fertility with respect to male income shocks can be much larger than predicted for the basic model when men contribute little to child-rearing time.

2 The model

Consider an economy that is populated by a non-overlapping population of adult individuals. Individuals live for one period of time as adults. During this period, they work, consume, have children, and may or may not obtain higher education. At any period t , any individual i chooses consumption $c_t(i)$ and the number of children $n_t(i)$ to maximize utility

$$U_t(i) = \log c_t(i) + \alpha \log n_t(i), \quad (1)$$

in which α denotes the weight of children in utility. Following the conventional literature, n_t is conceptualized as a continuous variable. Individuals share the same utility function but differ in their education and income.

All individuals have completed compulsory schooling, which can be upgraded through voluntary higher education. Higher education is modeled as a binary choice (e.g., obtain a college degree or not). Formally, the level of education chosen by individual i at time t is denoted by $h_t(i) \in \{0, 1\}$. The wage of individuals depends on the level of education and time, $w(h_t, t)$ with $w(0, t) \equiv w_{Lt}$, $w(1, t) \equiv w_{Ht}$. Individuals with only compulsory education are considered to be low-skilled. The skill premium is given by $s_t \equiv w_{Ht}/w_{Lt}$. Technological progress is implicitly captured by the influence of time on wages. Skill-biased technological progress is characterized by increasing wages and increasing skill premium.

Individuals have different abilities, and those with higher learning abilities need less effort to achieve higher education. Effort is conceptualized as the time cost of higher education such that individual i requires $\epsilon e(i)$ units of time to attain higher education, in which the parameter $\epsilon > 0$ captures the average time cost of education. Applying Occam's razor, I assume that individuals are identical in all other aspects. Higher education also requires an investment of κ units of income, and raising a child needs τ units of time. Individuals are endowed with one unit of time, and the time not spent on child rearing and education is supplied as wage work. The budget constraint of individual i is therefore given by the following:

$$w_t(h_t(i), t) [1 - \tau n_t(i) - \epsilon e(i)h_t(i)] = c_t(i) + \kappa h_t(i). \quad (2)$$

Solving the household problem for a given level of education leads to the optimal choices:

$$c_t(i) = \left[1 - \epsilon e(i)h_t(i) - \frac{\kappa h_t(i)}{w(h_t(i), t)} \right] \frac{w(h_t(i), t)}{1 + \alpha} \quad (3)$$

$$n_t(i) = \left[1 - \epsilon e(i)h_t(i) - \frac{\kappa h_t(i)}{w(h_t(i), t)} \right] \frac{\alpha}{(1 + \alpha)\tau}. \quad (4)$$

Proposition 1 (i) *Controlling for education, fertility is positively associated with income among high-skilled individuals and independent from income among low-*

skilled individuals. (ii) Across educational groups, fertility is negatively associated with education and income.

Claim (i) is verified by inspecting $\partial n_t(i)/\partial w(h_t(i), t) > 0$ in Eq. 4. Claim (ii) is verified by comparing Eq. (4) for high- and low-skilled individuals. The model thus replicates the stylized facts of a negative association of fertility with parental education (e.g., Hazan and Zoabi 2015, who show that fertility declines with female education up to women with some college education), a negative association of fertility and income in the cross-section (e.g., Jones et al. 2010), and a positive impact of income on fertility at the individual level (Lindo 2010; Black et al. 2013). The reason is that richer individuals can more easily afford the costs of higher education, which releases some resources that can be allocated for children and consumption. The inclusion of a fixed cost of children could create another channel through which fertility would be positively related to income for both high-skilled and low-skilled individuals. This feature is omitted for simplicity and because the evidence mainly supports a positive association between fertility and income for mothers with higher education (Black et al. 2013).

In the simple one-period model, the direct trade-off between time spent on children and higher education captures in reduced form a trade-off that is more complex and indirect in reality and includes the timing of fertility. For example, individuals may choose to complete their education before starting a family.

Individuals obtain higher education if utility with higher education exceeds utility without higher education, i.e., if $\Delta U_t(i) \equiv U_t(i)|_{h_t(i)=1} - U_t(i)|_{h_t(i)=0} > 0$. Inserting Eqs. 3 and 4 and education-specific wages into Eq. 1, the condition becomes as follows:

$$\Delta U_t(i) = \log \left(\frac{w_{Ht}}{w_{Lt}} \right) + (1 + \alpha) \log \left[1 - \epsilon e(i) - \frac{\kappa}{w_{Ht}} \right] > 0.$$

Thus, individual i obtains higher education if

$$\theta_t \equiv \frac{1}{\epsilon} \left[1 - (s_t)^{-\frac{1}{1+\alpha}} - \frac{\kappa}{w_{Ht}} \right] > e(i), \quad (5)$$

in which θ_t denotes the effort threshold below which individuals obtain higher education. Condition Eq. (5) shows that a rising wage for skilled labor or a rising skill premium s_t increases the incentive to acquire higher education. In order to obtain a simple analytical solution for average fertility, I assume that $e(i)$ is uniformly distributed in $(0, 1)$ and focus on an interior solution where some individuals are low-skilled and some are high-skilled, i.e., $\theta \in (0, 1)$. It then follows from Eq. 5 that the share of high-skilled individuals in society is given by θ_t . Inspection of Eq. 5 shows that a rising high-skilled wage or a rising skill premium leads to a larger share of high-skilled individuals.

From Eq. 4, fertility of low-skilled individuals is obtained as $n_L = \alpha/[(1 + \alpha)\tau]$, and average fertility of high-skilled individuals is obtained as follows:

$$n_{Ht} = \frac{1}{\theta_t} \int_0^{\theta_t} \frac{\alpha}{(1 + \alpha)\tau} \left(1 - \epsilon e(i) - \frac{\kappa}{w_{Ht}} \right) de(i) = n_L - n_L \left(\frac{\kappa}{w_{Ht}} + \frac{\epsilon \theta_t}{2} \right). \quad (6)$$

The implied average fertility level in society is

$$n_t = \theta_t n_{Ht} + (1 - \theta_t) n_L = n_L - n_L \left(\frac{\kappa \theta_t}{w_{Ht}} + \frac{\epsilon \theta_t^2}{2} \right). \quad (7)$$

Finally, inserting θ_t from Eqs. 5 into 7, the closed-form solution for average fertility is obtained as follows:

$$n_t = n_L - \frac{n_L}{2\epsilon} \left\{ \left[1 - (s_t)^{-\frac{1}{1+\alpha}} \right]^2 - \left(\frac{\kappa}{w_{Ht}} \right)^2 \right\}. \quad (8)$$

Proposition 2 *Average fertility in society declines with rising (high-skilled) income and rising skill premium.*

The proof follows from taking the derivative of Eq. 8 with respect to w_{Ht} and s_t . The theory explains why increasing income affects fertility positively at the individual level and negatively at the aggregate level. The reason is that increasing high-skilled wages and an increasing skill premium motivate more individuals to obtain higher education and better-educated individuals have fewer children because education increases the opportunity cost of having children.

3 Quantitative assessment

The theory motivates a negative impact of income on fertility at the aggregate level. But does it have *quantitative* explanatory power for the actually observed fertility decline? In order to address this question, I focus on the period 1950–2010 in the US, for which data is available at 10-year intervals. A calibration of the simple model requires the strong assumption that every decade is populated by a “characteristic cohort” that completes their education and fertility in this decade and has no feedback effects on other cohorts or the macro-economy. During the period 1950–2010, the population share with completed high school or college education rose from 34.3 to 87.1% while the share with 4 or more years of college rose from 6.2 to 29.9% (Census Bureau 2021). An exclusive focus on college education would thus miss a large part of the increase in voluntary education. In order to consider both the non-compulsory part of high school education and college education, I compute the skill premium as a weighted average, $s_t = (1 - \omega_t) s_t^H + \omega_t s_t^C$, where s_t^H is the high school graduate wage premium, s_t^C is the college graduate wage premium, and the weight ω_t is the share of those with high school graduation who also have 4 or more years of college. The population shares are obtained from Census Bureau (2021), and the skill premia are obtained from Goldin and Katz (2007). The data point for 2010 is obtained from extrapolation (since the Goldin–Katz data ends in 2005). The resulting time series is shown in the upper left panel of Fig. 1.

I normalize the initial value of the high-skilled wage to 1 and assume that w_{Ht} grows at the same rate as GDP per capita. The growth rate of GDP per capita is calculated

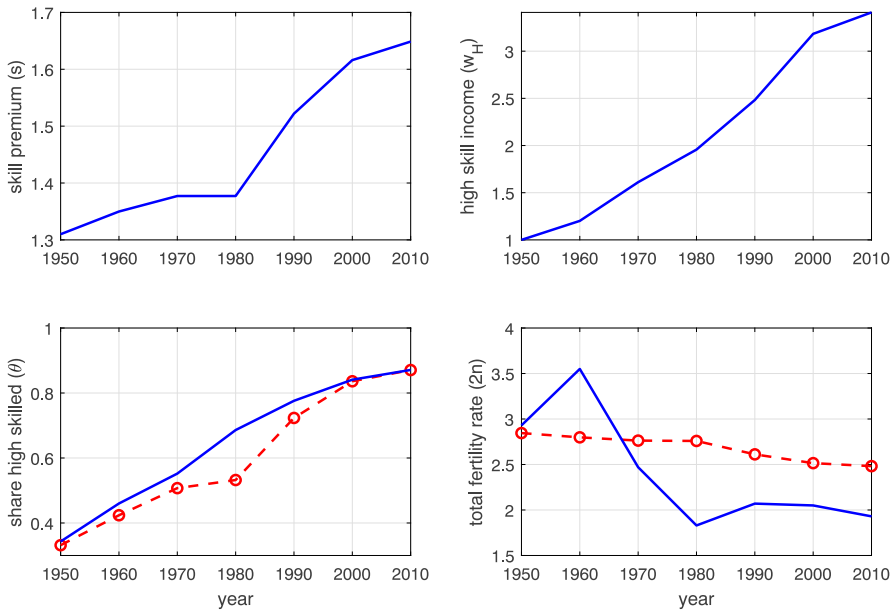


Fig. 1 Income, inequality, and fertility: 1950–2010. Blue (solid) lines: data (see text for sources and construction). Red (circled) lines: model prediction. The model is calibrated to provide the best fit of the θ_t time series. The fertility series is predicted with no degrees of freedom

from the Penn World Table (Feenstra et al. 2015). The implied series of income is shown in the upper right panel of Fig. 1.

The series of w_{Ht} and s_t are fed into the model, and the parameters ϵ and κ are calibrated such that the model's prediction of θ_t provides the best fit of the actual share of high-skilled individuals. This provides the estimates $\epsilon = 0.36$ and $\kappa = 0.07$. The calibrated value of κ implies that individuals in the year 2010 are predicted to spend on average 1.9% of their income on education. This non-targeted prediction agrees with the actual GDP share of private education expenditure of 1.9% in 2010 (OECD, 2023).

I set the time cost of a child τ to 0.125 and then calibrate the utility weight α such that the model's prediction for average fertility fits the actual fertility rate in 1950. This leads to the estimate $\alpha = 0.17$. It implies that low-skilled individuals have 1.5 children, i.e., 3 children per 2 adults. The time cost of children coincides with its recent calibration in Jones et al. (2010), which appears to be in the medium range of values considered in the related literature. For example, Greenwood and Seshadri (2002) assume a time cost of 0.10 for raising a child and endowing it with skills whereas Lagerloef (2006), in his calibration of the Galor and Weil (2000) model, assumes a fixed time cost (net of education) of 0.15. I meet the associated parameter uncertainty by showing the robustness of results to (much) higher or lower time costs than in the benchmark specification. Table A.1 in the Appendix summarizes the calibration procedure.

The predicted θ_t series is shown by the red circled line in the lower left panel of Fig. 1. For comparison, the blue solid line shows the share of high-skilled individuals according to the data (calculated as described above). Summarizing, the high-skilled wage increased by a factor of 3 from 1950 to 2010, the average skill premium increased from 1.3 to 1.65, and the share of high-skilled individuals increased from 34.3 to 87.1%. With no degrees of freedom left, the model is used to predict the time path of average fertility.

The red circled line in the lower right panel shows the predicted $2n_t$. Fertility per adult is multiplied by two in order to compare the prediction with the data for the total fertility rate (children per woman). The actual TFR is taken from UN (2022) and shown by the solid blue line. Naturally, the model cannot predict the fertility boom of the 1950s, but it correctly captures the secular trend of declining fertility. However, the actual decline of fertility was steeper than predicted by the model. The model explains about 33% of the actual fertility decline from 1950 to 2010.¹

Next, I use the explained share of the fertility decline as a simple statistic in a sensitivity analysis. I also use these numerical experiments to calculate some interesting income elasticities of fertility. Results are shown in Table 1. The first line reports results for the benchmark calibration. Columns (1) and (2) show the implied income elasticity of fertility for two different individuals with effort level $e(i)$ of 0.6 and 0.1. The micro elasticities of Table 1 are calculated with the skill premium of the year 2000. Before 1975, individuals with an effort level of 0.6 would not obtain a high school degree (see lower left panel of Fig. 1). The micro-level elasticities are positive (cf. Proposition 1) and in the range of 0.08 and 0.12. These values are relatively small when compared with the income elasticities estimated by Black et al. (2013) and other related micro studies. For example, Black et al., (2013, Table 3) estimate an income elasticity of about 0.35 when housing costs and location fixed effects are taken into account. However, it should be noted that in this literature, elasticities are estimated with respect to male income, which would approximate the pure income effect (net of substitution) if men contribute a negligible share to child-rearing costs.

In the present model, children are normal goods by assumption, and the pure income elasticity (net of the substitution effect) is 1.0 by construction due to the simple log form of the utility function. In order to relate better to the micro literature, I discuss in Appendix D an extended model set up for the fertility decision of a couple. Under the simplifying assumption of no wage discrimination in the labor market and perfect assortative mating according to ability, the model is a scaled-up version of the basic model and the distribution of child-rearing costs within the family can be set exogenously (for example, determined by social norms). I then investigate an unexpected shock in male income and compute the elasticity of fertility with respect to male income w_{jt}^M , defined as $(\partial n_{jt} / \partial w_{jt}^M)(w_{Lt}^M / n_{Lt})$, in which $j \in \{L, H\}$ denotes the skill level of the couple and n_{jt} is fertility of the couple. The elasticities are derived

¹ It has been argued that the fertility boom can be explained by a temporary decrease in the opportunity cost of fertility after World War II (Doepke et al. 2015). In the Appendix, I implement this idea in a reduced form and add a fertility boom to the model, which is explained by a reduction and subsequent increase in the time costs of children. This variant of the model results in a much better fit of the actual fertility curve, while still preserving, of course, that about a third of the decline in fertility is explained by the composition effect.

Table 1 Income elasticities and predicted fertility decline: US 1950–2010

Case	Inc. elasticity mic ($\epsilon = 0.6$) (1)	Inc. elasticity mic ($\epsilon = 0.1$) (2)	Inc. elasticity mac (time) (3)	Inc. elasticity mac (cross) (4)	% Δ fertility explained (5)
1) Benchmark	+0.12	+0.08	-0.07	-0.53	32.3
2) $\tau = 0.2$	+0.08	+0.07	-0.06	-0.46	28.5
3) $\tau = 0.05$	+0.14	+0.10	-0.08	-0.63	36.3
4) $\alpha = 0.35$	+0.09	+0.07	-0.06	-0.50	42.0
5) $\alpha = 0.15$	+0.11	+0.09	-0.07	-0.57	24.1
6) $w_{Ht} = w_{1950}$	+0.11	+0.08	n.a	-0.53	30.0
7) $s_t = s_{1950}$	+0.11	+0.08	-0.02	-0.53	2.0
8) Only college	+1.15	+0.21	-0.07	-0.71	17.0

Columns (1) and (2) show the implied income elasticity of fertility of individuals with effort levels of 0.6 and 0.1. Column (3) shows the implied long-run income elasticity of income during 1950–2010. Column (4) shows the implied income elasticity of a cross-section of 1000 individuals in the year 2000. Column (5) shows the percent of the actual fertility decline during 1950–2010 that is explained by the model. See text for description of scenarios 2)–7)

in Appendix D as equation (A.9) and (A.12) for low- and high-skilled couples. For the parameter values as for the basic model, I obtain an income elasticity of 0.35 when men contribute 15% to child-rearing costs. For couples with higher education, the income elasticity is slightly larger than for couples without higher education.

Column (3) of Table 1 shows the implied long-run income elasticity of average fertility (computed at the GDP levels of 1950 and 2010). The elasticity is negative (cf. Proposition 2) albeit relatively small. Column (4) shows the implied elasticity in a cross-section of 1000 simulated individuals with random effort level $e(i)$ in the year 2000. The elasticity is negative, showing that the negative income effect on fertility due to selection into education dominates the positive income effect within educational groups. The predicted elasticity is -0.53 and therewith larger than the cross-sectional elasticities of around -0.3% estimated in Jones et al. (2010). Finally, column (5) shows that the benchmark model can motivate about one-third of the actual fertility decline from 1950 to 2010.

Results for substantially higher and lower time costs of fertility are reported in rows 2) and 3) of Table 1. In these experiments, the utility weight on children α is recalibrated to fit the initial level of average fertility, and the education cost parameters ϵ and κ are recalibrated to fit the time path of θ_t . A higher value of τ (and thus a higher value of α) leads to the prediction of lower income elasticities and a slightly lower explanatory power of the composition effect for the fertility decline.

Results for direct changes of the utility weight of children α are reported in rows 4) and 5). In these cases, τ has not been recalibrated to allow different numerical experiments to cases 2) and 3). With τ kept at benchmark level, a higher α means that the model overpredicts initial fertility. The education cost parameters ϵ and κ , however, are recalibrated to fit the time path of θ_t . A higher value of α is associated with slightly smaller income elasticities (as in case 2) but a larger predicted fertility decline. The fertility decline is larger because the level of fertility is higher (see Eq. 8).

According to the model, both a rising skill premium and a rising high-skilled wage motivate an increasing share of people to pursue higher education and to reduce their fertility. But how big are the income level effect and the income inequality effect? To answer this question, rows 6) and 7) report results from a decomposition exercise. When high-skilled wages are held constant, the increasing skill premium motivates a fertility decline of 30% (row 6) whereas when the skill premium is held constant, rising wages motivate a fertility decline of 2% (row 7). Thus, most of the composition effect originates from the rising skill premium. In other words, the composition effect provides a negative income elasticity of fertility at the macro-level because high-skilled income is rising faster than low-skilled income.

The final numerical exercise determines how much of the fertility decline can be motivated by college education alone. For that, I counterfactually assume that obtaining a high school degree is compulsory, and thus, 100% (instead of 35%) of Americans had a high school degree in 1950. Being high-skilled is now defined as college graduation, which increased from 6.2 to 29.9% from 1950 to 2010. Thus, there is much less variation of θ_t . I feed into the model the college premium as time series for s_t and fit the time series of θ , which is now the share of college graduates. The calibration leads to much higher estimated costs of education; ϵ increases from 0.36 to 1.20, and

κ increases from 0.07 to 0.15. As a result, the predicted income elasticities are much higher than before. The very high micro elasticity reported for the individual with effort level $e(i) = 0.6$ is purely hypothetical since this individual will never obtain a college degree for the observed income and inequality levels. Because there is less variation in θ , the composition effect is less powerful. While the model still explains a significant part of the decline in fertility of 17% (instead of 32%), it also suggests that the American high school movement was an important contributor to the fertility transition.

In Appendix E, I provide an extension of the model that treats ϵ and κ as time-varying and differentiates between costs and effort of graduating from high school and college. The calibrated time path for ϵ implies that education effort increased by 13% from 1950 to 2010. The calibrated time path for κ implies that the expenditure share for education increased by 55% from 1950 to 2010, which means that the level of expenditure κw_H grew by a factor of 4.3. This estimate approximates the actual increase of college tuition fees over the considered time period (Hanson 2022). The remaining parameters α and τ are kept at their benchmark values. The results show that the implied income elasticities and the explained part of the fertility transition deviate insignificantly from the results of the benchmark case in Table 1.

4 Conclusion

This paper offered a new theory that explains the negative association of fertility in the cross-section and over time as a composition effect when rising income has a positive effect on fertility at the individual level. The model focused on heterogeneity in terms of learning ability. It should be mentioned, however, that any distribution of idiosyncratic costs of higher education (such as, for example, geographic dispersion of distance to college) could provide similar results. The key mechanism is based on an investment of effort (time) and income for higher education such that people with higher education have fewer children but, controlling for the level of education, increasing income leads to higher fertility. A negative income-fertility nexus at the aggregate level emerges because more people are willing to make the investment in higher education when high-skilled income and the skill premium increase.

For the theory to work, income growth needs to be associated with a significant increase in higher education. This was certainly the case in the second half of the twentieth century, when the US (and many other developed countries) experienced an unprecedented increase in high school graduation rates and college enrollment (Goldin and Katz 2010). As discussed in Section 1, the population share of college graduates seems to approach a plateau in the twenty-first century, which means that the composition effect loses power and contributes to a flattening income gradient of fertility. At the global level, however, the composition effect remains relevant, as many developing countries are only at the beginning of their “high school movement” and the process of college education is far from complete (UNESCO 2020). If these countries follow an educational path similar to that of the United States, the compositional effect will continue to be a major contributor to the global decline in fertility in the twenty-first century.

The model was deliberately kept simple in order to enable a formal proof of the main results. This means that the numerical calibration only provides a rough approximation of reality, especially with regard to the only binary choice of education. The calibration suggests that the proposed channel can explain about a third of the US fertility decline from 1950 to 2010. This result also implies that much remains to be explained by other, complementary theories.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00148-024-01017-8>.

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